DOCUMENTED BRIEFING

Predicting Military Innovation

Jeffrey A. Isaacson, Christopher Layne,
John Arquilla

Arroyo Center

19990405 017

The RAND documented briefing series is a mechanism for timely, easy-to-read reporting of research that has been briefed to the client and possibly to other audiences. Although documented briefings have been formally reviewed, they are not expected to be comprehensive or definitive. In many cases, they represent interim work.

RAND is a nonprofit institution that helps improve policy and decisionmaking through research and analysis. RAND® is a registered trademark. RAND's publications do not necessarily reflect the opinions or policies of its research sponsors.

DOCUMENTED BRIEFING

RAND

Predicting Military Innovation

Jeffrey A. Isaacson, Christopher Layne,
John Arquilla

Prepared for the
United States Army

DB-242-A

Arroyo Center

For more information on the RAND Arroyo Center, contact the
Director of Operations, (310) 393-0411, extension 6500, or visit the
Arroyo Center's Web site at http://www.rand.org/organization/ard/

PREFACE

This documented briefing describes a RAND research effort aimed at understanding and predicting how militaries may improve their battlefield effectiveness. This topic is particularly germane at a time when military technology is increasingly available and affordable.

Diffusing technology may stimulate military modernization. But many militaries suffer deficiencies in their capacity to integrate, or absorb, this technology. For these militaries, improved effectiveness requires more than hardware alone: some level of innovation is required to put the hardware to effective use. At one level, this could mean new warfighting concepts; at another level, reorganized command structures, better doctrine and tactics, improved logistics, or new training techniques may suffice. It is in this light that this documented briefing first analyzes military innovation conceptually and then formulates a preliminary framework for predicting the likelihood of innovative success.

Surely there are different definitions of military innovation, and we do not debate these at length. Moreover, the framework derives from a limited number of case studies, so further research is required to demonstrate its validity and robustness. These caveats notwithstanding, the research we describe synthesizes a broad literature on innovation and provides a useful tool for assessing future military developments.

This research complements current U.S. Army efforts aimed at developing new intelligence methodologies for the post–Cold War era. Because our approach provides indicators for predicting military innovation, the documented briefing should be useful primarily to military intelligence professionals. However, decisionmakers and analysts within the U.S. Army and the Department of Defense, as well as others generally concerned with conventional weapons proliferation, the revolution in military affairs, and the future international security environment should also find this document useful.

CONTENTS

SUMMARY

Although military technology is increasingly available and affordable, not all states have the capacity to improve military effectiveness by acquiring hardware. Indeed, integrative deficiencies—such as inflexible command structures, inappropriate doctrine and tactics, improper training, insufficient support—are quite common in the developing world. For many states, as a result, improving military effectiveness requires some level of innovation—e.g., reorganizing command structures, introducing new doctrine and tactics, modifying training techniques, and improving support.

Given that improved military effectiveness generally requires innovation,[1] what are the key indicators that intelligence analysts can use to predict whether a state is likely to achieve military innovation?

The literature reveals four dominant perspectives that attempt to explain military innovation: structural realist (neorealist), societal, organizational theory, and cultural (both strategic culture and organizational culture). Drawing on these perspectives,[2] we deduce hypotheses on military innovation that are tested in three case studies: the Israeli Defense Forces (1948–1982), the North Vietnamese Army (1965–1970), and the Chaco War (1932–1935).

The cases validate a number of the hypotheses and suggest a set of indicators particularly relevant to military innovation. Structural realist indicators identify factors that determine which states have an *incentive* to innovate militarily. Such factors include the presence of serious external threats, revisionist ambitions, or relative resource constraints. Societal indicators identify some of the factors that a state needs to *facilitate* innovation, the most important of these being societal cohesion. Organizational indicators also indentify factors needed to facilitate innovation, including the existence of "product champions" (senior officers who advocate innovative approaches to warfare) and career paths open to reformers. Recent failure is possibly another organizational indicator.[3]

---

[1]Consistent with the above, we define innovation as follows: For a *specific* military, innovation is manifested by the development of new warfighting concepts and/or new means of integrating technology.

[2]As discussed in the main body of the text, we have refrained from employing the cultural perspective in this work because we are skeptical about the utility of both the strategic and organizational culture approaches. In the authors' view, the cultural perspective has limited predictive power.

[3]The indicators are more probabilistic than deterministic. For example, a cohesive state that has product champions and faces serious external threats is more likely to succeed at military innovation than a divisive state facing no threats. But, of course, the cohesive state may fail to innovate altogether.

By applying these indicators sequentially (structural, societal, organizational), we construct the basis of a preliminary framework for predicting military innovation.[4] Structural realist indicators identify states with incentives to innovate and, depending on relative resource constraints, whether an asymmetric approach to innovation is likely. In addition, the societal indicator identifies militaries likely to extract resources for innovation, and organizational indicators identify states likely to adapt the resources to achieve innovation. But what resources are required for innovation? How must they be adapted to achieve it?

As described thus far, the predictive framework is incomplete because it leaves key questions unanswered. Military strategy completes the framework by helping to define the context for examining these questions. In large measure, it is strategy that connects objective indicators with innovative outcomes. Unfortunately, military strategy is hard to quantify. Compared to tabulating orders of battle or assessing military capabilities, understanding strategy entails a different analytical process utilizing different types of information. But to predict military innovation, we argue, understanding strategy is essential. Generic signposts include prior military strategy, doctrinal writings, exposure to foreign military doctrines, equipment inventories, force deployments, and training exercises.

In conclusion, we have constructed a preliminary framework for predicting military innovation comprising structural realist, societal, and organizational indicators that are applied within a given strategic context. The current international security environment underscores the importance of this context: without an understanding of an opponent's strategy, it is natural to assume he will do what is expected or desired. This is especially dangerous in a world where the asymmetric threat may be the real challenge faced by the U.S. military.

---

[4]The framework derives from a limited number of cases that are insufficient to test it fully. Further research is required to demonstrate the framework's validity and robustness.

ACKNOWLEDGMENTS

ABBREVIATIONS

IAF	Israeli Air Force
IDF	Israeli Defense Forces
NVA	North Vietnamese Army
POL	Petroleum, oil, and lubricants
SAM	Surface-to-air missile

1. INTRODUCTION

> ## Predicting Military Innovation
> ## Is an Important Intelligence Task
>
> * Diffusing technology may stimulate military modernization
>   - Technology is increasingly available and affordable
> * But technology alone does not determine military effectiveness
>   - Integration is required to put it to use
> * Key integrative deficiencies beset most militaries in the developing world
>   - Improving military effectiveness generally requires some level of innovation
>
> Arroyo Center   RAND

The current international security environment puts a premium on predicting military innovation. Diffusing technology has historically provided a stimulus for states to modernize their military forces.[1] As technology becomes increasingly available to a wide range of states—including those not considered advanced, industrial economies—global diffusion, and thus, military modernization, become increasingly likely. Such is the case today.

But technology alone does not determine military effectiveness. Specialized doctrine, tactics, training, and support are generally required to integrate, or absorb, technology into a military organization. In the absence of these integrative factors, technology's full battlefield potential will likely not be realized.

The Iraqi experience in absorbing conventional military technology offers a stark illustration. On the basis of weapons alone, Iraq looked quite formidable in 1990, fielding a large inventory that comprised main battle tanks, armored fighting vehicles, self-propelled artillery, unmanned aerial vehicles, attack helicopters, mobile air defense guns, night vision equipment, and surface-to-surface

---

[1]G. Herrera, Ph.D. dissertation, Princeton University, Princeton, NJ.

missiles.[2] In the months following the invasion of Kuwait, this led many to speculate that allied forces would suffer heavy casualties in a ground campaign. On the battlefield, however, Iraqi forces were capable of far less than its inventories alone might suggest. As demonstrated during its eight-year war with Iran, for example, Iraq suffered from a variety of integrative shortcomings, including deficiencies in doctrine, tactics, reliable intelligence support, night training, and maintenance.[3] In effect, such shortcomings impaired Iraq's ability to use its sizable weapons inventory to full advantage.

In the developing world, the Iraqi experience is neither uncharacteristic nor uncommon. Indeed, recent wars demonstrate that a number of similar integrative deficiencies plague other militaries in the developing world.[4] Thus, improving effectiveness in these militaries cannot be achieved by simply buying hardware; in general, some level of innovation is required—e.g., reorganizing command structures, introducing new doctrine and tactics, modifying training techniques, and improving support.

---

[2]See International Institute of Strategic Studies, *The Military Balance 1990–91*, London: Brassey's, 1990, p. 105; M. E. Gordon and B. E. Trainor, *The Generals' War*, Boston: Little, Brown and Company, 1995; and A. H. Cordesman and A. R. Wagner, *The Lessons of Modern War, Volume II*, Boulder, CO: Westview Press, 1990.

[3]See National Training Center, *The Iraqi Army: Organization and Tactics*, Fort Irwin, CA: National Training Center, Handbook 100-91, 3 January 1991; and Cordesman and Wagner, *The Lessons of Modern War, Volume II*, op. cit.

[4]For example, the battles described in R. E. Harkavy and S. G. Neuman (eds.), *The Lessons of Recent Wars in the Third World, Volume I*, Lexington, MA: D. C. Heath and Company, 1985, provide numerous examples of such deficiencies.

Research Issue

> • What are the key intelligence indicators associated with predicting military innovation?

Arroyo Center

RAND

Given that improved military effectiveness generally requires innovation, what are the key indicators that intelligence analysts can use to predict whether a state is likely to achieve military innovation?

To determine the key intelligence indicators that predict military innovation, we draw from three perspectives rooted in political science: neorealist (structural realist) international relations theory; social cultural (societal) analysis; and organizational theory. We conclude that structural realist indicators usefully predict which states will have *incentives* to innovate. States that face serious external threats, have revisionist ambitions, or face relative resource constraints all have powerful reasons to innovate militarily, making them more likely to do so.

We also conclude that societal and organizational indicators usefully predict what factors are needed to *facilitate* military innovation. Militaries rooted in cohesive societies are more likely to achieve successful military innovation than those rooted in divisive societies. At the organizational level, the existence of "product champions" (senior officers who advocate innovative approaches to warfare) and career paths open to reformers are indicators of military innovation that is likely to succeed. Similarly, military organizations that have recently experienced failure may be more likely to succeed at innovation than those that have not.

Although these structural realist, societal, and organizational indicators are useful in helping to predict military innovation, they alone are insufficient. The missing dimension necessary to predict military innovation is *military strategy*. Unless analysts focus on a particular state's approach to military strategy, it is impossible to determine whether that state will succeed at military innovation.

Outline

* Introduction
* Defining military innovation
* Formulating a conceptual framework
  - Existing perspectives
  - Hypotheses
  - Case studies
* Formulating a predictive framework
  - Indicators
  - Strategy: the missing dimension

Arroyo Center   RAND

The documented briefing is organized as follows. We first define military innovation and formulate a conceptual framework for understanding it. Drawing on existing perspectives from the literature, we deduce hypotheses on military innovation that are tested in three case studies: the Israeli Defense Forces (1948–1982), the North Vietnamese Army (1965–1970), and the Chaco War (1932–1935).

The case studies validate a number of the hypotheses and suggest a set of indicators that are particularly relevant to military innovation. By applying these indicators sequentially, we construct the basis of a preliminary framework for predicting military innovation.[5] We conclude with a discussion of strategy, which completes the predictive framework by providing the required context for understanding military effectiveness.

---

[5]The framework derives from three case studies of successful innovation. Additional cases are required to demonstrate the framework's validity and robustness.

2. DEFINING MILITARY INNOVATION

Military Innovation Defined

- For a *specific* military, innovation is manifested by
  - New warfighting concepts
  - New means of integration; e.g.,
    - Doctrine, tactics, training, support
- Military innovation may not require high technology
  - Some states cannot afford significant investment in high technology
  - Low-tech expedients may suffice if coupled with creative operational, or tactical concepts

Arroyo Center RAND

The literature on innovation is replete with definitions. For example, Michael Meese's definition—based on the work of March and Simon[6]—requires that some portion of an organizational routine is replaced by new procedures, tactics, or strategy. If change can coexist with an established strategy, then the change is not an innovation.[7] Stephen Peter Rosen defines a "major innovation" as

> a change that forces one of the primary combat arms of a service to change its concepts of operation and its relation to other combat arms, and to abandon or downgrade traditional missions. Such innovations involve a new way of war, with new ideas of how the components of the organization relate to each other and to the enemy, and new operational procedures conforming to those ideas. They involve changes in critical tasks, the tasks around which warplans revolve.[8]

These definitions distinguish between genuinely new warfighting concepts (e.g., German *Blitzkreig* in the 1930s) and new adaptations of established concepts (e.g., the Israeli shift to full combined arms in the 1970s). But effective military modernization need not require inventing new ways to wage war. This is well beyond the reach of most militaries, who may prefer established approaches. Maoist infantry tactics illustrate this point: in the narrow sense of the word,

---

[6]J. G. March and H. A. Simon, *Organizations*, New York: John Wiley & Sons, 1958.

