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RESEARCH BRIEF

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Innovation in the Interwar Years

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Defense innovation is the transformation of ideas and knowledge into new or improved products, processes, and services for military and dual-use applications. It refers primarily to organizations and activities associated with the defense and dual-use civil-military science, technology, and industrial base. Included at this level are, for instance, changes in planning, programming, budgeting, research, development, acquisition and other business processes. The period between the two world wars offers a rich set of cases for examining defense innovation. These include the development of armored warfare, strategic bombing, close air support, carrier aviation, amphibious warfare, and radio and radar. Whereas others have focused on military innovation in the interwar period, the focus of this brief is on defense innovation in general, and the development of tanks in Britain, the United States, and Germany in particular.

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UNDERSTANDING DISRUPTIVE INNOVATION

The development of armored warfare, of which tanks were a necessary but insufficient ingredient, qualifies as a disruptive innovation.¹ Across history, such disruptive innovations have led to large-scale changes in the character and conduct of war, producing winners and losers, and altering the geopolitical landscape.² In each case, new combat methods arose that augmented, displaced, or replaced previously dominant forms of warfare by shifting the balance between offense and defense, space and time, and fire and maneuver.³ The militaries that first adopted these innovations gained a significant advantage, forcing competitors to match or counter them to have any chance of prevailing on the battlefield. Those who adapted prospered, while those who did not declined, often precipitously.

History shows that catalytic factors are central in bringing about disruptive innovation. The threat environment plays a key role. First, most disruptive innovations have come about because of the perception of an operational or strategic problem that defied a conventional solution. The urgency of action and the absence of incremental, routine alternatives is often necessary to break the strong preference of existing bureaucracies to apply their standard solutions to the problem. Indeed, innovation is often an unnatural act for organizations that are, by their very nature, meant to routinize rather than innovate.

Second, top-level leadership support is crucial to the success of disruptive innovation. Leaders often must ensure that the innovation effort receives the economic, technological, and human resources it needs to be successful and also defend it against those who would seek to kill or sideline it. In addition, resources and resource constraints and organizational culture qualify as important supplementary drivers of innovation.

TANK DEVELOPMENT IN THE INTERWAR PERIOD

World War I saw the battlefield introduction of tanks. In the later stages of the war, Great Britain and France fielded sizable tank forces. The American Expeditionary Force, entering the war in 1918, largely used British and French tanks. Germany, by contrast, possessed a small tank force and was subsequently forbidden from possessing tanks by the Versailles Treaty. Thus in 1920, Britain and France were world leaders in tank technology, whereas Germany was banned from possessing tanks. Two decades later, by contrast, it was the Wehrmacht's tank force that played a central role in Germany's *Blitzkrieg* through France and the Low Countries. Although the development of tank technology was but one element of combined-arms armored warfare (and indeed not the only technological component: radios and close air support aircraft also played important roles), the development of tank technology in the interwar period nonetheless provides

a window into peacetime defense innovation.

Great Britain

As already noted, Great Britain in 1919 possessed the world's most formidable, and most experienced, tank force. By 1939, however, British tank capabilities had, in relative terms, diminished. This was partly the result of the lack of the sort of catalytic factors that would have driven innovation. First, Great Britain's threat environment militated against the development of armored forces: the Versailles Treaty disarmed Germany (at least ostensibly—see the section on Germany), and the so-called Ten-Year Rule, enacted in August 1919 and renewed annually until the mid-1930s, contained the planning assumption that “the British Empire will not be engaged in any great war during the next ten years, and that no Expeditionary Force is required for this period.”⁴ By contrast, the main task of the British Army during the interwar period was imperial policing, which seemed to have little place for armored forces. That is not to say that Britain did not purchase tanks or experiment with armored warfare; it did both. However, resource constraints, coupled with the British army's tank acquisition decisions, limited the force's flexibility. And although some of the world's foremost theorists of armored warfare were British, including Basil H. Liddell-Hart and J. F. C. Fuller, these mavericks did not speak for the institutional British Army. To the contrary, Fuller at least

1 A good discussion of defense innovation can be found in Tai Ming Cheung, Thomas G. Mahnken, and Andrew L. Ross, “Frameworks for Analyzing Chinese Defense and Military Innovation,” in *Forging China's Military Might: A New Framework for Assessing Innovation*, ed. Tai Ming Cheung (Baltimore, MD: Johns Hopkins University Press, 2014). For more on military innovation between the wars see Williamson Murray and Allan R. Millet, eds., *Military Innovation in the Interwar Period* (London: Cambridge University Press, 1996); Thomas G. Mahnken, *Uncovering Ways of War: US Military Intelligence and Foreign Military Innovation, 1918–1941* (Ithaca, NY: Cornell University Press, 2002).

