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**Author**

Bitzinger, Richard

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# RESEARCH BRIEF

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## Military-Technological Innovation in Small States: The Cases of Israel and Singapore

Richard A. Bitzinger

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Israel and Singapore are both countries with small populations and no strategic depth, and both see technology as a crucial force multiplier when it comes to national security. Israel, however, has been much more successful than Singapore in developing a range of indigenous military-technological innovations. The reasons are both geostrategic and cultural. Israel faces a much more looming and imminent threat which demands more military-technological innovation. Moreover, Israel's informal and anti-hierarchical society is much more supportive than Singapore's when it comes to risk-taking and experimentation.

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Israel and Singapore, on the surface, share many characteristics when it comes to security and defense. Both are small countries with small populations and no strategic depth, ostensibly surrounded by a metaphorical sea of adversaries or potentially hostile neighbors. Both rely heavily upon sizable conscript armies, drawn from universal national service and long reservist obligations. Both have military expenditures that are relatively high for countries of their size, and their armed forces—air, sea, ground, and other—are generally equipped with the most advanced weaponry that is readily available and kept in a high state of readiness.

Moreover, both Israel and Singapore place a great deal of importance on advanced military technologies for national defense. In both countries, technology is viewed to be a critical force multiplier when it comes to national security and defense, and the idea of leveraging advanced military-technological capabilities as much as possible is uncontested. In conjunction with this approach, achieving a high degree of self-sufficiency in sophisticated armaments has long been a priority for both countries. As such, both Israel and Singapore have by design created and nurtured a clutch of indigenous defense industries, with the intention of meeting—as much as it is financially and technological feasible—national requirements for the acquisition of advanced weapons systems and other types of military equipment.

In this regard, both countries are fortunate in that they are islands of superior economic and technological development within their respec-

tive regions, boasting considerable industrialization, state-of-the-art high-technology sectors (companies, laboratories, universities, technology incubators), and highly educated work forces. They therefore possess many indigenous capacities and competencies that can be exploited for advanced military-technological innovation and development. This has, theoretically at least, bolstered their faculties for advancing self-reliance in research and development (R&D) and manufacture of cutting-edge—or even novel—military equipment.

And yet, when we more closely examine the individual experiences of each country, we see a marked gap in achievement when it comes to military-technological innovation. In particular, Israel has been much more pioneering when it comes to original and state-of-the-art military systems. This is self-evident in a number of examples: drones, stand-off precision-guided weapons, missile defenses, electro-optical systems, systems for command, control, communications, computing, intelligence, surveillance, and surveillance (C4ISR). In comparison, most of the indigenous weapons systems coming out of Singaporean arms factories are remarkably prosaic in terms of technology and function; only rarely do Singaporean military systems approach the state-of-the-art. The question to ponder, therefore, is what domestic factors account for the differences in these two countries' approaches and outcomes?

## ISRAEL

Two factors have most affected the process of military-technological in-

novation in Israel: strategic necessity and a “culture of improvisation.” Israel subsists in a unique security environment, basically one of a permanent existential threat. Consequently, Israel’s approach to security is driven by a strategic culture characterized by an “obsessive siege mentality” and a “quest for absolute security.”<sup>1</sup> Israeli security policy emphasizes maintaining a “qualitative edge” over its adversaries in order to offset the latter’s likely numerical advantage.<sup>2</sup> Interestingly enough, Israel does not make a trade-off between quantity and quality, but rather seeks both. Faith in state-of-the-art technology (as a “quick fix”) has grown as an ideal, but at the same time the Israel Defense Forces (IDF) seeks to complement any technological superiority with a “faith in quantity as a quality.” In other words, “what doesn’t work with force will work with more force.”<sup>3</sup>

Given this faith in technology as a cure-all, continuous technological innovation has long been a “central tenet” of Israeli security policy.<sup>4</sup> In the first place, this has meant investing “vast resources” in such innovation reflected in part by high levels of defense R&D spending. Just as important has been the creation and nurturing of an “ultrasophisticated and innovative defense industry.”<sup>5</sup>

At the same time, Israeli strategic-military culture is still improvisational, characterized by a deliberate aversion to “paradigmatic shifts” in doctrine, organization, and operational concepts.<sup>6</sup> Rather, Israelis prefer to improvise, and thus the IDF has developed a tradition of learning and adapting on the fly. Consequently, the IDF deliberately does not “do” strate-

1 Dima Adamsky, *The Culture of Military Innovation: The Impact of Cultural Factors on the Revolution in Military Affairs in Russia, the United States, and Israel* (Palo Alto, CA: Stanford University Press, 2010), 125–26.