[7]M. J. Meese, "Institutionalizing Maneuver Warfare: The Process of Organizational Change," in R. D. Hooker, Jr. (ed.), *Maneuver Warfare: An Anthology*, Novato, CA: Presidio Press, 1993, pp. 193–216.

[8]S. P. Rosen, "New Ways of War: Understanding Military Innovation," *International Security*, Summer 1988, p. 134.

these were not considered innovative in the late 1960s. But the North Vietnamese Army executed them with great skill, rendering U.S. airpower and armored ground fighting relatively ineffective. In this sense, the NVA's use of these tactics *was* innovative. It would thus appear that a relatively broad definition of innovation has the most utility.[9]

In view of the above, we define military innovation as follows: For a *specific* military, innovation is manifested by the development of new warfighting concepts and/or new means of integrating technology. New means of integrating technology might include revised doctrine, tactics, training, or support.

It is important to recognize that military innovation and technological innovation are not synonymous. Surely military innovation may encompass the use of high technology, but it may *not require* high technology. Many states simply cannot afford to invest in either acquiring or mastering the use of leading-edge systems. Such states, however, can be very successful military innovators. By coupling low-technology expedients with creative operational or tactical concepts, such states can attain a high degree of military effectiveness; indeed, such states may be able to prevail against military opponents employing superior technology.

---

[9]In its broadest sense, innovation means simply the introduction of something new, so that any change may be interpreted as innovative. See *Webster's Ninth New Collegiate Dictionary*, Springfield, MA: Merriam-Webster, Inc., 1987, p. 624.

**Military Effectiveness
Determines Innovative Success**

- Victory is a common—but inadequate—measure of innovative success
  - Innovation does not always win wars
  - Exogenous factors play a central role; e.g., adversarial size, political landscape, economics
- Military effectiveness is a more useful measure
  - "A fully effective military is one that derives maximum combat power from the resources physically and politically available"
  - Context is important

Arroyo Center_s   RAND

New warfighting concepts and/or new means of integrating technology do not guarantee victory. This is because factors that are exogenous to military innovation play an important—often predominant—role in determining battlefield outcome. For the *Wehrmacht* in World War II, such factors (on the eastern front) included harsh weather, extensive geography, and the sheer size of the Red Army and its industrial base.

How, then, should innovative success be measured? Military effectiveness, rather than victory, is a more useful measure of innovative success. As Millet, Murray, and Watman argue, an effective military is one that derives maximum combat power from available resources. Context is clearly important to this measure: intrinsic political, strategic, operational, and tactical considerations affect a state's ability to generate military power.[10]

---

[10]A. R. Millet, W. Murray, and K. H. Watman, "The Effectiveness of Military Organizations," *International Security*, Summer 1986, pp. 37–71.

3. FORMULATING A CONCEPTUAL FRAMEWORK

Outline

- Introduction
- Defining military innovation
➤ - **Formulating a conceptual framework**
    - **– Existing perspectives**
    - **– Hypotheses**
    - **– Case studies**
- Formulating a predictive framework
    - – Indicators
    - – Strategy: the missing dimension

Arroyo Center

RAND

The literature on military innovation is extensive. Culling this literature, it is apparent that four dominant perspectives have emerged that attempt to explain military innovation: structural realist (neorealist), societal, organizational theory, and cultural (both strategic culture and organizational culture). We review each of these in what follows.

The Structural Realist Perspective Highlights Incentives to Innovate

- Geopolitical competition is key
  - Incentives to innovate are strongest when threats to security are perceived
  - Incentives are strong when political aims are revisionist
  - Incentives are nil in the absence of competition
- Competitive international politics drives states to emulate military capabilities of rivals
  - But states will adapt the innovations of others to fit their own geopolitical context, subject to relative resource constraints

Arroyo Center・   RAND

A state's external security environment determines whether it will have a strong incentive to innovate militarily. Structural realism posits that the international political system is fundamentally competitive.[11] It is also anarchic—there is no international rule-making and enforcement authority. Hence, the international political system is a self-help system in which states must ensure their own security either by external balancing (acquiring allies) or internal balancing (qualitative and/or quantitative enhancement of their own military forces).

Several indicators of incentives to innovate militarily can be deduced from structural realist theory. First, fear is a powerful incentive for a state to innovate: states that believe they are highly insecure have a strong incentive to innovate, and states that believe they are secure have little incentive. Second, states with revisionist political aims (general grievances, irredentist ambitions) have strong incentives to innovate. Because they are willing to use force to alter the geopolitical status quo, such states have every reason to ensure their militaries are "ready to go."[12] Third, states with expanding international interests and ambitions (especially rising powers) have strong incentives to innovate: the

---

[11]The classic exposition of structural realism is K. N. Waltz, *Theory of International Politics*, Reading, MA: Addison-Wesley, 1979.

[12]B. Posen, *The Sources of Military Doctrine: France, Britain, and Germany Between the World Wars*, Ithaca, NY: Cornell University Press, 1984, p. 74. Note that the use of revisionist aims as a structural variable is somewhat contentious. Although such usage is common among structural realists, a state's aims are not, strictly speaking, systemic constraints; rather, they reflect a state's response to the external environment.

outward projection of their power increases the risk of conflict with others, and their newly acquired stakes and interests must be defended. Fourth, insecure states that lack allies (that is, states that must rely exclusively on internal balancing for security) have strong incentives to innovate because it is imperative that their militaries be as effective as possible.[13]

Finally, the competitive nature of international politics impels states to emulate the military capabilities and innovations of their rivals.[14] This does not mean, however, that the militaries of rival states will be identical—states emulate their rivals, they do not necessarily copy them. There are a number of reasons why emulation can result in divergence rather than sameness: the effects of institutional change;[15] the effects of the state/society continuum;[16] and cross-societal effects.[17] States do emulate and adapt the military innovations of others, but tailor them to fit their own geopolitical context, social structure, and available resources.[18] In the absence of sufficient resources, however, emulation may be impossible and new innovations may be required. Thus, relative resource constraints provide yet another structural realist indicator of incentives to innovate.

---

[13]Ibid., p. 75.

[14]As Waltz says, "Contending states imitate the military innovations contrived by the country of greatest capability and ingenuity. And so the weapons of the major contenders, and even their strategies, begin to look much the same the world over." Waltz, op. cit., p. 127.

[15]See D. C. North, *Institutions, Institutional Change, and Economic Performance*, Cambridge: Cambridge University Press, 1990.

[16]Matthew Evangelista argues that when the state is strong and society is weak, the resulting centralization leads to the top-down flow of ideas, which inhibits innovations. Conversely, when society is strong and the state is weak, the resulting decentralization leads to a bottom-up flow of ideas, which encourages innovation. M. Evangelista, *Innovation and the Arms Race: How the United States and the Soviet Union Develop New Military Technologies*, Ithaca, NY: Cornell University Press, 1988.

[17]When organizational patterns are "transplanted," they always differ in some respects from the organization in its original environment. See D. E. Westney, *Imitation and Innovation: The Transfer of Western Organizational Patterns to Meiji Japan*, Cambridge, MA: Harvard University Press, 1987.

[18]Emulation is generally an alternative to innovation. But insofar as existing concepts may be adapted by applying new integrative mechanisms, innovation may be achieved. The Israeli case study (described later) illustrates this point.

**The Societal Perspective
Highlights Factors that Facilitate Innovation**

Social cohesion is key:
- Cohesive society—more innovation is likely
  - Less internal dissension
  - More resources (material and human) are available to the military
- Divisive society—less innovation is likely
  - State tends to focus on internal problems
  - Less resources are available to the military
  - Innovation may proceed if the military is insulated from societal divisions
    - Isolation facilitates innovation over the short term
    - But civil/military tension inhibits innovation over the long term

Arroyo Center

RAND

Structural realist indicators identify the factors that determine which states have incentives to innovate militarily. Societal indicators identify some of the factors that a state needs to facilitate innovation. The societal perspective posits that the ability of military organizations to innovate is affected crucially by the relationship between the military and its host society. This society/military relationship helps to determine both military effectiveness and innovation.[19]

The society/military relationship affects the amount of offensive and defensive power than can be generated from a given input of material resources. By this measure, the most effective militaries are those set in a cohesive host society.[20] That a military is set in a divisive society does not necessarily mean that it will be ineffective. Militaries that are able to isolate themselves from divisive host societies may be able to maintain effectiveness over the short term. Over time, however, such militaries will experience declining effectiveness. As Rosen explains:

> Military organizations that are separated from their host society and which draw on that society for resources are in tension with that society. They extract resources while being different from and underrepresentative of the larger society. This tension can and has created problems in prolonged war or prolonged peacetime

---

[19]S. P. Rosen, "Military Effectiveness: Why Society Matters," *International Security*, Spring 1995, pp. 5–31.
[20]Indicators of this kind of relationship are conscription, short terms of military service, and a military that is large in size relative to its society.

competition. An innovative military that extracts resources but is isolated from society may not be able to sustain that innovation in periods of prolonged conflict.[21]

Militaries that reflect the troubles of their divisive host societies will fare poorly in terms of effectiveness and innovation. Such militaries will find it difficult to extract the resources from society needed to sustain innovation and enhance effectiveness. Such militaries may also be harmed because the political and societal tensions of the host society may be imported into the military organization.

---

[21]S. P. Rosen, "Societies, Military Organizations and the Revolution in Military Affairs: A Framework for Intelligence Collection and Analysis," unpublished manuscript, June 1996, p. 1.

The Organizational Perspective Also Highlights Factors that Facilitate Innovation

- Institutionalist view—external influences are key
  - Past failure
  - "Slack"
  - Civilian intervention
- Professionalist view—internal influences are key
  - Product champions
  - Innovation-friendly career paths and structures
  - Competition and debate
    - Internal (intraservice)
    - External (interservice)

Arroyo Center

RAND

The structural realist perspective identifies those states that have incentives to innovate. The societal perspective identifies those states that have the kind of society/military relationships that can facilitate innovation. The organizational perspective identifies those states that have the kind of organizational characteristics that can facilitate innovation.

There are three main approaches to organizational theory: the rational systems approach, the open systems approach, and the natural systems approach.[22] The rational systems approach (corresponding to Allison's "Model I") sees organizations as essentially rational actors that pursue their goals efficiently.[23] The open systems approach sees organizations as having a limited ability to act rationally because they are embedded in, and constituted by, the environment in which they operate.[24] The natural systems approach sees organizations as having a limited ability to act rationally because of cognitive constraints, and as dedicated to pursuing their narrow self-interest (corresponding to Allison's "Model II").[25]

---

[22]W. R. Scott, *Organizations: Rational, Natural, and Open Systems*, New York: Prentice Hall, 3d ed., 1992.

[23]G. Allison, *The Essence of Decision: Explaining the Cuban Missile Crisis*, Boston: Little, Brown, 1971.

[24]T. Farrell, "Figuring Out Fighting Organizations: The New Organisational Analysis in Strategic Studies," *Journal of Strategic Studies*, March 1996, p. 124.

[25]Allison, op. cit.; March and Simon, op. cit.

In this work, we employ the natural system model of organizational theory. We do so because in real life organizations do not act as rational systems, and at best, because of cognitive constraints, organizations can only approach "bounded rationality."[26] The natural systems model is the dominant organizational theory paradigm. Applied to military organizations, however, this paradigm can be further subdivided into two different approaches: the "institutionalist" and "professionalist" schools.[27] Each of these has different implications with respect to military innovation.

The institutionalist approach holds that like all organizations, militaries are driven primarily by considerations of organizational well-being.[28] The institutionalist approach is pessimistic about the likelihood that military organizations will innovate successfully. The professionalist approach, on the other hand, views militaries as organizations driven by the goal of maximizing their state's security (this is their self-interest).[29] The professionalist school is relatively optimistic about the likelihood that military organizations will innovate successfully.

