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Germany's Potential for Military Innovation in Today's Security Environment

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Executive Summary

Title: Germany's Potential for Military Innovation in Today's Security Environment

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Thesis: Military innovation theory provides us with the ideal set of criteria for successful innovation, but the current strategic environment of Germany hinders innovation more than it promotes it. Germany's alliances seek stable multinational defense projects which rely on lengthy bureaucratic processes. Often, a modernization or an update of existing military material is preferred to taking the risk of innovative approaches and new equipment. Consequently, Germany does not promote revolutionary or innovative initiatives for its armed forces.

Discussion: First, the German *White Paper 2016* marks a decisive change in German Security Policy, which requires a combination of change, modernization, adaptation and innovation within the German Federal Armed Forces in order to meet the outlined political objectives and increase military efficiency and effectiveness. Second, the analytical framework for military innovation in peacetime must reflect military operations other than war (MOOTW) and the interdependencies between innovation in conventional and unconventional forces. Finally, MOOTW and Special Operating Forces (SOF) provide an outstanding environment for military innovation in the German Armed Forces, while the potential for innovation within the conventional area is significantly constrained. Increased experimentation with off-the-shelf technology could lead to an increased operational effectiveness and can function as an innovation source or battle lab for the German Armed Forces as a whole.

Conclusion: Germany is a nation with a world reputation in mechanical engineering and the export of highly sophisticated and innovative industrial products. Germany's national interests are strongly connected to preserving current international order and stability. At the same time, the German political approach favors diplomatic and comprehensive approaches to purely conventional military efforts. Although the potential for military innovation per its definition[1] is constrained within the conventional forces, great potential and benefit can be found within the SOF community of the German Armed Forces. Increased experimentation and a tight relationship between the SOF and the defense industry should create a battle lab, which would benefit the entire German Armed Forces.

[1] A military innovation is a change in the manner in which military formations function in the field. It must be significant in scope and impact and is tacitly equated with greater military effectiveness.

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THE OPINIONS AND CONCLUSIONS EXPRESSED HEREIN ARE THOSE OF THE INDIVIDUAL STUDENT AUTHOR AND DO NOT NECESSARILY REPRESENT THE VIEWS OF EITHER THE MARINE CORPS COMMAND AND STAFF COLLEGE OR ANY OTHER GOVERNMENTAL AGENCY. REFERENCES TO THIS STUDY SHOULD INCLUDE THE FOREGOING STATEMENT.

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Preface

Over the course of my career, I have witnessed that military organizations have limitations when it comes to change and adaptation. The study of innovation theory at Marine Corps University confronted me with German innovation in the interwar period (1918-1939) and the connected theories of change, adaptation, and innovation. Many innovation theories reach back to that interwar period, and so I started thinking about how the situation has changed for Germany today. Furthermore, I wanted to come up with some ideas of how the German Armed Forces can innovate more effectively and efficiently. I am thankful for the help of my friends at the Gray Research Center, who supported at any time and motivated me when I showed up in the library for another writing session. I also want to thank my mentor Dr. Nathan Packard for his professional and wise guidance on my project. Nathan provided me the freedom of movement and the space for my thoughts that a Command and Staff College should provide. It was incredible to see how Nathan perfectly balanced the birth of his twins and his responsibilities as a mentor.

The writing process helped me to understand Germany's history and its present challenges much better. I hope to combine these thoughts with all the other positive impressions I gained from my time with the Marines and help to shape the innovative future of the German Armed Forces.

"A number of points can be drawn from the experimentation in the 1920s and 1930s. First, it appears that top-down leadership usually resulted in flawed experimentation. Though innovation requires support from the top, experiments and exercises must test precepts and conceptions. Top-down leadership breeds institutional biases against ideas emerging from below. Such an approach leads to experiments that confirm revealed doctrine rather than provide objective testing. Second, effective innovation requires an identifiable enemy. Germany intended to fight both Poland and Czechoslovakia and eventually France. When enemies remain undefined, it is difficult to develop a coherent concept to fit national strategy or even the next war. Third, both experimentation and innovation must be historically connected to the recent past as well as understanding the unchanging nature of war- that fog, friction, and ambiguity will interfere with the conduct of operations regardless of technological advance. Finally, military culture was integral in developing realistic and effective experiments that examined the potential of innovation and exercises that contributed to the process. It had to be receptive to learning from tests and drills. Not surprisingly, a culture that encouraged the critical study of even the most closely held believed, innovated most intelligently."[1]

Williamson Murray, *Military Innovation in the Interwar Period*

I. Introduction

Military innovation theory provides us with the ideal set of criteria for successful innovation, but the current strategic environment of Germany hinders innovation more than it promotes it. Germany's alliances seek stable multinational defense projects, which rely on lengthy bureaucratic processes. Often, a modernization or an update of existing military material is preferred to taking the risk of innovative approaches and new equipment. Consequently, Germany does not promote revolutionary or innovative initiatives for its armed forces.

The often-used abstract idea of a separation between wartime and peacetime innovation does not fit the current security environment. Germany has been acting in a peacetime environment since the foundation of the German Armed Forces post-World War II. Although being per definition at peace, the German Armed Forces are, in fact, faced with and engaged in hybrid warfare and military operations other than war (MOOTW) and this on a permanent basis. The German Armed Forces planned for a conventional fight during the Cold War, but never engaged in a conventional war and consequently could not test and validate operational concepts and

doctrine. Therefore, a clear separation between wartime and peacetime innovation is not applicable to Germany.