2 Adamsky, *Culture of Military Innovation*, 113–15.

3 Adamsky, *Culture of Military Innovation*, 114.

4 David A. Lewis, “Diversification and Niche Market Exporting: The Restructuring of Israel’s Defense Industry in the Post-Cold War Era,” in *From Defense to Development: International Perspectives on Realizing the Peace Dividend*, ed. Ann Markusen, Sean DiGiovanna, and Michael C. Leary (London: Routledge, 2003), 130.

5 Adamsky, *Culture of Military Innovation*, 125–26.

6 *Ibid.*, 116.

gy or planning, and it takes a distinctly problem-solving and anti-intellectual approach to military operations (“doers, rather than talkers”).<sup>7</sup>

Israel’s improvisational nature has resulted in a number of military-technological innovations, including drones, active armor, missile defenses, C-RAM (counter rockets, artillery, and mortar) systems, and cyber viruses. It has also driven the process of constant innovation and improvement, such as the evolution of Israeli unmanned aerial vehicles (UAVs) from short-range tactical reconnaissance systems to more capable surveillance systems such as the Heron MALE (medium-altitude, long-endurance) UAV, and the Hermes attack drone.<sup>8</sup> Such improvisation has been particularly pronounced in Israel’s heavy employment of “crash” programs, such as Iron Dome to defend against short-range rockets fired by Hezbollah forces in Lebanon and Gaza, converting old or captured Soviet tanks into armored personnel carriers, and developing systems that use radar and 3D image-reconstruction algorithms to “see through” walls given IDF challenges when it came to house-to-house fighting in Lebanon and Gaza.<sup>9</sup>

Finally, Israeli military-technological innovation and adaptation has benefited greatly from the country’s uniquely non-hierarchical—even *anti-hierarchical*—society. Israelis are remarkably casual, informal, assertive, and flexible in their dealings with

each other.<sup>10</sup> This resulting overall informality and absence of hierarchy, together with a “common and collective sense of insecurity,” helps spur innovation—especially in the military-technological realm—by breaking down barriers to interaction and creating an atmosphere that encourages and enables the free exchange of ideas.<sup>11</sup> In short, Israel is a society more inclined to engage in high-risk military-technological innovation, because it is deemed essential to national survival.

### SINGAPORE

Singapore, like Israel, sees technology as a critical force multiplier.<sup>12</sup> Since around the turn of the twenty-first century, the country has been engaged in a “third-generation” (3G) transformation of its military. The interests of the Singapore Armed Forces (SAF) in defense transformation stems from a perception of new unconventional threats, a recognition of its traditional strategic weaknesses (lack of strategic depth, a small and aging population, and limited defense resources), and its economic and technological advantages, particularly in aerospace, shipbuilding, and computing and information technologies.

Consequently, the Singaporean defense industry plays an integral role in serving Singaporean strategic interests, particularly by providing the SAF with a “technological advantage over its regional rivals.”<sup>13</sup> The lo-

cal arms industry is inexorably linked to Singapore’s concept of “total defense,” that is, the idea that the entire resources of the nation must, if necessary, be mobilizable for the sake of national defense.<sup>14</sup> And while Singapore is hardly self-reliant when it comes to military equipment, the maintenance of at least some degree of indigenous armaments production is regarded as crucial to the physical and psychological defense of the nation.

Singapore’s defense ecosystem promotes a basically evolutionary approach to innovation. The Singapore Armed Forces “has particularly maintained a consistent ‘spiral’ capability development in key technological areas central for its warfighting capability.... These policies have been central to SAF’s evolutionary innovation and were spurred by a unified civil-military relation and rationalized in terms of the high level and diversity of threats Singapore has to continually confront.”<sup>15</sup>

At the same time, Singapore is a highly risk-averse culture. Corporate ownership in Singapore tends to be highly concentrated; additionally, the largest local firms are state owned. Such factors tend to encourage managers to focus on low-risk strategies. As two political economists put it, “Singaporean managers and employees may be exceptionally creative, but because the institutions foster conflicting innovation styles, their efforts do not produce sustainable innovative activity.”<sup>16</sup>

7 Ibid., 119.

8 Yaakov Katz and Amir Bohbot, *The Weapons Wizards: How Israel Became a High-Tech Military Superpower* (New York: St. Martin’s, 2017), 12.

9 Marc R. DeVore, “Commentary on the Value of Domestic Arms Industries: Security of Supply or Adaptive Innovation?” *Defense Studies* 17, no. 3 (2017): 250.

10 Adamsky, *Culture of Military Innovation*, 117–19; Katz and Bohbot, *Weapons Wizards*, 9–12.

11 Katz and Bohbot, *Weapons Wizards*, 12.

12 Tim Huxley, “Singapore and Military Transformation,” paper delivered to the conference on the RMA for Small States: Theory and Application, Singapore, February 25–26, 2004, 2.