The institutionalist approach holds that in military organizations, the deck is stacked against innovation; failure to innovate is the norm.[30] Organizations are viewed as innately conservative. They are more concerned with the internal distribution of status and power than with organizational goals. In this milieu, new ideas are perceived as threatening.[31] Organizations are driven by the need to maintain organizational well-being (defined in terms of budget, manpower, and territory/domain) and to reduce uncertainty.[32] Consequently, the focus is on short-term problem solving rather than long-term planning ("daily routine drives out planning");[33] standard operating procedures (or repertories) are used to maximize control over, and minimize uncertainty from, the external environment;[34] and search is problematic, undertaken to solve an immediate

---

[26]The concept of bounded rationality was developed first in H. A. Simon, *Models of Man, Social, and Rational*, New York: John Wiley & Sons, 1957.

[27]This typology is based on E. O. Goldman, "Institutional Learning Under Uncertainty: Findings from the Experience of the U.S. Military," unpublished manuscript, Department of Political Science, University of California, Davis, 1996.

[28]Examples of this approach are Posen, op. cit.; and J. Snyder, *The Ideology of the Offensive: Military Decisionmaking and the Disasters of 1914*, Ithaca, NY: Cornell University Press, 1984.

[29]See S. P. Rosen, *Winning the Next War*, Ithaca, NY: Cornell University Press, 1991; and "New Ways of War: Understanding Military Innovation," op. cit.

[30]M. Evangelista, *Innovation and the Arms Race*, op. cit., pp. 11–12; Posen, op. cit., p. 54.

[31]V. A. Thompson, *Bureaucracy and Innovation*, University, AL: University of Alabama Press, 1969, p. 22.

[32]Allison, op. cit.

[33]March and Simon, op. cit., p. 185.

[34]Allison, op. cit., pp. 67–68.

issue, not to innovate.[35] These impediments to innovation are likely to be overcome only when specific conditions are fulfilled. First, organizations that have recently experienced major failure are likely to be stimulated into innovation.[36] Second, organizations with "slack" (that is, substantial uncommitted resources) are more likely to engage in innovation.[37] Third, innovation will occur when the civilian leadership intervenes to force military organizations to innovate.[38] This outside intervention is required to overcome the status quo bias of military organizations.

In contrast to the institutionalist view, the professionalist view holds that innovation is much more likely to occur. The professionalist approach posits that under favorable conditions, organizations are capable of learning. The professionalist model assumes that military organizations will undertake innovation on their own; that is, outside stimulus in the form of civilian intervention is not required to spur innovation. Military organizations will take the initiative to innovate because they are professional organizations driven by the goal of providing security for the state.[39] The prerequisites for successful innovation are: existence of senior officers with a new vision of future warfare ("product champions"); reform-minded junior officers; and the creation of new career paths within the organization that allow the reform-minded younger officers to be promoted.[40] Innovation is stimulated by competition and debate either within a branch of the military or between branches of the military.

---

[35]Ibid.

[36]Posen, op. cit., p. 56; Allison, op. cit., p. 85. Note, however, Rosen's argument to the contrary, that failure is neither a necessary nor a sufficient condition for military innovation. Rosen, *Winning the Next War*, op. cit., pp. 8–9.

[37]Thompson, op. cit., p. 42; Evangelista, op. cit. Note that in contrast to the argument that organizational failure spurs innovation, having slack is a condition experienced by successful organizations.

[38]This is the thesis of Posen, op. cit.

[39]Rosen, *Winning the Next War*, op. cit.

[40]Ibid. See also K. M. Zisk, *Engaging the Enemy: Organizational Theory and Soviet Military Innovation, 1955–1991*, Ithaca, NY: Cornell University Press, 1993.

Cultural Factors Have an Indeterminate Effect on Innovation

- Strategic culture—ideational factors are key
  - States have distinct, consistent, and persistent patterns of thinking about military force
  - Different states will respond differently to objective strategic reality
- Organizational culture—civilian-military interplay is key
  - Civilian decisionmaking driven by concerns about domestic distribution of power
  - Military decisionmaking driven by military belief system and worldview

Arroyo Center   RAND

Recently, there has been a renewed interest in employing the cultural perspective to explain military innovation and doctrine. The cultural perspective encompasses both the strategic culture and organizational culture approaches. The former emphasizes ideas about the use of force within a state (including the state's military), while the latter emphasizes ideas about the use of force within a given military organization.

Strategic culture posits that states have distinctive, consistent, and persistent views on how they (that is, the relevant elites) think about the use of force.[41] The strategic culture approach focuses on how ideational factors shape a particular state's response to the objective strategic environment (levels of threat, opponent capabilities, technology).[42] To identify a state's strategic culture and measure the impact of that strategic culture on state policy, it is necessary to analyze

---

[41]Strategic culture has been defined as "an integrated system of symbols (i.e., argumentation structures, languages, analogies, metaphors, etc.) that acts to establish pervasive and long-lasting grand strategic preferences by formulating concepts of the role and efficacy of military force in interstate political affairs, and by clothing these conceptions with such an aura of factuality that the strategic preferences seem uniquely realistic and efficacious." (A. I. Johnston, *Cultural Realism: Strategic Culture and Grand Strategy in Chinese History*, Princeton, NJ: Princeton University Press, 1995, p. 36.) Jack Snyder has offered an alternate definition: "Strategic culture can be defined as the sum total of ideas, conditioned emotional responses, and patterns of habitual behavior that members of a national strategic community have acquired through instruction and imitation and share with each other." (J. Snyder, *The Soviet Strategic Culture: Implications for Limited Nuclear Operations*, Santa Monica, CA: RAND, R-2154-AR, 1977.)

[42]Johnston, op. cit.

important recent strategic texts and identify ranked grand strategic preferences; analyze key historical strategic texts and identify ranked grand strategic preferences; and determine if there is a congruence between the recent and historical texts. If such a congruence exists, it can be inferred that a strategic culture exists and that it influences the state's grand strategic choices.

The organizational culture approach suggests that a state's choice of military doctrine is shaped by cultural factors; military doctrine is not viewed as primarily responsive to the state's external security environment. Specifically, military doctrine results from the interplay of civilian political culture and military organizational culture.[43] According to this view, civilian decisions about military organization are driven by concerns about how civil-military relations (that is, the distribution of domestic political power) will be affected; military concerns about doctrine, on the other hand, are shaped by the military's belief system and worldview (that is, by the military's organizational culture).

We have refrained from employing the cultural perspective in this work because we are skeptical about the utility of both the strategic and organizational culture approaches. Indeed, the track record of culture-based analyses is weak; [44] other perspectives have far more explanatory power than the cultural perspective.[45]

---

[43]See E. Kier, "Culture and Military Doctrine: France Between the Wars," *International Security*, Spring 1995, pp. 65–93.

[44]For a detailed critique of the use of the strategic and organizational culture approaches in security studies, see M. C. Desch, "Culture Clash: Assessing the Importance of Ideas in Security Studies," *International Security*, Summer 1998, pp. 141–170.

[45]Johnston concedes this point implicitly when he admits that the conclusions derived from his strategic cultural analysis of Chinese grand strategy could also have been predicted by structural realism. This raises the question: What, then, is the "value-added" of the strategic culture perspective? See Johnston, op. cit.

From the three theoretical perspectives we employ, we have deduced testable hypotheses.

The structural realist perspective yields the following hypotheses: (1) innovation is most likely to occur in states that confront a high threat environment, have revisionist aims, or must defend exposed geostrategic positions; and (2) relative resource constraints will affect the type of innovation undertaken, that is, whether innovation will be imitative or asymmetric.

The societal perspective yields the following hypothesis: insofar as there is a correlation between resource inputs and innovative outcomes, cohesive states are more likely to achieve military innovation than divisive states (because the former will be better able to extract resources from their host society than the latter).

**These Perspectives
Suggest Testable Hypotheses (2 of 2)**

- Organizational (Institutionalist)
    - Militaries innovate when organizational well-being is advanced; past failure, slack, or civilian intervention are required
- Organizational (Professionalist)
    - Learning enables militaries to innovate without exogenous stimuli; product champions and career paths are required
- Cultural
    - Culture-based approaches have limited predictive power

Arroyo Center   RAND

The organizational theory perspective (institutionalist approach) yields the following hypothesis: militaries innovate when their organizational well-being is advanced; however, they will not innovate unless they have recently experienced failure, are the beneficiaries of "slack," or civilian intervention compels them to innovate.

The organizational perspective (professionalist approach) yields the following hypothesis: learning enables militaries to innovate without the necessity of exogenous stimuli (for example, failure or civilian intervention); however, product champions and innovation-friendly career paths are necessary for militaries to undertake innovation.

Because cultural factors (both strategic and organizational) have an indeterminate effect on innovation, we deduce no hypotheses from the cultural perspective.

In what follows, we test these hypotheses against three case studies in military innovation: The Israeli Defense Forces (IDF) from 1948–1982, the North Vietnamese Army (NVA) from 1965–1970, and the Chaco War from 1932–1935.

The Israeli Defense Forces are a useful case study in military innovation for at least two reasons. First, the IDF fought and won five major campaigns between 1948 and 1982, so there exists a large volume of historical data pertaining to their military capabilities. Moreover, all of these campaigns involved large-scale combat in open (desert) terrain, making the interplay of strategy, tactics, and technology relatively transparent and amenable to analysis.

Second, despite its small population relative to that of its adversaries, Israel has evolved steadily as a regional military power. The IDF is rooted in the *Haganah*, a volunteer force that became the de facto army when Israel achieved independence in 1948.[46] At the time, this army consisted of nine light brigades and local defense groups lacking armor, artillery, and air power. In the ensuing years, the IDF evolved into a force favoring paratroops (early 1950s), a fighter-bomber air force (late 1950s and beyond), armor dominance (1960s), static defense (early 1970s), and combined arms (mid-1970s and beyond). With the exception of static defense, all of these transformations required innovation.[47] And today, the IDF is recognized as one of the most capable military forces in the developing world.

---

[46]Department of the Army, *Israel: A Country Study*, Washington, D.C.: U.S. Government Printing Office, DA Pam 550-25, 1990, p. 255.

[47]The early years of the IDF are best captured in E. Luttwak and D. Horowitz, *The Israeli Army*, New York: Harper & Row, 1975.

The IDF Emphasizes the "Relational" Approach

- Exploit adversary's inability to improvise amidst confusion
    - Maximize confusion with movement, surprise
- Embrace fog of war
    - Train with an emphasis on uncertainty
- Encourage risk taking, tactical initiative
    - Decentralization with "optional control"
    - Senior commanders lead by example
- Match tactics and technologies
    - Selective acquisition strategy

Arroyo Center   RAND

In many respects, Israel's military effectiveness has derived from its ability to exploit key adversarial weaknesses. In particular, the IDF has long sought to capitalize on the relative inability of the larger, better-equipped Arab militaries to improvise amidst confusion on the battlefield. By using the fog of war to its advantage, the IDF has been innovative less in its capacity to develop new warfighting concepts than in its capacity to marry existing concepts with effective integrative mechanisms, and thereby adapt them to the local conditions of the Middle East. In this sense, the Israeli approach may be thought of as "relational,"[48] in that it relates *in detail* to their anticipated warfighting environment.