The latest 2016 *White Paper* on German Security Policy and the Future of the Bundeswehr breaks with the practical obstacles to innovation. In the paper, Germany articulates a desire for greater effectiveness and efficiency in its military and promotes innovative responses to new demands. This paper is structured on the analysis found in the German *White Paper 2016* and analyzes the potential for innovation within the German Armed Forces in the current security environment. It identifies both the key factors that already determine the innovative potential and factors that need to be changed or newly established in order to support successful innovation better. The analysis concludes with recommendations for change and adaption that will increase the operational effectiveness of the German Armed Forces. This paper presents three arguments.

First, the German *White Paper 2016* marks a decisive change in German Security Policy, which requires a combination of change, modernization, adaptation, and innovation within the German Federal Armed Forces to meet the outlined political objectives and increase military efficiency and effectiveness. Second, the analytical framework for military innovation in peacetime must reflect MOOTW and the interdependencies between innovation in conventional and unconventional forces. Finally, MOOTW and Special Operating Forces (SOF) provide an outstanding environment for military innovation in the German Armed Forces, while the potential for innovation within the conventional area is significantly constrained. Increased experimentation with off-the-shelf technology can lead to an increased operational effectiveness and can function as an innovation source and battle lab for the German Armed Forces as a whole.

II. Framework for Military Innovations Theory in Peacetime

"…there is nothing more difficult to carry out, nor more doubtful of success, nor more dangerous to handle, than to initiate a new order of things." [2]

Niccolo Machiavelli, *The Prince* (1513)

A. Innovation Theory

The study of military innovation has developed into its own scientific field, which tries to understand the sources and criteria for military innovation based on historical cases. The assessment of the interwar period and innovations in Britain, France, and Germany as described in Barry Posen's book *The Sources of Military Doctrine* (early 1980s) represents one of the first social science studies of military innovation.[3] Here, Posen weighs "the bureaucratic, 'power political,' technological, and geographic influences that shape the grand strategies and military doctrines of states."[4] Adam Grissom, as a highly respected researcher in the field, analyzed the state of military innovation research in his 2007 article on *the Future of Military Innovation Studies*.[5] To answer his own question, what exactly constitutes a military innovation, Grissom states that "authors in the field have proposed a tangle of orthogonal, even contradictory, definitions."[6] As there was no suitable definition available, Grissom proposed a tacit definition. This he introduces as follows:

> Fortunately, much of this dissonance is more apparent than real. A close examination of actual practice in the field, as reflected by major publications and dissertations, reveals that military innovation scholars gravitate toward historical cases that share a distinct set of attributes. These attributes, in effect, constitute a consensus (if tacit) definition of military innovation. This tacit definition has three components.[7]

This tacit definition is the one to work with and presents itself in three components. At first, the innovation changes the manner in which military formations function in the field, second the innovation is significant in scope and impact and third, the innovation is tacitly equated with

greater military effectiveness. All three attributes for military innovation lift the tag ‘military innovation’ to the very top of a hierarchy of labels for changes within a military organization. Military innovation is a fundamental change and not just a small change to the organization. If it comes to change in general, other terminologies like modernization or adaptation are used to describe the update of already existing material or ideas, which are improved to a new level of quality. In the military context, adaptation often describes a reaction to opposed strategies, tactics or weapons generations. Particularly for tanks and fighter aircraft, the generation of weapons systems is utilized as an indicator of relative superiority. Furthermore, military innovation should be considered as an active process and is naturally not reactive. A responsive innovation is more likely to some kind of adaptation. Military innovation as an active process and therefore seeks to increase military effectiveness and to achieve military objectives more effectively.

In addition to defining military innovation as such, it is important to distinguish the different models that are used to describe military innovation. These models identify various sources of military innovation. Four different models are utilized. At first the civil-military model. Peter Rosen, a well-respected and leading researcher in the field, describes this type as the primary determinant and driver for the potential for innovation of militaries in the interwar period (1918-1939). He concludes that military innovation does not occur as a miracle, but is strongly driven by civil-political demands and political objectives as well as technological innovations. Two other models concentrate on the intra-service and inter-service rivalry. These two distinct models examine historical cases and determine the constraints for military innovation resulting from rivalries within or between the services. It becomes apparent that the obstacles to innovation also lie in the bureaucratic nature of military organizations and the inherent resistance to change. The fourth model for military innovation explores the impact of

different cultures on innovation. Although service culture is in the focus of the fourth model, its findings can be extrapolated to the level of national cultures for innovation.[8]

B. Military Innovation in Peacetime

Looking back in history and especially into the interwar period, it becomes obvious why the theory distinguishes between innovation in war and innovation in peacetime. The First and Second World Wars and the time in between, make this distinction compelling to structure and shape research and theories. While it makes historical and academic sense to draw this line for the benefit of clarity and discrimination, today's reality for western militaries lies in a gray zone of MOOTW and hybrid threats. The German Armed Forces are a force of the post-World War II and Cold War eras. While wartime military innovation in World War II involved the totality of national assets with redirected industrial capacities and a nation at war, today's military innovation confronts a peacetime economy and limited resources. This is only one example of the significant differences between historically based innovation theories and the practical constraints of today. An analysis of Germany as a case study identifies even more limitations to successful innovation.