13 IHS Jane’s, *Navigating the Emerging Markets: Republic of Singapore* (Coulson, Surrey: IHS Jane’s, 2011), 18.

14 Bilveer Singh, “ASEAN’s Arms Industries: Potential and Limits,” *Comparative Strategy* 8 (1989): 251.

15 Evan A. Laksmna, “Threats and Civil–Military Relations: Explaining Singapore’s ‘Trickle Down’ Military Innovation,” *Defense and Security Analysis* 33, no. 4 (2017): 11–12.

16 Richard W. Carney and Loy Yi Zheng, “An Explanation for Singapore’s Innovation Gap,” *RSIS Commentary* CO200849, April 21, 2008.

In addition, Singapore's society is nearly the opposite of Israel's. Singapore is a highly hierarchical and stratified society, with an emphasis on top-down governance and administration. The government (itself a single-party state) is involved in everything deemed worthwhile. Citizens are only asked to be obedient, conformist, and hardworking. The SAF, therefore, is supposed to act more as a melting pot than an actual defense force. It is intended to get the four main races (Chinese, Malay, Indian, and "other") to come together, interact, and learn to recognize that they all have a common identity (Singaporean) and a common goal of protecting and preserving the Singaporean state. Consequently, military-technological innovation is basically gradualist and evolutionary (i.e., sustaining innovation), and the emphasis is more on adaptation than invention.

## CONCLUSIONS

Both Israel and Singapore engage in military-technological innovation in areas deemed critical to strategic sovereignty. In both cases, top-level leadership support for a strong national defense is high. Correspondingly, political elites in both countries have consistently championed high levels of funding for military R&D and for maintaining and nurturing indigenous defense industries. Both countries have, to a varying degree, strongly supported the cultivation of local S&T, including the spin-on of commercial high-technology breakthroughs into the defense sector. And both countries recognize the need to promote risk-taking in order to encourage innovation (especially military-technological innovation), although both countries have experienced contrasting success in this regard.

Consequently, both countries have successfully carved out particular

niches for themselves when it comes to armaments production. In Israel's case, these include unmanned systems, missile defenses, active armor defenses, precision-guided munitions and C4ISR technologies. In the case of Singapore, core competencies are in small arms, light armored vehicles, naval ship construction, and the maintenance, repair, and overhaul (MRO) of weapons systems used by the SAF.

In a comparative sense, however, the Israeli military-industrial complex appears to be much more comprehensive than Singapore's, and much more capable of state-of-the-art military-technological innovation. Singaporean efforts at innovation appear to be geared toward modest R&D efforts to retain the minimal means for supplying its armed forces with the basics of military requirements or else revolve around adapting and modifying foreign innovations to national use. Therefore, while there is defense innovation, there actually exists little actual military-technological innovation. In sum, while Israel's defense industry has engaged in a number of original, even disruptive types of innovation (such as Iron Dome and Trophy<sup>17</sup>), Singapore is mostly engaged in "copy innovation," or, at best, "creative adaptation."

Why is it that Israel seems to be outperforming Singapore when it comes to military-technological innovation? Part of it is motivation: Israel innovates because it has to; its strategic situation is much more tenuous than Singapore's. There is also a continuous need to innovate, to remain one (or preferably several) steps ahead of one's adversaries. Necessity is the mother of invention. Consequently, Israel devotes many more resources to its defense than Singapore and to underwriting military-technological innovation. It has a large military R&D budget, strong links to civilian high-tech/dual-use

technology centers inside the country, and its defense industrial base is much more oriented toward creative innovation and adaptation.

Singapore, on the other hand, mostly innovates because it wants to. It faces much less of an existential threat, and it already possesses a huge technological (and numerical) advantage over its presumptive competitors or adversaries. That capabilities gap is not likely to narrow anytime soon. In the first place, most other militaries in the region remain follower/adaptor types (even more so than Singapore), as opposed to true innovators. Most of these militaries could not even be called "fast followers" when it comes to military-technological developments.

There is also the important matter of culture and society. Israel's society is characterized by a casual, informal, assertive, and flexible style, and a dearth of hierarchy in social relations. Israelis are, by nature, much more risk-prone and improvisational, and more comfortable with on-the-fly decision-making and with making (and correcting for) errors. Hence, they are almost natural innovators, and this is reflected in the strategic culture of the IDF and the national defense industry. Singaporean society and culture is nearly the exact opposite: a very hierarchical, top-down system that emphasizes stability and national unity. Hence, it is a society that tends to promote caution and risk aversion, and, subsequently, inhibits innovation.

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**Richard A. BITZINGER** is a senior fellow and coordinator of the Military Transformations Program at the S. Rajaratnam School of International Studies, where his work focuses on security and defense issues relating to the Asia-Pacific region, including military modernization and force transformation, regional defense industries and local armaments production, and weapons proliferation.

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<sup>17</sup> Iron Dome is an air-defense system used to shoot down short-range missiles and artillery shells. Trophy is an active protection system for armored vehicles that utilize shotgun-like projectiles to defend against incoming anti-armor munitions.