The Israeli focus on maximizing battlefield confusion dates back at least to the 1950s when Ariel Sharon, the commander of the 202nd paratroop battalion, conceived of a new tactic for assaulting fortified positions. Rather than employing the conventional "fire and movement" approach that was preferred up to that point, Sharon's method dispensed with covering fire in favor of silent movement until troops were fired upon. Once the enemy was engaged, the shock effect of surprise, counterfire, and movement sought to maximize confusion. This tactic was employed successfully in night raids against Egyptian and Jordanian fortifications in 1954. By conducting these raids at night, not only

---

[48]Ibid., p. 116.

was the shock effect increased, but the strengths of Egyptian and Jordanian rifleman were offset.[49]

The 1982 air campaign against Syria in the Bekaa Valley provides a more recent example. In the thirteen months leading up to this campaign, the Israeli Air Force (IAF) flew drones into Syrian air space, enticing the Syrians to lock on with their air defense radars and reveal to the Israelis information about their air defense tactics, command and control procedures, and radar characteristics. The Syrians complied and the information so obtained helped the IAF devise the air campaign. Israel attacked Syria from the west during the afternoon hours of June 9, 1982. The first wave of the attack comprised unmanned drones that looked like F-4s to radar, as well as manned aircraft following behind. Because of the sun's position in the sky, Syrian air defenders had difficulty using optical methods to verify the radar images. Amidst the confusion, they engaged the drones with their ready surface-to-air missiles, leaving their air defense radars vulnerable to Israeli counterattacks with anti-radiation weapons. These attacks quickly destroyed most of the radars, and contributed to the successful suppression of Syrian air defenses.[50]

The examples above illustrate that success using the Israeli approach relies not only on the adversary being vulnerable to the effects of battlefield confusion, but on friendly forces embracing the fog of war. To this end, IDF training techniques have been geared toward instilling confidence in commanders facing uncertainty. For example, brigade and battalion commanders would be asked to prepare and present attack plans in training exercises. Just before presenting their plans, they would be told that the situation has changed drastically and that new plans were needed immediately. This forces officers to think on their feet and confront uncertainty in real time. In the IDF, "plans are a basis for changes."[51]

Embracing the fog of war generally requires risk taking and tactical initiative. The IDF fostered these traits by emphasizing decentralized command structures with only "optional control" by headquarters units. Here, commanders are free to make their own tactical decisions and are encouraged to lead by example.[52] That commanders need not wait for orders to proceed was demonstrated clearly during Operation Kadesh (1956), when Uri Ben Ari's 7th Brigade violated orders by attacking Egyptian forces ahead of schedule. In so doing, the 7th achieved

---

[49]Ibid., pp. 112–116. As Luttwak and Horowitz point out, it was the suitability of Sharon's technique to the Arab-Israeli context, rather than the technique itself, that was especially noteworthy. Indeed, others had employed similar techniques previously, including Washington during the Yorktown campaign in 1781.

[50]W. S. Carus, "Military Lessons of the 1982 Israel-Syria Conflict," in Harkavy and Neuman, op. cit., pp. 263–265.

[51]Luttwak and Horowitz, op. cit., p. 174.

[52]Ibid., pp. 87, 161–163.

deep penetration and took control of most of central Sinai in a single day. Impressed by this performance, Chief of Staff Moshe Dayan argued for increased emphasis on armor in the aftermath of the operation and did not punish his officers for violating the original plans.[53]

Another key facet of the Israeli approach is a selective acquisition strategy that matches technology to tactics. In the 1950s, when most of the Israeli General Staff were convinced that air superiority would be achieved by a conventional defensive counterair campaign, Dan Tolkowsky (the IAF commander) argued in favor of bold, offensive counterair tactics to destroy enemy aircraft on the ground. Relatedly, the IAF opted for a fighter-bomber air force, and Israel's use of fighter-bombers in the preemptive strike at the outset of the Six Day War tends to validate Tolkowsky's conviction.[54] Another example is in the area of armor modernization, where the IDF has historically emphasized crew protection. While this was related ostensibly to Israel's desire to limit wartime casualties, safer tanks tend to make armor crews more willing to take risks in battle.

---

[53]Prior to the 7th's stunning success, armor enthusiasts tried to convince a skeptical Dayan that an increased emphasis on armor was prudent. See ibid., p. 153; and F. H. Toase, "The Israeli Experience of Armoured Warfare," in J. P. Harris and F. H. Toase (eds.), *Armoured Warfare*, New York: St. Martin's Press, 1990, pp. 164–168.

[54]Luttwak and Horowitz, op. cit., pp. 121–122.

**Battlefield Support
Has Long Been an IDF Priority**

- Intelligence (1950s)
  - Topographical collection efforts
  - Strategic warning required for mobilization
- Aircraft maintenance (1950s)
  - High sortie rates offset inventory limitations
  - Civilian schools teach electronic, mechanical skills
- Ground vehicle maintenance (1950s)
  - Tanks disassembled and rebuilt
- Battlefield logistics utilize "supply push" (1970s)

Arroyo Center   RAND

Battlefield support is an integrative element that militaries in the developing world often neglect. This has not been the case in Israel: since the 1950s, the IDF has worked to improve its support capabilities.

Intelligence is one example. In its infancy, the IDF conducted aerial reconnaissance missions over the Sinai and were reputed to know the terrain there better than the Egyptians.[55] Because the IDF has historically relied upon reserve mobilization, moreover, collection efforts supplying strategic warning information have been particularly important.[56]

Maintenance is another example. Outnumbered by its adversaries in the number of aircraft possessed, the IAF in the 1950s worked to increase the serviceability of aircraft and thereby decrease the maintenance time required between sorties, increase sortie rates, and offset its numerical inferiority. To this end, Tolkowsky and Ezer Wiezman—his successor in command of the IAF—championed the establishment of civilian schools to teach electronic and mechanical skills. In ground vehicle maintenance, the Israelis improved their skills early on by disassembling tanks and rebuilding them with modifications.[57] By 1973, the

---

[55]Ibid., pp. 117–118.

[56]Israel has generally used early warning information to its advantage. The glaring exception is the Yom Kippur War in 1973, when the political leadership failed to act on indications of an impending attack. See E. A. Cohen and J. Gooch, *Military Misfortunes: The Anatomy of Failure in War*, New York: The Free Press, 1990.

[57]Luttwak and Horowitz, op. cit., pp. 123, 171.

IDF's superior ability to repair damaged tanks—and the Arabs' relative inability—had a telling impact on the outcome of the Yom Kippur War.[58]

Finally, the IDF has adapted and modified its battlefield logistics. Owing largely to inefficiencies experienced in the 1973 campaign, the IDF employs a Soviet-styled "supply push" (vice "demand pull") system, wherein overstocking reduces the demands on centralized logistics management.[59]

---

[58]A. H. Cordesman and A. R. Wagner, *The Lessons of Modern War, Volume I*, Boulder, CO: Westview Press, 1990, p. 102.

[59]Ibid., pp. 104, 215; Luttwak and Horowitz, op. cit., p. 175.

Keys to Israeli Success

- High external threat: "Israel has no foreign policy—only a defense policy"
    - Surrounded by adversaries ("extensive threat")
    - State survival continually at risk ("dormant war")
    - Strategic depth lacking
    - Resource asymmetry constrains capacity to wage protracted war
- Cohesive state, good civil/military relations
    - Extensive reliance on reserves
- Organizational learning
    - Intellectual—vice authoritarian—approach to planning
    - Reappraisal of successes and failures

Arroyo Center

RAND

Israeli success at military innovation seems to derive from three key considerations: Israel must survive in a high threat environment, it has a cohesive state with good civil/military relations, and it has been effective at organizational learning.

Threats to Israeli security have provided ample incentives to innovate militarily. Many factors lead to a perceived threat: Israel is surrounded by adversaries (the threat is "extensive"); its survival as a state has continually been at risk (war is "dormant," prone to erupt at any time); it lacks strategic depth (Israel is small geographically); and it lacks the resources necessary to wage protracted war (Israel is relatively small demographically and economically).[60] As Ben-Horin and Posen asserted in 1981,

> Most Arab states are seen as actual or potential members of a coalition seeking Israel's destruction or truncation. A single defeat may destroy the state. A single Israeli military victory cannot settle the conflict. Israel may face a future of endless war.[61]

Perhaps Dayan best summarized the preponderance of realist influence when he said "Israel has no foreign policy—only a defense policy."[62]

---

[60]See Department of the Army, op. cit., pp. 266–270.

[61]Y. Ben-Horin and B. Posen, *Israel's Strategic Doctrine*, Santa Monica, CA: RAND, R-2845-NA, 1981, p. v.

[62]Quoted in Department of the Army, op. cit., p. 272.

Societal cohesion has also influenced innovative outcomes. Israel is by no means wealthy, yet it has been willing to devote scarce financial resources to its military establishment. And while relying on reserve forces in lieu of costly, large, standing armies saves money, reserve mobilization in Israel can affect national production and lead to economic disruption.[63] Here, too, Israeli society has been willing to accept the economic burden of defense.

It is hard to pinpoint the exact reasons for strong Israeli civil/military relations. Nevertheless, two facts seem particularly significant: (1) military life in Israel is pervaded by civilian influences, and (2) Israeli military expertise is not confined solely to the military.[64] Ultimately, mandatory military service seems to have strengthened civil/military relations in Israel.

Finally, organizational learning has been central to Israel's success. In 1948, the Israeli army lacked real military traditions; open-mindedness was essential to effective defense planning. In effect, sound arguments prevailed over rank, and Israeli defense planning emphasized an intellectual—vice authoritarian—approach.[65]

Moreover, reappraisal of tactical and operational doctrines—even after victory—was commonplace in the IDF, as far back as the early 1950s.[66] In most cases, reappraisals led to rational, implementable, strategic plans. Israel's planning and implementation in the aftermath of the 1973 campaign illustrates this point.

In 1967, with territorial gains in hand, Israel shifted toward a defensive-oriented strategy by increasing its reliance on reserve mobilization and tactical warning. Owing to successes during the Six Day War, though, armor came to be viewed in somewhat ethereal terms, almost at the expense of other arms:

> Fighting was declared to be "90 percent technics and 10 percent tactics";
> accordingly, future wars were conceived in terms of massive frontal clashes
> between tank armies which, once victory had been won through the superior
> quality of Israel's tankmen, would be followed by a campaign of maneuver deep
> into the rear of an already defeated enemy. An army that had traditionally put its
> trust in subtlety and the indirect approach now came to regard the frontal armored
> charge as the acme of tactics.[67]

The shortsightedness of this view became evident in 1973. But the need for battlefield improvisation during this campaign—and reappraisal of doctrine

---

[63]Even regularly occurring partial mobilizations can have this effect. Ibid., p. 308.

[64]Luttwak and Horowitz, op. cit., p. 203.

[65]Ibid., p. 54.

[66]Ibid., p. 89.

[67]M. van Creveld, *Military Lessons of the Yom Kippur War: Historical Perspectives*, Beverly Hills, CA: Sage Publications, 1975, pp. 2–3.

afterward—inevitably led to important changes within the IDF, ultimately improving its effectiveness.

In the period 1967–1973, Egyptian and Syrian forces received a substantial infusion of Soviet technology, especially in the form of air defense and anti-tank systems,[68] and their employment in October 1973 "threatened to render the IDF's traditional superiority in tank and air combat irrelevant."[69] To begin with, the Egyptians and Syrians coordinated a two-front assault on Suez and the Golan Heights. This, combined with tactical surprise, severely weakened the IDF defensive response. In order to regain the initiative, Israel relied largely on its infantry to put down suppressive fires—especially those from anti-tank guided missiles. In effect, the beginnings of a combined arms campaign was improvised, to be further developed in the years ahead.[70] Second, the lack of tactical warning[71] put the IAF in the uncomfortable position of providing close air support prior to neutralizing air defenses and achieving air superiority.[72] Since the Arab forces shielded their assaults with these defenses, Israeli performance in this mission was one of the most problematic areas of the war.[73]

The IDF had many lessons learned from the 1973 campaign. Among the most important, as alluded to above, were those relating to warfighting doctrine. To begin with, tanks were employed in more balanced formations to help ameliorate their newly recognized vulnerability.[74] Moreover, the dominance of armor within the IDF ground forces was replaced by a stronger emphasis on mobility in a combined arms setting. The goal was not simply to supplant the crushing effect of armored thrusts with mechanization, but to exploit armored potential more effectively. To achieve this, IDF planners sought to combine frontal and flank assaults utilizing armor, combat engineers, and infantry with artillery barrage, commandos behind enemy lines, and aircraft targeting key installations. With the added tactic of night operations, it was hoped that a confused enemy

---

[68]For example, SA-7, SA-6, SA-3, AT-3, and ZSU-23-4. See Cordesman and Wagner, *The Lessons of Modern War, Volume I*, op. cit., pp. 74–78.

[69]Toase, op. cit., pp. 176–177.

[70]Turning the tempo of the campaign was influenced greatly by the IAF, which, exploiting Egyptian movements beyond the range of their air defenses, waged opportunistic ground attacks with great success. The accuracy of Israeli gunnery was also an important factor. See Toase, ibid., p. 178.

[71]Although the Arabs mounted an effective deception campaign prior to the commencement of hostilities, apparently Israel did piece the warning signs together on the eve of the attack. Because of political considerations, Israel chose not to launch a preemptive strike. See Cordesman and Wagner, *The Lessons of Modern War, Volume I*, op. cit., p. 35.

[72]Toase, op. cit., p. 181.

[73]Cordesman and Wagner, *The Lessons of Modern War, Volume I*, op. cit., p. 90.