Innovative ideas and concepts during peacetime are more likely to be evaluated based on their inherent risk of failure. Failure of new and innovative systems, tactics, and approaches are widely not accepted. In military hierarchies, good news moves faster and more often up through the chain of command. In contrast, reports on failures, mistakes, or any inability to operate, fail to reach the higher levels in time or at all. The absence of failure therefore measures success in peacetime. Consequently, conservative approaches dominate the system and modernization or adaptation are favorable to revolutionary concepts. Modernization of already-established systems

is preferred to innovative and creative new ideas, since the risk of system failure is significantly reduced, although the system might no longer fully meet the operational requirement.

The German military strives to counter the culture of risk avoidance by establishing a culture of failure tolerance.[9] A culture of failure tolerance accepts failure as a natural part of an organizational development and embraces innovative approaches and creates opportunities for new ideas. The initiative to change the culture followed a series of unreported failures and a lack of trust within the military. The expectation is to improve the capability for innovation within the respective organizations and create a more transparent system for risk management. Risk aversion in wartime follows the opposite cultural approach. Risk aversion is reduced for the willingness to achieve success. The ultimate objective to win the war has historically helped to overcome individual change resistance mechanisms and safeties. Success is rewarded, and although failures are not praised, they are accepted as an implied cost of success. One might come to the conclusion that without clearly defined political and military objectives and a certain freedom to operate, military success in today's security environment is difficult to define. While during peacetime and wartime, the cultural and innovative factors theoretically differ, MOOTW occurs somewhere in the middle of both. During Germany's operations in the Balkans and Afghanistan, military adaptation and modernization were enforced and strengthened, since the military organization was confronted with new objectives and new mission requirements. The interdependencies between conventional and unconventional warfighting in today's security environments need to be better reflected in the military innovations theory.

C. Conventional and Unconventional Innovation

The military world today is divided into conventional and unconventional forces. In US military terminology, conventional forces are described as forces that are capable of conducting

operations using nonnuclear weapons and also as those forces other than designated SOF. Any forces that are nonnuclear and not SOF are conventional forces. Also, conventional forces are defined as those forces that prepare and fight the conventional war against peer and near-peer adversaries. For the purpose of this analysis, the term conventional is used in this sense. The importance and numbers of SOF Forces in operations have significantly increased. The numbers of authorized military SOF positions in the US Armed Forces rose from 42,800 personnel in 2001 to 68,000 in 2014 and direct SOF funding grew by 213% to 9.8 billion in the same timeframe.[10] The author considers the conventional domain in western militaries more likely to modernize and adapt instead of searching for innovative approaches. Reasons lie within political risk aversion, organizational resistance to innovation and, among other things, the existence of security alliances like NATO, which result in standardized doctrine and capability development processes. Western NATO militaries are designed around a conventional core, which sets requirements for long-term acquisition and budgeting. Structures are closely related to the number of weapon systems and therefore possess an inherent political aspect and attract political interest. The civil- political- military dynamics related to the defense industry, basing and acquisition foster the inflexibility of conventional structures in today's peacetime military. Conventional forces, especially within the German Air Force, are responsible for large portions of the defense acquisition and modernization budget and consequently are suspect to intense political interest.

On the other hand, the growing importance of unconventional forces since the end of the Cold War is evident in the numbers of deployed SOF, but also the increased political tendency to utilize SOF instead or in addition to conventional forces. In the US, SOF are defined as "those Active and Reserve Component forces of the Services designated by the Secretary of Defense

and specifically organized, trained, and equipped to conduct and support special operations."[11] In theoretical terms, special operations are missions to accomplish strategic objectives where the use of conventional forces would create unacceptable risk. The theory of SOF Operations argues that "SOF are differentiated from conventional forces by their fundamental qualities of elite warrior-ship, flexibility, and creativity."[12] Flexibility can be thought of as tactical innovation using or modifying a broad range of existing capabilities, whereas creativity can be thought of as operational innovation to create new capabilities. This creativity in SOF is an expression of rapid operational innovation which is unique to SOF forces.

D. The Current Political Environment for the Application of Military Force

The social, cultural, and political sensibility for the use of military force and the reduced willingness to accept casualties favors the utilization of unconventional to conventional forces. The political and social willingness to take high casualty numbers during military missions and generally to engage in military operations has declined as consequence of operations in Afghanistan and Iraq. SOF operations, combined with the utilization of high technology systems, offer the opportunity to increase control and at the same time decrease the deployed military footprint as well as the risk of failure or casualties. The combination of SOF as the human component and high-technology innovations allow for the human factor in decision making and ultimate control of any military effort. Technological advances combined with SOF creativity will result in rapid operational innovation.

On the other hand, the current political environment in Europe as demonstrated by the reaction to the Crimean Crises and Russian actions underlines the demand for modern conventional forces in high readiness. The perception of a near-peer enemy threat reached a new peak since the assumed and celebrated end of the Cold War. The new threat perception resulted

in a reorientation within Western militaries. The Crimean Crisis led especially to a serious reorientation of NATO during the Wales Summit in 2014 and the Warsaw Summit in 2016. Conventional deterrence is back on the table and goes along with increased defense budgets, the reactivation of Cold War capacities and capabilities, and a general appreciation of nearly forgotten tactics, techniques, and procedures. Because the conventional threat largely falls into old categories of east-west Cold War confrontation, many counter-measures meet the criteria of modernization or adaptation but fall short in innovative concepts to counter the threats. The Western responses are reactive to the threat environment. Far ahead of other nations, the US and Israel are utilizing new technologies like drones and robotics within their conventional forces in an increasing effort. These technologies support the political demand for less risk, fewer casualties, and a smaller footprint. However, the current technological developments in the conventional forces per definition do not meet the attributes of a military innovation. Considering the social, cultural and political environment, unmanned systems, robotics and drones possess the potential to decisively change the way formations function in the field in a significant scope and impact and also lead to greater military effectiveness.