2 See Bernard Brodie, “Technological Change, Strategic Doctrine, and Political Outcomes,” in *Historical Dimensions of National Security Problems*, ed. Klaus Knorr (Lawrence: University Press of Kansas, 1976); William H. McNeill, *The Pursuit of Power: Technology, Armed Force, and Society Since AD 1000* (Chicago: University of Chicago Press, 1982); Geoffrey Parker, *The Military Revolution*, 2nd ed. (Cambridge: Cambridge University Press, 1996); and Clifford J. Rogers, ed., *The Military Revolution Debate: Readings on the Military Transformation of Early Modern Europe* (Boulder, CO: Westview Press, 1995).

3 Eliot A. Cohen, “A Revolution in Warfare,” *Foreign Affairs* 75 (2) (1996): 43–44.

4 Cited in Paul Kennedy, *The Rise and Fall of British Naval Mastery* (New York: Penguin, 2004), 273.

ridiculed the British officer class and was in return spurned by it.⁵

Immediately after the armistice, the Tank Corps contracted and dispersed as the Army readopted a minor role as colonial police. The industrial base scattered as well, and only Vickers was left to make tanks. Vickers did its design in-house and sold prototypes overseas, so it had unusual flexibility, and produced the Vickers Medium Mk I, which was slow and under-armored but carried a real anti-tank gun.

The tank advocates, Fuller and Liddell-Hart, worked with sympathetic Chief of the Imperial General Staff, General George Milne, to arrange an experimental mechanized force for exercises starting in 1926. The exercises continued off and on until 1932. They inspired the tank community, but radical tank advocates interpreted failures as failures of combined arms, and pushed for an all-tank army that would conduct operations like a fleet of ships at sea.

Before the inspiration and lessons of the exercises could be put into practice through research and development (R&D), the Great Depression stifled R&D budgets. Vickers had to cut production of its Mk III "Sixteen-Tonner," which would have been the heaviest British tank. The industrial base languished and almost nothing was produced until rearmament programs began in the mid 1930s.

As rearmament began, the lost time of the early 1930s meant that no acceptable tanks were available to go into production. The tank designers had lost talent, so the R&D process went slowly. The Army wanted new tanks to be Mediums with better armor and firepower, but no designer was able to adequately meet standards. The new Master-General of Ordnance, Sir Hugh Elles, had been

commander of the Tank Corps during WWI, and his experiences predisposed him to favor very heavy "Infantry" tanks that could support armored assaults. The current CIGS, Montgomery-Massingberd, pushed a plan that used cavalry as the base for mechanization; anticipating cavalry-like maneuvers and led by radical tank advocates, the Royal Tank Corps demanded fast, light 'Cruiser' tanks that could operate away from infantry. Ordnance, unable to produce an all-purpose Medium, decided to just design both types.

With demand now for two different types of tanks, plus a third 'Christie' tank that Giffard Martel, Assistant Director of Mechanization at the War Office, pushed for after seeing them in action in Russia, the industrial base (Vickers) couldn't keep up. Two new firms, Nuffield and Vulcan Foundry, were brought in, but their inexperience meant they were slow to start and error-prone. Therefore, although the government now had support for rearmament in the rising threat environment, only a small number on inadequate tanks could be designed and manufactured before the war.

The United States

The United States faced some of the same constraints as Britain. It was unclear how tanks would fit into the most likely contingencies the United States faced: the need to defend the Philippines against a Japanese attack, expeditionary warfare in Central America and the Caribbean, and the need to defend the Panama Canal. Funding for tanks was also lacking throughout much of the period. Furthermore, the fact that the 1920 National Defense Act assigned tanks to the Infantry constrained the way that Army officers thought about

them (but did not, however, prevent the Cavalry from procuring "cavalry cars" that were indistinguishable from tanks for cavalry missions). Still, the United States developed and acquired its own tanks and closely observed the development of armored warfare by other states, including Britain and Germany. These efforts served the Army well when it stood up the Armored Force a month after the fall of France.⁶

From 1927 to 1931, following the example of Britain, Secretary of War Davis established first an Experimental Mechanized Force and then an ostensibly permanent Mechanized Force to serve as a test bed to explore the utility of tanks. These formations had a mixed effect on armor innovation. On the one hand, because they used the aging fleet of WWI-era tanks, which broke down continuously, they reinforced the perception that tanks had only situational utility. On the other, they brought together for the first time a large number of officers from across the branches of the Army, including Cavalry officers such as Adnan Chaffee and Daniel van Voorhis who would continue to advocate for the development of armor throughout the interwar period.