[74]Toase, op. cit., p. 182.

would become vulnerable to emerging defensive gaps for armored breakthrough.[75]

Organizationally, artillery became an organic divisional asset and new mobility requirements were met by increasing the proportion of self-propelled guns in service.[76] The surface-to-air missile (SAM) threat was addressed by focusing air doctrine more on SAM-suppression (including jamming), especially before the onset of land operations.[77] An advanced command and control system was developed, including mobile segments and data networks for integrating combat and support. Even logistics was reorganized to better supply forward units.[78]

Finally, bringing about the changes outlined above required an effective weapons acquisition strategy, as harnessing new technologies became crucially important. As a result, many modern systems were incorporated into the IDF weapon inventory in the ensuing decade, including remotely piloted vehicles, airborne reconnaissance and control systems, attack helicopters, precision-guided munitions, electronic countermeasures, night vision devices, computerized fire control systems, and reactive armor.[79]

---

[75]G. E. Rothenberg, *The Anatomy of the Israeli Army*, New York: Hippocrene Books, Inc., 1979, pp. 216–218.

[76]While 75 percent of Israeli guns were self-propelled in 1973, 90 percent were by 1977 (Rothenberg, op. cit., p. 219). Note also that fifteen independent artillery brigades were fielded by 1982, compared to none in 1973 (Cordesman and Wagner, *The Lessons of Modern War, Volume I*, op. cit., p. 110).

[77]See Toase, op. cit., p. 182; and Rothenberg, op. cit., pp. 211–212.

[78]Cordesman and Wagner, *The Lessons of Modern War, Volume I*, op. cit., pp. 110, 112.

[79]See Toase, op. cit.; Rothenberg, op. cit., p. 221; and Cordesman and Wagner, *The Lessons of Modern War, Volume I*, op. cit., p. 111.

The North Vietnamese Army (1965–1970)

- Asymmetric combatants paired
  - U.S. a wealthy, industrial power
  - North Vietnam a poor, agrarian state
- NVA innovation offsets overwhelming U.S. superiority in mobility and firepower
- But several contextual anomalies are significant
  - Self-imposed limitations on U.S. conduct of the war
  - "Privileged sanctuaries" in Cambodia and Laos
  - Soviet/Chinese material assistance to the NVA

Arroyo Center,   RAND

Like the previous case, our study of the NVA from 1965–1970 illustrates asymmetric innovation. There was a huge disparity between American and North Vietnamese capabilities. The United States was the most economically powerful and advanced state in the world; North Vietnam was a poor agrarian state with only the rudiments of an industrial infrastructure. The United States, with a population of nearly 200 million and armed forces possessing the full panoply of advanced nuclear and conventional weaponry, confronted a nation with a population of about 17 million and a military substantially lacking the major indicia of modern conventional military power (jet aircraft, tanks, heavy artillery).[80] Notwithstanding this power imbalance, the NVA was able to prevail by finding innovative techniques to offset the superior mobility and firepower of U.S. forces.

In analyzing this case study, however, several anomalies must be kept in mind. First, the United States fought the war with self-imposed constraints on its use of military power (mostly for fear of provoking Chinese or Soviet intervention). Second, as a consequence of those constraints, the NVA enjoyed "privileged sanctuaries" in Cambodia and Laos throughout the conflict. These sanctuaries were crucial in providing the NVA with a secure logistics base and strategic depth. Finally, the NVA benefited enormously from the lavish supply of war materiel furnished to it by the Soviet Union and China. Taken together, these three strategic anomalies affected the war's outcome in important ways.

---

[80]For comparisons between North Vietnam and the United States, see International Institute of Strategic Studies, *The Military Balance 1965–66*, London: Brassey's, 1965.

**North Vietnamese Approach:
Wage "Protracted War"**

- Attack and exploit the inability to sustain a prolonged, costly, and indecisive war in Indochina
  - Convince the enemy that victory is unattainable at a reasonable cost
  - Destroy the enemy's political will
- Mobilize political organizations
  - To extract resources for the war effort
  - To support insurgency
- Avoid set-piece conventional battles unless success is likely
  - Employ mobility, guerrilla tactics

Arroyo Center   RAND

To defeat the United States, North Vietnam developed a strategy based on the waging of "protracted war." The key to North Vietnam's protracted war strategy was to attack and exploit the key U.S. politico-military weakness: America's inability to sustain a prolonged, costly, and indecisive war in Indochina.[81] As General Vo Nguyen Giap stated:

> [The enemy's] weak point lay in the unjust character of his war. As a result, he was internally divided, not supported by the people of his own country and did not enjoy the sympathy of world opinion. His army was strong at the beginning but its fighting spirit was deteriorating... Our strong point lay in the just nature of our Resistance War. Our people and troops were always imbued with the spirit of sacrificing themselves in fighting the enemy ... The more the war was protracted the lesser would be his strong points, and their weak points would grow weaker.[82]

The aim of a protracted war strategy is to convince the enemy that victory is impossible or unattainable at any cost the enemy is willing to incur.[83] Protracted war is a means of offsetting the advantages enjoyed by an opponent possessing superiority in technology, mobility, and firepower. As the Central Committee of North Vietnam's Communist Party declared in 1963:

---

[81]North Vietnamese strategy focused on exploiting the opponent's military *and* political vulnerabilities. See D. Pike, *PAVN: People's Army of Vietnam*, Novato, CA: Presidio, 1986, pp. 54–55.

[82]V. N. Giap, *People's War, People's Army: The Viet Cong Insurrection Manual for Underdeveloped Countries*, New York: Frederick A. Praeger, 1962, pp. 98–99.

[83]Pike, op. cit., p. 239.

The war waged by the people in South Vietnam is a protracted one because we are a small people having to fight an imperialist ring leader which is the USA. We are using our political and moral strength with our military and material weakness to oppose an enemy who is weak politically and morally but strong militarily and materially.

We need time and efforts to overcome many difficulties in order to tip the balance of power between the enemy and us in our favor: we can become stronger while the enemy become weaker, only in this way can we gain the final victory.[84]

Protracted war requires intensive political and military mobilization by the state practicing it. The essence of North Vietnam's protracted war strategy was the concept that the people were the primary instrument of warfare.[85] North Vietnam's strategy was based on using political organizational techniques to mobilize support for the insurgency in the South and applying the same techniques in the North to extract from North Vietnam's population the resources necessary to sustain the war effort.[86] Protracted war as practiced by North Vietnam sought to avoid set-piece conventional battles except where success seemed probable. Rather than slugging it out conventionally with a superior opponent, protracted war aimed at using light infantry mobility and guerrilla tactics to attrit the opponent and to undermine the enemy's political will.[87] By following this strategy, North Vietnam was able to avoid superior American firepower, give battle on its own terms, and limit its own casualty rates to a level deemed acceptable to Hanoi.[88]

[84]Quoted in W. J. Theis, *When Governments Collide: Coercion and Diplomacy in the Vietnam Conflict*, Berkeley: University of California Press, 1980, p. 251.

[85]Pike, op. cit., p. 247.

[86]See J. M. Van Dyke, *North Vietnam's Strategy for Survival*, Palo Alto, CA: Pacific Books, 1992, p. 29.

[87]As Giap put it: "To maintain and increase our forces was the principle to which we adhered, contenting ourselves with attacking when success was certain, refusing to give battle likely to incur losses to us or to engage in hazardous actions. We had to apply the slogan: to build up our strength during the actual course of fighting." Giap, op. cit., p. 29.

[88]On this last point, see M. L. Lanning and D. Cragg, *Inside the VC and the NVA*, New York: Fawcett Columbine, 1992, pp. 82, 117–118; and A. F. Krepinevich, *The Army and Vietnam*, Baltimore: The John Hopkins University Press, 1986, p. 11.

Tactical Innovation:
Offset Firepower with Low-Tech Expedients

- Defend using tunnels, bunkers, and fortifications
- Negate air/artillery strikes by "hugging" U.S. forces
- Conduct raids with special sapper units (post-Tet)
- Use low-tech logistics to foil air interdiction
    - Preposition road repair materials every few miles
    - Utilize fords, pontoons, underwater bridges, and camouflage
    - Disperse POL in small drums along roads and in rice paddies

Arroyo Center   RAND

During the Vietnam War, the NVA engaged in military innovation at the tactical, as well as at the strategic, level. The NVA sought to negate superior U.S. firepower by making extensive (and sophisticated) use of tunnels, bunkers, and fortifications. The NVA also sought to neutralize U.S. artillery and air strikes by the tactic of "hugging" U.S. and South Vietnamese forces.[89] After the costly Tet Offensive, the NVA again innovated by creating special sapper units to conduct raids against U.S. and South Vietnamese fixed positions.[90]

The NVA also proved extremely adept at finding low-tech—but innovative— methods to offset the U.S. air campaigns against the Ho Chi Minh Trail and North Vietnam itself.[91] For example, the NVA prepositioned tools and materials for road repair every several miles along the Ho Chi Minh Trail. This meant that after U.S. air strikes, repair units could quickly get to work without having to wait for equipment to be brought up from a distance. The NVA also minimized the trail's vulnerability to air interdiction by making extensive use of fords, pontoons, and underwater bridges. The NVA also skillfully employed camouflage to protect its logistics assets. Another low-tech expedient was to store petroleum, oil, and lubricants (POL) in 55-gallon drums (rather than large, vulnerable high-capacity storage tanks) and to disperse the drums along roads

---

[89]For further discussion of the NVA's tactical innovations, see Lanning and Cragg, op. cit., pp. 175–178.

[90]Ibid., p. 84; Pike, op. cit., pp. 227–229.

[91]See Lanning and Cragg, op. cit., pp. 73–78, 119–127; Giap, op. cit., pp. 249–253; and Van Dyke, op. cit., pp. 34–56.

and in rice paddies. This made the U.S. objective of denying the NVA POL extremely difficult.[92] Finally, the NVA employed a labor-intensive response to the capital- (and technology-) intensive U.S. air interdiction campaign: the NVA assigned 97,000 personnel to full-time road repair work, and this effort was supported by the part-time utilization of another 370,000–500,000 part-time road repair personnel (mostly civilians).

---

[92]See M. Clodfelter, *The Limits of Air Power: The American Bombing of North Vietnam*, New York: The Free Press, 1989, p. 132.

Keys to North Vietnamese Success

- Revisionist aims
  - Determined to reunite Vietnam
- High external threat
  - U.S. opposition to reunification by North Vietnam
- Relative resource constraint
  - Spurred North Vietnamese innovation
- Cohesive state, good civil/military relations
  - "A basic unity of will and purpose"
  - Total national mobilization

Arroyo Center

RAND

The North Vietnamese case study validates many of our hypotheses. As the structural realist perspective would predict, North Vietnam was a state with very high incentives to engage in military innovation. North Vietnamese strategy was driven by revisionist ambitions: Hanoi did not accept the 1954 partition of Vietnam as permanent and was determined to unify all of Vietnam into a single state under its control. The North Vietnamese also believed that they existed in a very high threat environment. Even before 1965 (when the U.S. air campaign against the North commenced and U.S. ground forces were introduced into the South), ongoing American military and political assistance to South Vietnam indicated that the United States would probably use force to prevent Hanoi from unifying Vietnam. Finally, the pronounced resource imbalance between the United States and North Vietnam spurred North Vietnam to innovate militarily to compensate for America's material advantages.[93]

While the structural realist perspective correctly predicts North Vietnam's propensity to innovate militarily, the societal perspective predicts North Vietnam's success in extracting resources from its society to support its innovations. North Vietnam was an extremely cohesive state. Civil/military

---

[93]As Giap said, "Only a long-term war could enable us to utilize to the maximum our political trump cards, to overcome our material handicap and to transform our weakness into strength." (Giap, op. cit., p. 29.) And Douglas Pike observes that American material superiority was "sharply minimized by an agrarian-based movement fighting a protracted conflict marked by gradual attrition and slow strangulation on both military and political fronts." (Pike, op. cit., pp. 250–251.)

relations were harmonious; indeed, because at senior levels the leadership of the party, government, and military were intertwined, the very concept of civil/military relations hardly applies to the North Vietnamese. There was within North Vietnam's political and military structures "a basic unity of will and purpose."[94] Civil/military integration coupled with social cohesion enabled Hanoi to fully mobilize the state and nation behind the war effort. North Vietnam was characterized by "a national will to focus the entire country's assets on the war effort . . . Practically everyone in North Vietnam worked either directly or indirectly to support the war. Sacrifices were expected and revolutionary zeal abounded."[95]

---

[94]T. Lomperis, *From People's War to People's Rule: Insurgency, Intervention, and the Lessons of Vietnam*, Chapel Hill: University of North Carolina Press, 1996, p. 120.

[95]Lanning and Cragg, op. cit., pp. 117–118.