E. Current Civilian and Military Technological Environment

The theory of military innovation describes at large the independencies between available civilian technologies and the links and application of these new technologies within the military.[13] The efforts of militaries in the interwar period to adapt to motorized and mechanized warfare, which were initiated and facilitated by the internal combustion engine, provides an excellent example of those interdependencies. Defense, security, and private industry see a range of cases for dual-use products today, which range from vehicles to helicopters. Dual- use civilian

technology in the military offers opportunities, but presents inherent risks. The missing military specification can result in a reduction of interoperability.

Drawing from military history and current changes in the civilian-industrial complex, the majority of future military innovation will build on private technological innovation. The capacity of the private industrial base outruns the defense industry regarding innovation cycles and capacity. Consequently, it makes sense to take a closer look at what currently represents civilian technological innovation and conclude from there what will most likely determine the military innovation cycle. Air and land drones are beginning to revolutionize the transportation sector. Drones as airborne video and photograph platforms are widespread and the industry faces exponential civilian market growth. Their application ranges from private use to industrial purposes. The military, in general, uses drones in different sizes for different purposes ranging from the weapon platform to small unit reconnaissance assets. The US Air Force successfully tested the in-flight release of a swarm of 103 semi-autonomous Perdex mini-drones, which share information across data links during operation and can make mission-adaptive decisions faster than RPV's controlled in the more conventional manner.[14] Drones support conventional capabilities, replace existing capabilities or increase the capacity of current capabilities. As such drones have the potential to lead to a military innovation in all domains, but currently do not fulfill the provided definition.

III. Case Study Germany

A. Strategic Environment and Strategic Priorities

The German government issued the *White Paper 2016* in reaction to a changed security situation and therein redefined Germany's security policy interests, priorities, and objectives.[15] The *White Paper 2016 on German Security Policy and the future of the Bundeswehr* is the German government's most current statement on national security policy, and it supersedes all other documents. In her foreword to the *White Paper 2016,* German Chancellor Angela Merkel states that it "sets the basis for the future course of the Bundeswehr as one of the instruments of German security policy."[16]

German security interests are determined by Germany's geographical position at the heart of Europe and its membership in the European Union. Furthermore, Germany depends on its economic strength and global trade. Article 26 of the German Constitution stipulates the necessary prerequisites to preserve peace. Consequently, it lies in the security interest of Germany to deepen European integration and consolidate the transatlantic partnership. Germany values reliability and loyalty to its allies. It is only in cooperation with others that Germany can protect its territory and liberal society, make efficient use of its profound but limited resources, and unleash its innovative and productive potential. Pursuing German interests therefore always means taking into account the interests of its allies and other friendly nations.

The *White Paper 2016* outlines Germany's security environment and concludes that the system of international order as it was established after World War II and whose organizations and institutions still provide the framework for international politics, is undergoing profound changes. For the purpose of this case study and the necessary conclusions, it is important to note that Germany's security environment has become more complex, volatile, dynamic and thus

increasingly unpredictable.[17] The drivers and effects are varied and numerous, and the identified key areas are presented in Figure 1: Challenges for German Security Policy, *White Paper 2016*.

Figure 1: Challenges for German Security Policy, *White Paper 2016*

1	Transnational Terrorism	5	Global Arms Build-Up and Proliferation of Weapons of Mass destruction
2	Challenges from the Cyber and Information Domain	6	Threats to Information and Communication Systems, Supply lines, Transportation, and Trade routes as well as to the Secure Supply of Raw Materials and Energy
3	Interstate Conflict	7	Uncontrolled and Irregular Migration
4	Fragile States and Poor Governance	8	Epidemics and Pandemics

All challenges for German Security Policy require a comprehensive response and the military cannot counter or solve the problems on its own. A conventional force alone cannot combat these challenges. A scenario of near-peer conflict is hard to imagine as the consequence of the depicted problems.

The *White Paper 2016* emphasizes that Germany would stand up to its leadership role and responsibility within the international system. At the same time, Germany acknowledges its limited own national capabilities and capacity. Consequently, German capabilities and capacity need to be supported through alliances and multinational approaches. With regards to the transatlantic relationship, The *White Paper* outlines that the trend of more European responsibility is unlikely to change. Following the publication of the *White Paper* the latest US policy statements to increase the European defense budgets confirmed this estimate. Germany, therefore, needs to find the effective and efficient means to respond to these challenges and make the best use of its available resources. A multinational and integrated approach within international organizations and alliances represents Germany's current and future approach to security policy.

The term innovation is broadly used to describe an innovative mindset positively and does not automatically intend to point to military innovation as defined in this paper. The German Secretary of Defense Dr. von der Leyen summarizes the widespread expectations for the future of the Bundeswehr and underlines the need to drive innovation forwards. The demand to drive innovation represents a high demand task for the German Armed Forces.