Because of the confusing user requirements throughout the 1920s, the Ordnance Department was unable to produce a satisfactory tank that could be used by the Mechanized Force. Depression-era cuts to the R&D budget meant that they could only procure a small number of prototypes, so they could not practically experiment, while user requirements continued to grow. Designers chafed at continued demands for accessories such as compasses and communications gear when they struggled to find the resources to develop an ef-

⁵ See, for example, J. F. C. Fuller, *Generalship: Its Diseases and Their Cure: A Study in the Personal Factor in Command* (Harrisburg, PA: Military Services Publishing, 1936).

⁶ See, for example, Thomas G. Mahnken, "Beyond Blitzkrieg: Allied Responses to Combined-Arms Armored Warfare During World War II," in *Adaptive Enemies, Reluctant Friends: The Impact of Diffusion on Military Practice*, eds. Emily O. Goldman and Leslie C. Eliason (Palo Alto, CA: Stanford University Press, 2003).

fective chassis or engine. Their work was further complicated by the appearance of the inventor J. Walter Christie, who appealed directly to the Tank Board with prototypes of high speed, convertible wheel-to-track tanks. The Tank Board, seeking 'strategic mobility,' directed the Ordnance Department to procure a series of Christie's expensive prototypes. The Ordnance Department was obliged to expend scarce resources on those prototypes, but did not approve any for standardization, because Christie achieved high speeds in part by testing his tanks without guns or adequate armor. Ultimately, the concept of relying on a single inventor for tank design was at odds with the Ordnance Department's plan for making the most of limited resources: although some of Christie's innovations were ground-breaking, such as his suspension system, they wanted to use commercially-available components that could be employed across different tank and combat car designs.

In 1931, Army Chief of Staff Douglas MacArthur overrode the intent of the 1920 National Defense Act and articulated a new plan for mechanization: he reorganized the Mechanized Force as a Cavalry unit, and directed all branches to pursue mechanization simultaneously. He called for a gradual approach that made use of the few available prototypes for doctrinal experimentation while awaiting the development of a tank for mass production. The reorganization ensured that a larger community throughout the Army considered the possibilities of mechanization. Influenced by reports from Europe of heavier tanks, a broad consensus began to develop in favor of heavy tanks, with the light tank concept abandoned altogether. The trend can be seen in the design work at Rock Island Arsenal from 1935–1939: as they designed prototypes for the M2A1, the M2A2, and the M2A4 in sequence, the

armor iteratively increased from 6 to 25 mm. As the conception of a tank standardized throughout the Army, the Ordnance Department in 1938 was finally able to approve a prototype which went into production as the M2 a year later.

The interwar period was a time of experimentation, as different tank concepts competed. The designers in the Ordnance Department, however, were not funded accordingly. While the War Department and the tank users called for high-quality vehicles to match each of their evolving concepts, the Ordnance Department could only procure a small number of prototypes, each of which failed to meet the high and changing standards. Only in the mid-1930s did the concept for a tank stabilize to the extent that they could develop a series of prototypes into a production-ready design. Stability in design concept then came at the expense of innovation: the alternative concept that would eventually be proven in combat, a well-armored tank with a heavy gun, was neglected until 1940.

Germany

At first blush, Germany is the last country one would have expected to develop a powerful armored force. Germany had deployed a miniscule tank force in World War I, and the Versailles Treaty that followed forbade Germany from possessing tanks. However, Germany's threat environment, leadership support, and hard and soft factors conspired to create a sort of hothouse of innovation and spurred German armor development.

Germany's threat environment and the prospect of a two-front war against France and Poland, combined with the resource constraints imposed by the Versailles Treaty (including its limitation of the size of the *Reichswehr* to 100,000 men) drove Germany to explore modern technology as a source of qualitative advan-

tage. These were reinforced by an interwar army dominated by staff officers who were dedicated to studying and learning the lessons of WWI.⁷ Germany's tank development was aided by covert arms development programs in violation of the Versailles Treaty (including the so-called "Light Tractor" and "Heavy Tractor" programs), as well as programs by German industry to design tanks for export to Sweden and Hungary.

CONCLUSION

The development of tank technology in the interwar years highlights the role of catalytic factors in promoting disruptive innovation. Despite its initial lead in tank technology, the lack of a strategic or operational challenge that demanded innovation in tank warfare hampered innovation, as did the lack of leadership support, constrained resources, and organizational culture. The United States similarly lagged in tank development, but was able to adapt rather quickly once a threatening security environment emerged. For Germany, a pressing set of strategic and operational challenges, senior military leadership support, the unique resource constraints imposed by the Versailles Treaty, and organizational culture together created a sort of hot-house for innovation. As a result Germany, which had very much been a second-tier player in tank technology in WWI, moved to the forefront by WWII.

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⁷ James Corum, *The Roots of Blitzkrieg: Hans von Seeckt and German Military Reform* (Lawrence: University Press of Kansas, 1992).