The Chaco War (1932–1935)

- War fought in a period of ferment
  - Dominance of defensive firepower recognized
  - Revolutionary technologies (airplane, tank) and doctrines (Blitzkrieg, amphibious warfare) available
- Asymmetric combatants paired
  - Bolivia wealthy (oil), more populous
  - Paraguay poor, small, deep in debt

Arroyo Center   RAND

Our final case study was selected for two key reasons. First, the Chaco War was fought during an important interwar period that featured both great technological change and doctrinal ferment. The major studies of this era have focused on the behavior of the various great powers as they assessed and assimilated the lessons learned from the experience of World War I. In the main, these studies have noted the tension between those who thought the next war would resemble the last and those who believed that new operational territory would be explored.[96] The former believed in defense dominance through the combination of machine guns, barbed wire, and artillery. The latter saw the relatively new technologies of the tank and the airplane as heralding a renaissance of offense-dominant maneuver warfare on land—in the form of *Blitzkrieg*—and at sea—with aircraft carriers and amphibious operations replacing (eventually, and after much institutional resistance) the old paradigm of the battle line of capital ships.

The second reason that this war commends itself for analysis is that, like the previous cases, it features quite unequal and differing combatants. Bolivia, on the one hand, had a substantial oil wealth that even the Great Depression had not sharply dented. Further, it was much larger than Paraguay and more populous. Paraguay, in contrast, was impoverished, small, and suffering from a paucity of natural resources. Thus, in theory, Bolivia was ideally poised to act upon the insights of the leading militaries of the day, while Paraguay was severely

---

[96]See, for example, Posen, op. cit.; Rosen, *Winning the Next War*, op. cit.; and Kier, op. cit.

constrained in its defense expenditures. One would expect the Paraguayans to fall behind Bolivia in relative power.

There were also intriguing contrasts in the politics and strategies of each. Both were nominally democratic states—making this yet another example of democracies fighting—but Bolivia's civil-military relations were poor, with an ever-present possibility of a coup, while Paraguay's were far more balanced. This meant that the Bolivian military was allowed to go its own way and to command substantial societal resources; whereas, in Paraguay, the military was tightly controlled and had to demonstrate great budgetary nimbleness. In the realm of strategy, Bolivia benefited from a standing German military mission that helped it to modernize its military. Paraguay sent some dozens of its brightest officers to military schools in France and Russia, where they were exposed to strategic cultures that tended toward views of defense dominance (one via fortification, one through trading space for time) but which also had extensive recent experience in irregular warfare (e.g., France in the Moroccan Rif, and the Soviets in their civil war).

In sum, the Chaco War took place at an important time characterized by an earlier revolution in military affairs; and it featured actors with interesting differences that allow for direct testing of our hypotheses about the structural, societal, and organizational underpinnings of innovation. Finally, our examination of this case allows the possibility for a reinterpretation of traditional thinking about the war's outcome. The dominant strain of thinking among historians has been that the Bolivian military performed very poorly. At the command level, its leadership has been characterized as hidebound and incompetent (a verdict also levied against the chief German adviser, General Hans von Kundt). Its common soldiery, drawn from the high altitudes of the Altiplano, has been judged sorely wanting in the dry lowlands of the Chaco.[97] What we have found, instead, from official histories and primary sources on both sides, was a more balanced picture of a Bolivian military that fought with consistent gallantry under often energetic leadership. Bolivia lost not because it performed so poorly, but because the Paraguayans innovated, and performed much better relative to their foes.

---

[97]The major indictment of Bolivian military effectiveness was advanced in R. A. Moreira, *Por Que No Ganamos la Guerra del Chaco*, La Paz: Talleres Graficos Bolivianos, 1959, which criticizes all levels. R. T. Villa, *Campana del Chaco: El General Hans Kundt*, La Paz: Editorial Don Bosco, 1961, is somewhat kinder to the German military adviser.

Bolivia Had Incentives to Initiate Conflict

* Long-standing territorial dispute

* Bolivia seeks river route to the sea

* Paraguay seemingly weak
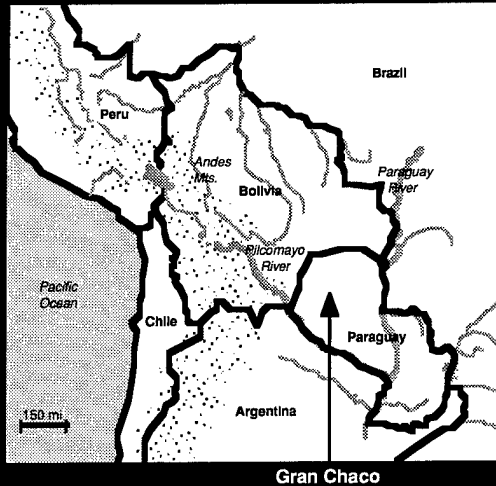
Arroyo Center

RAND

The origins of the Chaco War are not dissimilar to many other conflicts, being deeply rooted in competing territorial claims. The Chaco consists of a large, rectangular dry lowland area several hundred kilometers in length, bordered by the foothills of the Andes on the west, the Pilcomayo and Paraguay Rivers on the south and east, respectively, and by dense jungle to the north. (See the larger map on page 43.) Both Bolivia and Paraguay could, and did, muster convincing legal claims before, first, the Hague and later the League of Nations on the basis of control through discovery, conquest, and settlement. Between the 1880s and the 1920s, each established settlements and military outposts in the Chaco, with the Bolivians generally controlling more ground and taking more all the time. All mediation efforts failed miserably, in large part because Bolivia's aims could only be achieved by full annexation.[98]

Bolivia had to control the Chaco, it felt, in order to guarantee access by river to the Atlantic. After its defeat at the hands of Chile in the Pacific War (1879–1884), Bolivia had lost its Pacific access and felt the keen need to make up for this loss. Compounding this perceived geostrategic need was the apparent weakness of Paraguay. In addition to its smaller size and inherent poverty, Paraguay was still suffering mightily from the effects of the calamitous Lopez War (1864–1870) against Brazil, Argentina, and Uruguay, in which over 80 percent of its military-

---

[98]Good English-language summaries of the context of the conflict can be found in D. Zook, *The Conduct of the Chaco War*, New Haven: Bookman, 1960; and B. Farcau, *The Chaco War*, Westport: Praeger, 1996.

aged manhood was killed.[99] Further, crippling reparations payments had been inflicted upon Paraguay by the harsh terms of the peace of 1870—payments still being made beyond the turn of the century. But perhaps most important of all, Paraguay appeared weak in terms of its inability to keep up with the needs of force modernization in the wake of World War I. For Bolivia, with its oil revenues, uncontrolled military, and German advisers, the reverse was true, a situation that encouraged aggressiveness in the handling of the Chaco dispute.

Gran Chaco

---
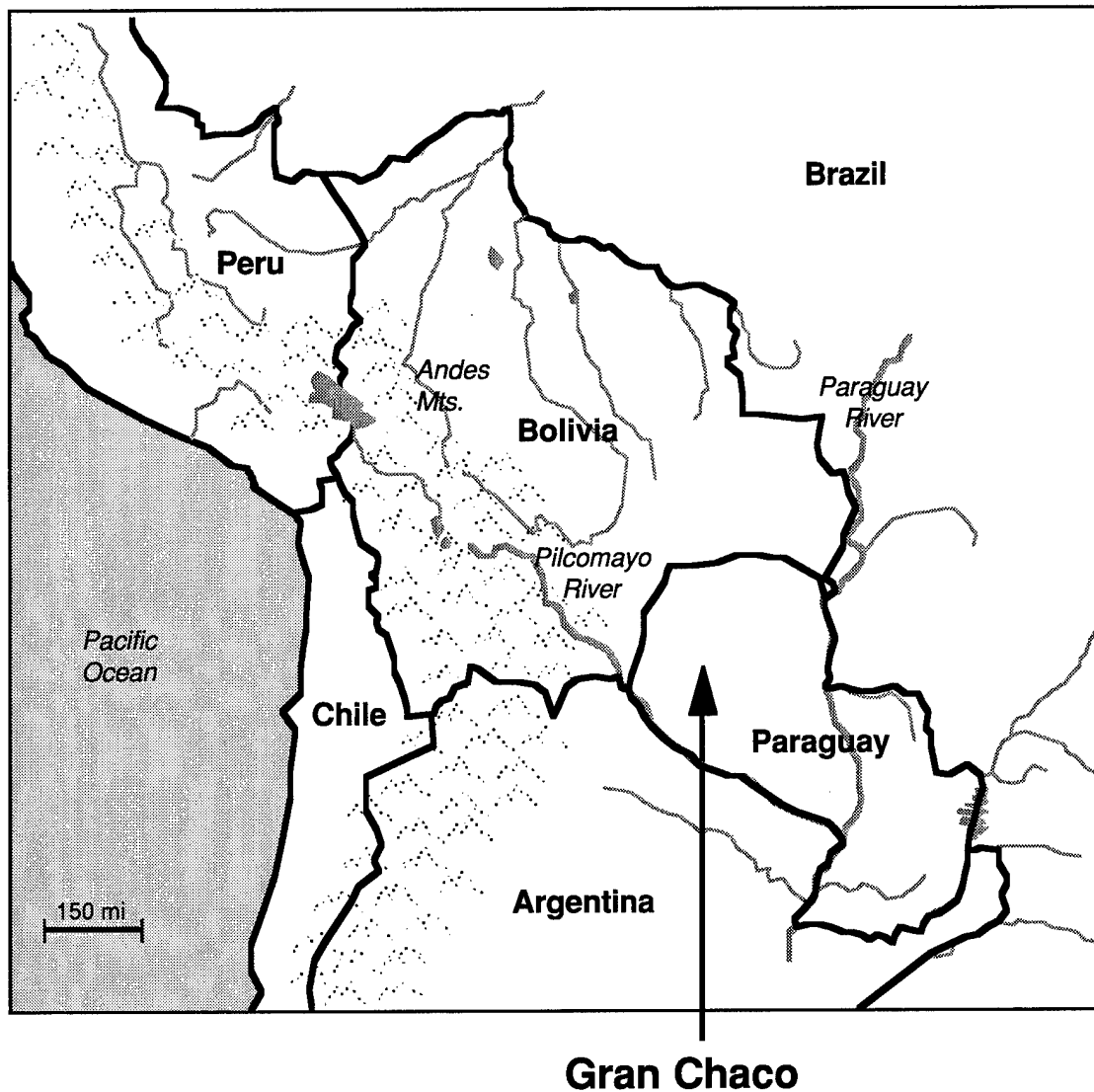
[99]See the Correlates of War Index, available through the Interuniversity Consortium for Political and Social Research (ICPSR).

Comparing the Combatants:
An Apparent Imbalance of Power

Category	Bolivia	Paraguay
Population	2,500,000	900,000
Mobilized manpower	400,000	140,000
Tanks	200	nil
Warplanes	150	12
Howitzers	500	50
Stokes-Brandt mortars	nil	10

Arroyo Center

RAND

A quick glance at the table shows that the Bolivians enjoyed sizable quantitative advantages over the Paraguayan army. With nearly three times the population base and mobilized manpower, Bolivia would seem well poised to wage an attritional war, which was its basic strategy. Bolivian forces would advance slowly, secure their logistics, and consolidate their gains with the construction of *fortines*, or fortified bases. Beyond their advantages in numbers, though, the Bolivians also had absolute air supremacy, and their armored forces faced no like opposition. In field artillery, they were also very much ahead of the Paraguayans. Though they pursued an attrition-oriented limited aims strategy, the Bolivians had also planned extensively to fight maneuver battles in the Chaco—in the event of active Paraguayan resistance—which they believed would showcase their advantages in air and armor. The Bolivian general staff (modeled after its German counterpart) fully expected their adversaries to beat a fighting retreat to the Paraguay River, there to make a last stand before capitulating under heavy Bolivian attritional blows.[100]

In analyzing the correlation of forces, we must acknowledge Bolivian advantages in numbers and technology—but raise a few cautionary points. First, their tanks, while generally of an advanced design (for the time), had inadequate support and recovery services. Also, their World War I–vintage planes, while very good for reconnaissance, carried very limited bomb payloads, and the Bolivian

---

[100]Bolivian views and assessments are most thoroughly exposited in E. Paz-Soldan, *Guerra del Chaco: Planes y Conduccion de Operaciones Militares*, Cochabamba, Bolivia: Impresiones Poligraf, 1989.

aviators were far more interested in "strategic bombing" than in close-support strafing. Finally, the Paraguayans did hold the advantage in one key area: the Stokes-Brandt trench mortar, which was to provide simple, mobile (many were truck mounted) fire support for Paraguayan infantry throughout the war.