> As the demands on the Bundeswehr grow in variety and volume, the demands on its personnel will increase as well. The Bundeswehr needs the best possible equipment and sustainable funding to effectively meet challenges such as hybrid warfare, transnational terrorism, cyber-attacks, and pandemics and at the same time to fulfill the requirements of stronger national and collective defense. In future, it must have a comprehensive, modern range of capabilities at its disposal. It must also drive innovation and be a reliable and dependable partner to our allies.[18]

The strategic priorities set the basis for innovation within the Bundeswehr. Theoretically, the identification of objectives through a strategic planning process allows for innovative approaches to achieve these goals. In reality, the creative means and ways to the ends are limited. Compared to the interwar period, when the purpose of military innovation was to win the next conventional war, today's innovation aims for other objectives than war. The *White Paper* introduces five strategic priorities for Germany, as can be seen in Figure 2: Germany's Strategic Priorities, *White Paper 2016*.

Figure 2: Germany's Strategic Priorities, White Paper 2016

1	Guaranteeing a Whole-of-Government Approach to Security
2	Strengthening the Cohesion and Capacity to the Act of the North Atlantic Alliance and the European Union
3	Unhindered Use of Information and Communication Systems, Supply lines, Transportation, and Trade Routes as well as the Secure Supply of Raw Materials and Energy
4	Early Recognition, Prevention, and Resolution of Crises and Conflicts
5	Commitment to a Rules-based International Order

While the strategic environment and the strategic priorities influence the whole-of-government approach to security policy, the conventional tasking for the Armed Forces (in Germany's case -the Bundeswehr-) determine the more specific factors and objectives for military innovation potential.

B. Guiding Principles for the Bundeswehr of the Future

The character of conventional national and collective defense has changed in comparison to the Cold War era. Armed forces of today often face a spatially focused threat posed by military forces below or above the threshold of open warfare at short notice. This is increasingly part of a hybrid strategy that is characterized by the orchestrated use of military and non-military means across the full range of the threat spectrum. The mission of the Bundeswehr is based on constitutional guidelines as well as Germany's values, interests, and strategic priorities.[19] While the mission itself derives from Germany's strategic priorities and interests, the more basic guidance is outlined in the tasks for the Bundeswehr. The *White Paper 2016* includes Guiding Principles for the Bundeswehr of the Future, which leads the way and states the requirements for future innovation. The guideline encompasses three different principles.

First, *multinational and integration* refers to a set of bilateral and multilateral instruments for the Bundeswehr and are a key element for German defense and military policy. This first principle also relates to the complementary set of capabilities within NATO and the EU. Apparently, the more integrated the set of capabilities in multinational organization is, the more time flows into international coordination, and the less innovative the process will be. Multinationality itself can be seen as an innovative solution to achieve policy objectives, but it hinders classical military innovation under the given definition.[20]

As the second principle, the *White Paper 2016* lists *Flexibility and Agility with a single set of forces* and elaborates by describing the needs of the Bundeswehr to generate this particular set of effects. Although, the need for future technologies is explicitly mentioned, the kinds of technologies that are required for specific purposes are not explained.

The third principle is the *comprehensive approach in a national and international environment* and claims that security and stability can only be endured by a coordinated, comprehensive approach involving all relevant national and international stakeholders. This guiding principle is making an ever deeper impact on the entire spectrum of Bundeswehr operations and has integrated the Bundeswehr into a coordinated joint crisis management process.

C. Guidelines for the capabilities of the Bundeswehr

The changing nature and quantity of Bundeswehr tasks must be reflected in capability development. The Bundeswehr organizes its capabilities according to four areas: command and control, reconnaissance, effects, and support. These areas are equal and mutually dependent on each other and must, therefore, be interlinked. An agile, resilient and robust Bundeswehr must be ensured in this military engagement network.

The area of command and control (C2) must be geared towards employing forces and assets by the mission and requirements so that the desired effect can be achieved. Especially, the area of C2 is deeply linked to technological innovation and projects such as network-centric warfare, which were not only supposed to change the way formations function in the field, but also to represent a revolution in military affairs. Increased military effectiveness in the area of C2 remains an ongoing topic for the Bundeswehr although it predominantly still relies on the modernization and adaptation of technology, which will not change the way the Bundeswehr

functions in the field. Command and control evolves to a new level if one adds new innovative methods to control, e.g. unmanned vehicles within the three domains air, land, and sea. A reconsideration of C2 might be possible and necessary. Robotic technologies and other new technologies are closely linked to the area of globally oriented and internationally compatible reconnaissance. This is essential for effective intelligence collection and the ability to analyze, assess, and lead at the strategic, operational and tactical levels. The *White Paper 2016* underlines that the build-up of regional expertise must be encouraged and sustained. Reconnaissance in this sense must encompass the entire spectrum of national and international crisis prevention and crisis management. The *White Paper* assesses innovation to be the key to the future but does not explicitly outline which kind of innovation is intended.

D. MOOTW tasks and peacetime innovation under operational conditions

The order of battle for conventional German Forces has not changed much since the end of the Cold War. Drastic decisions like the deletion of the German Army Air Defense capability for budgetary reasons, a general reduction in capacity of conventional forces, or shrinking defense budgets were summarized as peace-dividend effect after the Cold War. The primary driver for modernization resulted from MOOTW and especially NATO operations in the former Yugoslavia and in Afghanistan. The material was adapted to the new operational environment. Overall, the conventional doctrine and structure of the Bundeswehr did not change, but forces were tailored to the respective mission, sourced out of a peacetime establishment. The conventional collective defense task continued to exist in theory, but the operational reality moved far away from any near-peer or peer war in the conventional sense and resources were directed towards current operational needs. The new demand created an innovative environment for new tactics, techniques, and procedures (TTP), which became a paradigm of growing

importance. For example, the security environment in Afghanistan required military observation and liaison team (MOLT) structures, which was not reflected in the peacetime establishment. The tactical level created new TTPs, which fitted the operational requirement. Innovative concepts for the new mission set-up were developed, and the procurement of new equipment and vehicles was initiated.