The Bolivians were aware of the Paraguayan investment in trench mortars; but rather than seeing this as a signpost of a novel strategy, they reasoned that Paraguay's military opted for these weapons because they could afford nothing else and could not coerce their government into providing better tools of war for their forces. In other words, the Bolivians suffered from a kind of cognitive bias, seeing in the acquisitions of the Paraguayans what they "expected" to see from their impoverished adversaries. When war came in 1932, as the Paraguayans finally decided to resist the "creeping offensive," the Bolivians shifted to their more active plan for annexation of the whole Chaco. But Paraguay had no intention of ceding it to them.

**Paraguayan Innovation
Offsets Bolivian Imitation**

Bolivia	Paraguay
◦ Plan a linear, methodical offensive	◦ Employ a forward, decentralized defense
-- Division-sized maneuvers	-- Utilize small, mobile infantry detachments
-- Combined arms attritional attacks	-- Use Stokes-Brandt mortars for fire support
-- Search relentlessly for decisive battle	-- Attempt to defeat Bolivia in detail
◦ Adopt "defense dominance"	◦ Reject "defense dominance"
-- Emphasize tanks and aircraft	-- Emphasize neither tank nor aircraft
-- Construct lines of fortification	-- Decide against river fortifications

Arroyo Center·   RAND

The opening weeks of the war featured a Paraguayan attack on the *fortin* at Boqueron in a Bolivian-controlled area of the Chaco. Caught somewhat off guard by the Paraguayan decision to take the offensive, the Bolivian garrison was soon besieged—but acquitted itself admirably until forced to surrender due to lack of water. The fall of Boqueron was seen as a minor setback of the type that often occurs at the outset of war, and the Bolivians went ahead with their well-rehearsed war plan. A general mobilization soon began, with steps quickly taken to reinforce other *fortines* and to plan for the advance to the Paraguay River. The Bolivians soon had division-sized elements on the march supported by tanks and planes, all in search of a decisive engagement with the Paraguayans. However, some armor and air power was also allocated to shoring up the defenses of the *fortines* where, it was hoped, they would inflict heavy casualties upon any new Paraguayan attacking forces. For the Bolivians believed that taking the offensive required massive numerical superiority—one of the key lessons of World War I.[101]

The Paraguayans quickly disconcerted their foes. Despite losing some ground to the Bolivians initially, they were clearly rejecting the idea that defense from fortified positions—such as were naturally provided by the Paraguay River— was advantageous. Instead, the Paraguayan army, under the leadership of General Felix Estigarribia, defended the Chaco far more actively—and far

---

[101]This is a point made again and again throughout the official Bolivian planning documents. See J. A. Osorio, *Entretelones de la Guerra del Chaco: Documentos Basicos para el Juicio Historico*, La Paz: Talleres Graficos Bolivianos, 1973.

forward. The Paraguayans maneuvered their forces separately, employing decentralized, small (company-sized) units of infantry supported by their trench mortars, which had a highly disconcerting effect on the Bolivians. Though maneuvering separately, the Paraguayan detachments could also combine against portions of the Bolivian army. In this manner, the "swarming" tactics of the Paraguayans soon disrupted the Bolivian offensive, not least because the former avoided a classical decisive battle in favor of disrupting key nodes of the extended Bolivian logistical chain. The Bolivians fought with great valor, yet, despite their superior overall numbers, they fought most of the battles at numerical disadvantage—they were being defeated in detail. The Bolivians had decided to imitate the most advanced armies of their day, but found themselves being defeated by a smaller, lesser-equipped force that had found a way to innovate.[102]

---

[102]Pablo Max Ynsfran's annotated version of *The Epic of the Chaco: Marshal Estigarribia's Memoirs of the Chaco War, 1932–1935*, Austin: University of Texas Press, 1950, especially pp. 18–39, contains Estigarribia's own lengthy description of how he championed the case for "forward defense" of the Chaco, as well as the vital support he received from those Paraguayan officers who had been to French and Soviet military schools and absorbed their ideas. See also J. B. Ayala, *Planes de Operaciones en la Guerra del Chaco*, Asuncion: Talleres Graficos de la Escuela Tecnica Salesiana, 1969.

Paraguay Prevails!

- After initial success, Bolivia loses all Chaco conquests; 80,000 killed
- Paraguay retains Chaco; loses 50,000
    - Truck-mounted mortars wildly successful against static defenses
    - Airpower ineffective against dispersed bands
    - Bolivian logistical needs too great
- The key to Paraguayan success: synergy of doctrine, tactics, and technology
    - Fiscal constraint necessitates creative approach to warfighting
    - A visionary military leader champions decentralized operations

Arroyo Center RAND

Despite the territorial gains of their major concentrated forces, and their good tactical results in open battle with the Paraguayans, the Bolivians were never able to come to grips with Estigarribia's main force—mostly because there wasn't one! The decentralized detachments struck consistently at key pressure points of the Bolivian army, resulting in the Altiplanans often having to fight with scant ammunition and supplies against superior numbers. The Stokes-Brandt mortar had a shattering effect on the battlefield, causing grievous casualties—Bolivia lost 80,000 battle dead. The valor of the Bolivians, and their occasionally effective air power, armor, and artillery, did inflict 50,000 battle deaths on the Paraguayans.[103]

A key factor in deciding this war, though, was the relative advantage of the mobile trench mortar in providing very accurate fire on demand, versus the low-payload aerial bombardment campaign with which Bolivia hoped to undermine the Paraguayan strategy. Further, because it was a modern, technology-heavy force using traditional divisions as its units of maneuver, the Bolivian army faced sharp logistical requirements that made it particularly vulnerable to the Paraguayan strategy of disruption. Paraguay pioneered a way of war that grew

---

[103]Reported death figures vary by about 20,000 both higher and lower than the above-mentioned losses. We have surveyed the primary literature and official military histories of the war from both sides, and have found that estimates from the Correlates of War Index, op. cit., fall between Bolivian and Paraguayan estimates, which routinely underestimate friendly losses and overestimate the enemy's. We therefore use the Correlates of War estimates herein; note that they include deaths from infection or disease as a result of wounds.

out of its tight fiscal constraints and the vision of one key officer, who was in turn backed up by an officer corps that had been systematically exposed to nonlinear, irregular operations in French and Russian military schools.[104] Bolivia lost the whole Chaco in this war, including all the territory upon which it had been encroaching for decades.

---

[104]See Zook, op. cit.; Farcau, op. cit.; and Ynsfran, op. cit. While the French were thinking about fortifications at this time, and the Russians about armor, both were also studying what we now call "low-intensity conflict" very closely. Indeed, the French waged a counterinsurgency in the Moroccan Rif in the 1920s and the Russians utilized small detachments fighting nonlinearly during their civil war.

4. FORMULATING A PREDICTIVE FRAMEWORK

Outline

- Introduction
- Defining military innovation
- Formulating a conceptual framework
    - Existing perspectives
    - Hypotheses
    - Case studies
- **Formulating a predictive framework**
    - **Indicators**
    - **Strategy: the missing dimension**

Arroyo Center

RAND

The Cases Validate Similar Hypotheses and Suggest a Set of Indicators

		The IDF	Vietnam	Chaco
Structural Realist	External threat and/or revisionist aims?	yes	yes	yes
	Relative resource constraints?	yes	yes	yes
Societal	Cohesive society?	yes	yes	yes
Organizational (Institutionalist)	Past failure?	unclear	unclear	unclear
	Slack?	no	no	no
	Civilian intervention?	no	unclear	no
Organizational (Professionalist)	Product champions?	yes	yes	yes
	Career paths?	yes	yes	yes

Arroyo Center•   RAND

The IDF, Vietnam, and Chaco cases validate and refute similar hypotheses. For example, Israel, North Vietnam, and Paraguay faced a high external threat and relative resource constraints, and North Vietnam also had revisionist aims. Each society was cohesive. Product champions played an important role—Sharon, Dayan, and Tolkowsky in Israel; Giap in North Vietnam; and Estigarribia in Paraguay. Career paths allowed innovation to take hold. Slack was not a prerequisite.[105]

Two hypotheses are neither validated nor refuted fully. First is the hypothesis that innovation requires past failure. In the IDF case, poor performance furthered innovation in the early 1950s and again after 1973. And, conversely, success in 1967 did not promote continued innovation. On the other hand, success in 1956 *did* promote continued innovation, as was made clear in 1967. In the case of Vietnam, guerrilla campaigns against the French in the 1940s and 1950s surely provided useful lessons about fighting a more advanced adversary. But it is hard to relate this experience to the tactical innovations demonstrated against the United States in the late 1960s. In the Chaco case, finally, it is unclear whether Paraguay's disastrous experience in the Lopez War played a role in shaping its defense planning. Although this conflict ended more than sixty years before the Chaco War began, its effects—including costly reparations and

---

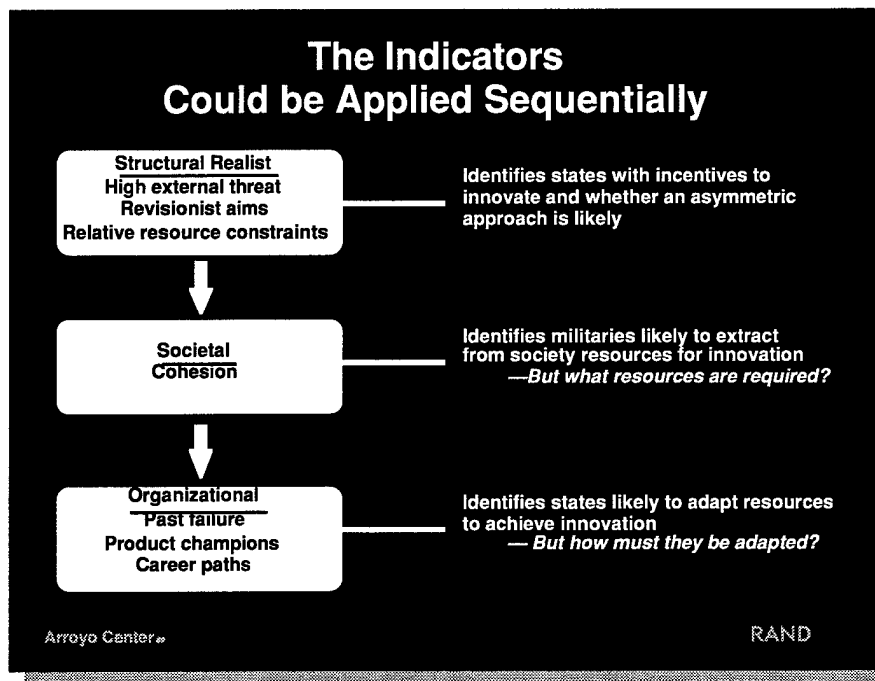[105]In fact, the absence of slack was important in all cases.

massive population loss[106]—were enduring. Overall, the cases suggest that past failure *may* promote innovation, but is not required for it.

The second hypothesis that is neither validated nor refuted fully concerns the role of civilian intervention. In the IDF and Chaco cases, civilian intervention was not required for innovation to proceed, whereas in the Vietnam case, the military and civilian authorities are so closely intertwined that the question is moot. Overall, civilian intervention is like past failure: it may play a role in promoting innovation, but it is certainly not required. Unlike past failure, though, its usefulness as an indicator is limited.

In summary, the cases suggest a set of indicators that are particularly relevant to military innovation:

- High external threat
- Revisionist aims
- Relative resource constraints
- Societal cohesion
- Past failure
- Product champions
- Career paths.

---

[106]R. E. Dupuy and T. N. Dupuy, *The Harper Encyclopedia of Military History*, New York: HarperCollins, 1993, p. 998.