E. The German (Defense) Industry and the German Armed Forces within Europe

Germany's economic capacity for innovation is the driving force behind its economic strength. The increase in research and development (R&D) activities since 2007 have spurred trends. The federal government *High-Tech Strategy* has been an essential stimulus. In 2013, a total of almost 80 billion euros was spent on R&D in Germany, which corresponds to a 2.84-percent share of gross domestic product (GDP). This puts Germany in fifth place among comparable OECD countries, ahead of the USA and well ahead of France and Great Britain. Of Germany's main rivals, only South Korea and Japan invested more in R&D. Furthermore, Germany is considered to be Europe's champion inventor. In 2014, German companies filed around 32,000 applications for patent protection to the European Patent Office in Munich.[21]

The defense industry in the EU remains highly fragmented along national lines. This results in unsatisfactory cost structures, disadvantages in international competition, and potentially higher burdens for the defense budget. The German government supports the European approach to plan, develop, procure, and deliver military capabilities on a multinationally and thereby also increase the interoperability of armed forces in Europe. On the other hand, in the defense sector, it is necessary to protect Germany's own technological sovereignty by maintaining vital national technologies, which ensure military capabilities and the security of supply chains. Germany, especially, has declared armored vehicles and submarines as

military capabilities within the German defense sector, which are essential technologies of particular relevance and highest protection to guarantee nationalized availability.[22]

It is evident that constant innovation is needed to deliver adequate protection and ensure the superiority of armed forces. The *White Paper 2016* identifies the need for high-technology armaments as reaction to the significant improvement of protective technology in the 20th century. Again, this is an example of the tendency to say 'innovation', rather than to use the word adaptation.

Armaments-related research and technology (R&T) activities are thus a central driver of innovation in the armed forces and the defense industry. Spillover effects into private industry (dual-use applications) continue to be a desirable secondary effect and goal of military R&T. The current challenges surrounding the cyber and information domain, digitalization, autonomous systems, and hybrid tactics, however, call for the further development and expansion of the traditional R&T approach with one's own resources. Many sources of forward-looking technological innovation exist outside the defense sector. Their numbers are increasing. Innovation is becoming less linear and instead more and more disruptive and exponential. Technologies such as artificial intelligence have many applications that require not only planning but also explorative development.

The *White Paper 2016* recommends that Germany should play a greater role in innovation outside its own R&T and approach new drivers of innovation such as start-ups and the digital economy as a whole. A new agency should function as an interface to innovative actors and where necessary, also to manage resources for investment in studies or start-ups in key technologies. An organization such as the Marine Corps Warfighting Laboratory (MCWL)[2]

[2] The Marine Corps Warfighting Laboratory/Futures Directorate identifies future challenges and opportunities, develops warfighting concepts, and comprehensively explores options to inform the combat

might provide some guidance, elements, and ideas how such an agency on the service level should look like. This body needs to be positively disconnected from the conventional procurement and acquisition hierarchy. The agency should be located close to the SOF units and potentially attached to existing SOF development elements. A key factor is the experimentation with new technologies based on innovative concepts. The military research community in the German Armed Forces cannot be compared to US agencies like the Defense Advanced Research Projects Agency (DARPA)[3]. The new entity should mirror independence, budget, and success of DARPA on a smaller scale and guide the improvement of existing structures and procedures within the Bundeswehr.

Key technologies are based on the military requirements of the Bundeswehr, on foreign, security, and European policy interests, on Alliance commitments, and on Germany's responsibility. They are subject to regular review.[23] The key technologies in Germany, as identified by the German Ministry of Economic Affairs and Energy are depicted in Figure 3: Germany's Key Technologies, BMWI 2014. Federal Programs to strengthen the innovative potential of smaller businesses are in place.

For the Bundeswehr to drive innovation as directed by the Minister of Defense, the link between industry and the Bundeswehr must be strengthened. The budgets for R&D and experimentation must be increased. Independent funds with a high flexibility are necessary to promote innovative and experimental investments. Germany is a world leader in certain technology areas like nanotechnology as well as information and communications technology. Unfortunately, the German Military currently does not transfer this advantage into innovative

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development process to meet the challenges of the future operating environment for the United States Marine Corps (USMC).

[3] DARPA's mission is to make pivotal investments in breakthrough technologies for national security of the USA. More information under http://www.darpa.mil/.

solutions for current military problems in Hybrid Warfare or MOOTW. The conventional threat to NATO is countered by a modernized conventional force and the application of conventional concepts and doctrine, which do not differ too much from the doctrine of the Cold War. The recommendation is to utilize parts of the increased R&D budgets and to invest into experimentation for unconventional conflict solution in MOOTW scenarios. The question how the technological advantage of nanotechnology or other high-tech areas can help to come up with really innovative and alternative solutions to military problems has yet to be answered.

Figure 3: Germany's Key Technologies, BMWI 2014

1	Nanotechnology	6	Information and Communications Technology
2	Vehicle and Systems Technology	7	Lightweight Technology
3	Energy Technology	8	Electronic Industries
4	Air and Space Technology	9	Biotechnology
5	Optical Technology	10	Materials Industry

IV. Recommendations for Future Development

Effective military innovation can also increase the efficiency of the military on the battlefield. In times of austerity and strictly monitored military budgets and together with the political hesitation towards risk of failure and human losses, effectiveness and efficiency grow in importance. Effectivity should aim at the achievement of political and military objectives with military force and answer the question whether the utilized military force is adequate for the purpose. A conventional force is too often the automatic response to military problems, although more innovative ways and means might exist. Efficiency in times of austerity aims at resource efficiency and answers the question how military budgets can best serve all military-response options. Military innovation seeks to fulfill military objectives better and to support political goals. Germany's security policy insists on having a comprehensive and multinational approach towards security. The current security environment makes many recommendation specific to the German situation. Four different areas allow for recommendations for a higher military effectivity and efficiency.

A. Conventional Forces

Although the German conventional forces have severe limitations for military innovation, the German Defense industry represents a world leading industry for future technologies. The political interest in this industrial capability is unlikely to be reduced, and therefore the procurement of German and European military technology offers modernization opportunities. If the German conventional forces continue to function as a testing ground for the German Defense industry, it remains of utmost importance that the military budgets meet the demands of agreements and allow for the consequent modernization of these particular conventional forces.

The German defense budget should develop towards reaching two percent of the GDP, but even so a still more complicated question remains as to which investments are to be made. The strong multinational dependencies and alliances require functioning conventional forces, which must maintain a high level of readiness. This readiness can only be maintained by a high availability of material and an increased amount of training and exercises. The latest NATO concepts for forwarding presence in the Baltics present a case for intensified training deployments and the need for greater readiness. Although Germany takes an active part as a framework nation, the availability and readiness of the whole conventional force are significantly limited. The capacity and capability of Germany's conventional forces largely depend on multinational requirements and NATO Defense Planning. Germany functions as the logistical hub of Europe. This became evident during US Army Europe Operation Atlantic Resolve, which began in 2016, when US troops deployed to Europe to strengthen NATO's Eastern Flank and promote European Security. Germany's seaports, airports, and railway networks were vital infrastructure during the deployment of US forces.[24] Dual-use logistical capabilities for civilian-military logistics should be increased and further explored for potential efficiencies. Germany does not need to create additional tank battalions. On the contrary, it has to reconsider smart investments that profit its role in the multinational European defense concert. Conventional forces need to be kept modern, responsive and operational on a standard which meets both national and international requirements.

B. MOOTW

Military modernization of conventional forces was enforced by deployments in MOOTW like the former Yugoslavia or Afghanistan. New requirements resulted from new climate, terrain, military objectives, and in general a different operational environment. Although the theory

would define MOOTW as a peacetime operation, today's reality demands a strong linkage between the requirements of a potential conventional war and all the other tasks the Bundeswehr has to fulfill. MOOTW can function not only as a testing ground for new TTPs, but also for new technologies. As seen throughout the German deployment to Afghanistan, the whole stock of military vehicles was renewed and adapted to the new operational requirements. The Bundeswehr vehicle park at the beginning of the Afghanistan conflict was still designed to operate in the European theater and personal protection measures were at a minimum. The new operational requirements in the MOOTW environment of Afghanistan changed the requirements and led to an increased investment in procurement and acquisition of protected vehicles, personal equipment, and reconnaissance technology. A clear political will to provide the best possible protection for the deployed soldiers facilitated this change. The presence of defense industry contractors in the theater allowed for quick adaptation of weapon stations and vehicle configurations according to the tactical requirements of the deployed forces. Settings, which seemed perfect in the design department of the defense industry, were often proven dysfunctional by the customer in the field. This bottom-up innovation from the operating force to the industrial base enabled a quick feedback cycle and fine-tuned innovation in many different fields ranging from the vehicles to weapons technology.

MOOTW also allow for the testing of existing conventional capabilities in the field and so that they can be combined for new purposes. Consequently, tactical innovation and increased effectiveness and efficiencies can be achieved. This result requires a change in the mindset and enhanced creativity and experimentation during MOOTW and especially in stability operations. The standardization of required capabilities during NATO Force Planning Conferences decreases creativity and experimentation on the part of military commanders. However, Germany should

demonstrate its increased responsibilities by finding new ways for the application of its forces in MOOTW. Thus, it is important that the political and military objectives are clearly articulated and achievable through military means. The proper implementation of and participation in the comprehensive approach by all stakeholders is a precondition for success. The preparation for the next conventional war should not be entirely cut off from MOOTW which represent a significant part of military activity in today's security environment.