**The Indicators
Could be Applied Sequentially**

Structural Realist
High external threat
Revisionist aims
Relative resource constraints

Identifies states with incentives to
innovate and whether an asymmetric
approach is likely

Societal
Cohesion

Identifies militaries likely to extract
from society resources for innovation
—*But what resources are required?*

Organizational
Past failure
Product champions
Career paths

Identifies states likely to adapt resources
to achieve innovation
— *But how must they be adapted?*

Arroyo Center•

RAND

When they are applied sequentially, the indicators construct the basis of a preliminary framework for predicting military innovation.[107] Structural realist indicators identify states with incentives to innovate and, depending on relative resource constraints, whether an asymmetric approach to innovation is likely. In addition, the societal indicator identifies militaries likely to extract resources for innovation, and organizational indicators identify states likely to adapt the resources to achieve innovation. The indicators are more probabilistic than deterministic. For example, a cohesive state that has product champions and faces serious external threats is more likely to succeed at military innovation than a divisive state facing no threats.[108]

Key pieces of information are not specified, however: (1) the resources required for innovation, and (2) how they must be adapted to achieve innovation. The absence of this information reveals two inherent contradictions. First, the likelihood of extracting resources from society must depend on the level of resources to be extracted. Second, the likelihood of adapting resources to achieve innovation must depend on how they are to be adapted. In effect, the framework cannot predict the likelihood of achieving innovative success independent of defining the particulars of what innovation entails.

---

[107]The framework derives from three case studies of successful innovation. Additional cases are required to demonstrate the framework's validity and robustness.

[108]But, of course, the cohesive state may fail to innovate altogether.

As it stands, the predictive framework is incomplete because it leaves key questions unanswered. Military strategy completes the framework by helping to define the context for examining these questions. In large measure, it is strategy that connects objective indicators with innovative outcomes.[109]

The Chaco case illustrates this point. Paraguayan military strategy required limited material resources (to purchase trucks and trench mortars) and a relatively straightforward program for adapting them (Paraguay sought to execute decentralized, small-unit operations). The military was therefore more likely to extract and adapt what was needed for innovation. Had the Paraguayan strategy called for complex, technology-intensive operations, the military would have been unlikely to extract and adapt what was needed. Indeed, Paraguay could scarcely afford tanks, aircraft, and artillery, and would have been hard pressed to satisfy the logistical requirements such platforms create.

Unfortunately, military strategy is hard to quantify. Compared to tabulating orders of battle or assessing military capabilities, understanding strategy entails a different analytical process utilizing different types of information. But to predict military innovation, we argue, understanding strategy is essential.

---

[109]In many cases, it is a subcomponent of an overall military strategy that is pertinent to innovation. In the 1960s, for example, the strategy to develop helicopter air-mobility within the U.S. Army was a subset of a broader U.S. military strategy.

**There Are Generic Signposts
That Help Illuminate Military Strategy**

* Prior military strategy
* Doctrinal writings
* Exposure to foreign military doctrines
* Equipment inventories
* Force deployments
* Training exercises

Arroyo Center   RAND

As difficult as military strategy is to quantify, generic signposts can shed light on the subject. These signposts are listed above.

Returning to the Chaco case, could the Bolivians have foreseen Paraguayan strategy? Given a sensitivity to the issue of possible innovation, they might well have. First, they were well aware of Paraguay's poverty and its fears that war might come. At a structural level, these factors should send up warning signals of there being "demand" for innovation. Second, the Bolivians knew where the Paraguayans were getting their training, and knew how closely they studied the counterinsurgencies in the Rif and the Russian civil war. These were the major recent conflicts studied in the military schools of the 1920s, and they were highly nonlinear in nature. Third, the Bolivians knew that the Paraguayans had not fortified the Paraguay River in preparation for its defense. They should have considered the possibility that this was not simply a function of poverty, but rather an indication of possible intent to wage a forward defense. The Paraguayan decision to purchase trench mortars (through Argentina, and against which the Bolivians protested) should have also provided a hint as to the maneuver nature of the war that the Paraguayans envisioned. If they intended to defend the Paraguay River by fighting a set-piece defensive battle, they would certainly have acquired some artillery.

Bolivia failed to detect Paraguayan innovation largely because of its focus on measuring the quantitative correlation of forces, and because it assessed possible innovations solely in light of technological advances—neglecting the possibility of a new strategy emerging to defeat them. In this regard, the case of the Chaco War provides an instructive, truly cautionary tale.

Final Remarks

- Structural realist, societal, and organizational indicators provide the basis of a preliminary framework for predicting military innovation
- But the framework requires a strategic context
  - Assuming that an opponent will do what is expected or desired is dangerous
  - The asymmetric threat may be the real challenge
- The U.S. may be driving others toward asymmetric approaches
  - Imitating the U.S. has high entry and integrative costs
  - Asymmetric approaches can ameliorate these costs

Arroyo Center   RAND

In conclusion, we have constructed a preliminary framework for predicting military innovation comprising structural realist, societal, and organizational indicators that are applied within a given strategic context. Three case studies of successful military innovation highlighted the relevance of these indicators and the significance of strategic context. Additional case studies (perhaps examining failure to innovate) are required to further demonstrate the validity and robustness of the framework.

The current international security environment underscores the importance of military strategy. Without an understanding of an opponent's strategy, it is natural to assume he will do what is expected or desired. This is especially dangerous in a world where the asymmetric threat may be the real challenge faced by the U.S. military. Indeed, imitating the United States has high entry and integrative costs; to the extent that asymmetric approaches help ameliorate these costs, the United States may be driving others toward asymmetric strategies.

BIBLIOGRAPHY

Allison, G., *The Essence of Decision: Explaining the Cuban Missile Crisis*, Boston: Little, Brown, 1971.

Ayala, J. B., *Planes de Operaciones en la Guerra del Chaco*, Asuncion: Talleres Graficos de la Escuela Tecnica Salesiana, 1969.

Ben-Horin, Y., and B. Posen, *Israel's Strategic Doctrine*, Santa Monica, CA: RAND, R-2845-NA, 1981.

Clodfelter, M., *The Limits of Air Power: The American Bombing of North Vietnam*, New York: The Free Press, 1989.

Cohen, E. A., and J. Gooch, *Military Misfortunes: The Anatomy of Failure in War*, New York: The Free Press, 1990.

Cordesman, A. H., and A. R. Wagner, *The Lessons of Modern War, Volume I*, Boulder, CO: Westview Press, 1990.

Cordesman, A. H., and A. R. Wagner, *The Lessons of Modern War, Volume II*, Boulder, CO: Westview Press, 1990.

van Creveld, M., *Military Lessons of the Yom Kippur War: Historical Perspectives*, Beverly Hills, CA: Sage Publications, 1975.

Department of the Army, *Israel: A Country Study*, Washington, D.C.: U.S. Government Printing Office, DA Pam 550-25, 1990.

Desch, M. C., "Culture Clash: Assessing the Importance of Ideas in Security Studies," *International Security*, Summer 1998, pp. 141–170.

Dupuy, R. E., and T. N. Dupuy, *The Harper Encyclopedia of Military History*, New York: HarperCollins, 1993.

Evangelista, M., *Innovation and the Arms Race: How the United States and the Soviet Union Develop New Military Technologies*, Ithaca, NY: Cornell University Press, 1988.

Farcau, B., *The Chaco War*, Westport: Praeger, 1996.

Farrell, T., "Figuring Out Fighting Organizations: The New Organisational Analysis in Strategic Studies," *Journal of Strategic Studies*, March 1996.

Giap, V. N., *People's War, People's Army: The Viet Cong Insurrection Manual for Underdeveloped Countries*, New York: Frederick A. Praeger, 1962.

Goldman, E. O., "Institutional Learning Under Uncertainty: Findings from the Experience of the U.S. Military, unpublished manuscript, Department of Political Science, University of California, Davis, 1996.

Gordon, M. E., and B. E. Trainor, *The Generals' War*, Boston: Little, Brown and Company, 1995.

Harkavy, R. E., and S. G. Neuman (eds.), *The Lessons of Recent Wars in the Third World, Volume I*, Lexington, MA: D. C. Heath and Company, 1985.

Harris, J. P., and Toase, F. H. (eds.), *Armoured Warfare*, New York: St. Martin's Press, 1990.

Herrera, G., Ph.D. dissertation, Princeton University, Princeton, NJ.

International Institute of Strategic Studies, *The Military Balance 1965–66*, London: Brassey's, 1965.

International Institute of Strategic Studies, *The Military Balance 1990–91*, London: Brassey's, 1990.

Johnston, A. I., *Cultural Realism: Strategic Culture and Grand Strategy in Chinese History*, Princeton, NJ: Princeton University Press, 1995.

Kier, E., "Culture and Military Doctrine: France Between the Wars," *International Security*, Spring 1995.

Krepinevich, A. F., *The Army and Vietnam*, Baltimore: The John Hopkins University Press, 1986.

Lanning, M. L., and D. Cragg, *Inside the VC and the NVA*, New York: Fawcett Columbine, 1992.

Lomperis, T., *From People's War to People's Rule: Insurgency, Intervention, and the Lessons of Vietnam*, Chapel Hill: University of North Carolina Press, 1996.

Luttwak, E., and D. Horowitz, *The Israeli Army*, New York: Harper & Row, 1975.

March, J. G., and H. A. Simon, *Organizations*, New York: John Wiley & Sons, 1958.

Meese, M. J., "Institutionalizing Maneuver Warfare: The Process of Organizational Change," in Hooker, R. D., Jr. (ed.), *Maneuver Warfare: An Anthology*, Novato, CA: Presidio Press, 1993.

Millet, A. R., W. Murray, and K. H. Watman, "The Effectiveness of Military Organizations," *International Security*, Summer 1986.

Moreira, R. A., *Por Que No Ganamos la Guerra del Chaco*, La Paz: Talleres Graficos Bolivianos, 1959.

National Training Center, *The Iraqi Army: Organization and Tactics*, Fort Irwin, CA: National Training Center, Handbook 100-91, 3 January 1991.

North, D. C., *Institutions, Institutional Change, and Economic Performance*, Cambridge: Cambridge University Press, 1990.

Osorio, J. A., *Entretelones de la Guerra del Chaco: Documentos Basicos para el Juicio Historico*, La Paz: Talleres Graficos Bolivianos, 1973.

Paz-Soldan, E., *Guerra del Chaco: Planes y Conduccion de Operaciones Militares*, Cochabamba, Bolivia: Impresiones Poligraf, 1989.

Pike, D., *PAVN: People's Army of Vietnam*, Novato, CA: Presidio, 1986.

Posen, B., *The Sources of Military Doctrine: France, Britain, and Germany Between the World Wars*, Ithaca, NY: Cornell University Press, 1984.

Rosen, S. P., "Military Effectiveness: Why Society Matters," *International Security*, Spring 1995.

Rosen, S. P., "New Ways of War: Understanding Military Innovation," *International Security*, Summer 1988.

Rosen, S. P., "Societies, Military Organizations and the Revolution in Military Affairs: A Framework for Intelligence Collection and Analysis," unpublished manuscript, June 1996.

Rosen, S. P., *Winning the Next War*, Ithaca, NY: Cornell University Press, 1991.

Rothenberg, G. E., *The Anatomy of the Israeli Army*, New York: Hippocrene Books, Inc., 1979.

Scott, W. R., *Organizations: Rational, Natural, and Open Systems*, New York: Prentice Hall, 3d ed., 1992.

Simon, H. A., *Models of Man, Social, and Rational*, New York: John Wiley & Sons, 1957.

Snyder, J., *The Ideology of the Offensive: Military Decisionmaking and the Disasters of 1914*, Ithaca, NY: Cornell University Press, 1984.

Snyder, J., *The Soviet Strategic Culture: Implications for Limited Nuclear Operations*, Santa Monica, CA: RAND, R-2154-AR, 1977.

Theis, W. J., *When Governments Collide: Coercion and Diplomacy in the Vietnam Conflict*, Berkeley: University of California Press, 1980.

Thompson, V. A., *Bureaucracy and Innovation*, University, AL: University of Alabama Press, 1969.

Van Dyke, J. M., *North Vietnam's Strategy for Survival*, Palo Alto, CA: Pacific Books, 1992.

Villa, R. T., *Campana del Chaco: El General Hans Kundt*, La Paz: Editorial Don Bosco, 1961.

Waltz, K. N., *Theory of International Politics*, Reading, MA: Addison-Wesley, 1979.

Webster's Ninth New Collegiate Dictionary, Springfield, MA: Merriam-Webster, Inc., 1987.

Westney, D. E., *Imitation and Innovation: The Transfer of Western Organizational Patterns to Meiji Japan*, Cambridge, MA: Harvard University Press, 1987.

Ynsfran, P. M., *The Epic of the Chaco: Marshal Estigarribia's Memoirs of the Chaco War, 1932–1935*, Austin: University of Texas Press, 1950.

Zisk, K. M., *Engaging the Enemy: Organizational Theory and Soviet Military Innovation, 1955–1991*, Ithaca, NY: Cornell University Press, 1993.

Zook, D., *The Conduct of the Chaco War*, New Haven: Bookman, 1960.