C. Special Operating Forces (SOF)

SOF operate and innovate in different ways than conventional forces.[25] The unconventional way and the non-standard solution for problems that occur during planning or operations are inherent in the SOF culture. SOF within the German Armed Forces represents a small percentage of the overall force with one brigade-sized element. German SOF maintains relative freedom for R&D and follows different practices for the interaction with the defense industry. Contrary to the rest of the Armed Forces, SOF supports a decentralized organization for R&D and naturally procures the next generation of small-arms and personal equipment. Regular R&D expositions and conferences are held at the Army special operations command to strengthen the ties between manufacturers and the operating forces. This enables both sides to describe and explore opportunities and demands. Special reconnaissance (SR) assets are unique to SOF and offer the opportunity to build on this capability with new technologies like autonomous systems. Not only is SR a function of SOF, but it also connects to the utilization of high-technology equipment, which is operated by highly specialized SOF soldiers. Drones and nano-drones were introduced into the SOF units before the capability spread into the conventional forces. This procedure is common to many new high-technology assets, small arms or personal protection equipment. SOF already fulfill the function of a battle lab for the conventional forces. The latest acquisition of a

new rifle for the German Armed Forces as a whole is based on a rifle which was utilized and tested in the German SOF Forces for many years. The direct link of SOF to the political and strategic leadership of the Armed Forces facilitates short innovation cycles and enables greater flexibility and creativity for experimentation with new technology. SOF can function as an innovative hub for the rest of the Bundeswehr by testing and fielding new equipment. Furthermore, innovation can also materialize through new approaches to missions or entirely new technologies, which have never been fielded in the military before. The ability to directly achieve strategic effects, together with the reduced footprint of SOF, make them more attractive for the political leadership. As the USSOCOM Vision stated, "we will lead the services in leveraging the latest technological advantages, but will actively strive to share this technology with them."[26] Therefore, a combination of new tactical and operational approaches to missions and new technologies do find an ideal ground in the SOF domain.

D. Experimentation

The culture of risk averseness can change through the active use and enforcement of testing. The German military continuously stresses a need for more innovation and a mindset of failure acceptance. Experimentation, therefore, represents a tool to strengthen both of these elements. The Marine Corps Warfighting Lab (MCWL) accounts for an example of fruitful and innovative experimentation.[27] Although the German Armed Forces utilize scientific test centers to verify the technical standards of new equipment, shortcomings do exist in field experimentation. Even though technical standards are tested under different climate environments and the tests concentrate on the fulfillment of technical specifications, this cannot be counted as innovative experimentation. The Warfighting or Battle Lab function should test off-the-shelf and prototype technology in close cooperation with the defense industry. The mission should be to find creative

TTP's and ways to approach a mission and potentially change the way military functions in the field. The German SOF battle lab should not aim for much additional personnel. The key enabling factor is budget and an uplift of restrictions for the use of equipment, which is not fully fielded with the Armed Forces. Experimentation should be conducted during regular training, exercise and deployment cycles. A key to success is tactical freedom to test and field available new technology and tools with unconventional means. The 1-star SOF commander is already responsible for the development of SOF within the Bundeswehr and accountable for R&D programs. The increased capability and capacity as head of SOF innovation expands his responsibility further and creates a flexible mechanism and an innovative testing environment. A cycle of standing conferences and future development events needs to accompany the battle-lab work.

Military training facilities in the German Armed Forces maintained units to fulfill the role of experimentation and testing until recently, although structural reforms after the 1990s resulted in their abundance. The USMC utilizes regular units for experimentation, which are dedicated to the MCWL for an extended period. The Bundeswehr should follow a similar approach for conventional experimentation. SOF units already apply certain elements of experimentation in their regular training cycles. This function should be increased and built into a Battle Lab service for certain areas of experimentation. Special reconnaissance, new weapon technology and the complete spectrum of unconventional warfare should be dedicated to SOF forces for experimentation and interlinked with an R&D plus HT industrial hub function.

E. The Battle Lab

The German Armed Forces need a center for innovation, which operates in a context experimentation and exploration. Hereby ‘battle lab’ describes a function for the Armed Forces,

but also an entity, which should be located within the German Special Forces. The centralization of Army Development centers into one command for Army Development moved all decentralized resources for the benefit of envisioned cost, procurement, and manpower efficiencies. At the same time it was a cut of creativity and innovative potential. The only remaining decentralized and partly independent future development station with extended rights and responsibilities is collocated to the German Army Special Forces Command. The battle lab will be built around this future development branch. In many aspects the battle lab function is not a question of specific manpower resources, but of a decrease of restrictions and an increase of budget. Furthermore, the cooperation between industry and the battle lab needs to be intensified. A special program to address robotics and autonomous systems generated. This project should be lifted upon the constraints of branches and services and by its very nature find unconventional and new approaches to warfare for identified new technologies and tools.

V. Conclusion

Germany is a nation with a world reputation in mechanical engineering and the export of highly sophisticated and innovative industrial products. Germany's national interests are strongly connected to preserving the current international order and stability. At the same time, the German political approach favors diplomatic and comprehensive approaches to purely conventional military efforts. Although the potential for military innovation per its definition is limited to the conventional forces, great potential and benefit can be found within the SOF community of the German Armed Forces. Increased experimentation and a tight relationship between SOF and the defense industry should create a battle lab which benefits the German Armed Forces as a whole.

The theoretical line between innovation in peacetime and innovation in war time is eroded by Hybrid Warfare and MOOTW. The changed factors for successful military innovation must be reflected in innovation theory. The German Government created the strategic initiation for a greater emphasis on innovation through the *White Paper 2016*. The current security environment provides opportunity and risk at the same time. It is easy to fall back into conventional procedures from the Cold War area, which cannot be considered sufficient for the identified challenges. The opportunity to pursue unconventional approaches and find innovative, effective and efficient responses and to embrace the latest technological developments has the greatest chance of changing the way military forces function in the field and how Germany’s defense engagement should come to a new level.

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