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14. ABSTRACT: Successive UK governments have recognized the enduring importance of maritime power for Britain as an island nation and have directed the Royal Navy (RN) to retain and develop a powerful, adaptable maritime warfighting force. The future multi-domain maritime battlespace will be a competition between access and denial. Maritime Autonomous Systems (MAS) offer a means of ensuring the RN's future remains credible and expeditionary. The RN has a decade-long interest in MAS. Despite establishing a maritime test and evaluation unit in 2004, and twelve years of continuous investment and assessment, the RN has failed to deliver any sustainable MAS operational capability. A vision for MAS finally materialized in 2014. Yet, the vision statement remains without substance and reason, providing no direction and purpose to an important program. The decade-long hiatus serves as a valuable case study for why and how innovation and change can fail within the military. The program is failing for two specific reasons. Primarily, it originated from an aversive, the desire to avoid loss of life, rather than responsive requirement, the ability to enhance combat power that arises to fill a capability gap, or meet a defined threat. Second, it is failing due to a lack of direction and commitment internally. The individuals responsible for RN MAS delivery are not incentivized to deliver meaningful objectives, nor deliver to a strict deadline. There is no consensus within the RN that MAS will enhance fighting power. Meanwhile, the commercial sector's rate of technological progress and innovation in MAS is too rapid for the current military acquisition process. The result is decision making paralysis. Research will justify the relevance of MAS in the context of the UK's National Security Strategy, and the character of future conflict. The RN's current approach to MAS will be deconstructed and compared with historical military transformations to analyze the importance of vision to the success of a program, the cultural and leadership frictions within the RN, and the influence of the commercial sector. The paper will consider the reality of financial constraint, and the intellectual capacity to implementing simultaneous change within the RN, before suggesting an alternate vision and approach to securing the future of MAS.					
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JOINT FORCES STAFF COLLEGE
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A VISION IN JEOPARDY:
ROYAL NAVY MARITIME AUTONOMOUS SYSTEMS (MAS)

by

Ashley C. Spencer
Commander, Royal Navy

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A VISION IN JEOPARDY:

ROYAL NAVY MARITIME AUTONOMOUS SYSTEMS (MAS)

by

Ashley C. Spencer

Commander, Royal Navy

A paper submitted to the Faculty of the Joint Advanced Warfighting School in partial satisfaction of the requirements of a Master of Science Degree in Joint Campaign Planning and Strategy. The contents of this paper reflect my own personal views and are not necessarily endorsed by the Joint Forces Staff College or the Department of Defense.

This paper is entirely my own work except as documented in footnotes.

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To my friend and love,
unconsciously a genius,
gliding through life with compassion and freedom.
Thank you for holding me together.
“This is water.”

Abstract

Successive UK governments have recognized the enduring importance of maritime power for Britain as an island nation and have directed the Royal Navy (RN) to retain and develop a powerful, adaptable maritime warfighting force. The future multi-domain maritime battlespace will be a competition between access and denial. Maritime Autonomous Systems (MAS) offer a means of ensuring the RN's future remains credible and expeditionary.

The RN has a decade-long interest in MAS. Despite establishing a maritime test and evaluation unit in 2004, and twelve years of continuous investment and assessment, the RN has failed to deliver any sustainable MAS operational capability. A vision for MAS finally materialized in 2014. Yet, the vision statement remains without substance and reason, providing no direction and purpose to an important program.

The decade-long hiatus serves as a valuable case study for why and how innovation and change can fail within the military. The program is failing for two specific reasons. Primarily, it originated from an aversive, the desire to avoid loss of life, rather than responsive requirement, the ability to enhance combat power that arises to fill a capability gap, or meet a defined threat. Second, it is failing due to a lack of direction and commitment internally. The individuals responsible for RN MAS delivery are not incentivized to deliver meaningful objectives, nor deliver to a strict deadline. There is no consensus within the RN that MAS will enhance fighting power. Meanwhile, the commercial sector's rate of technological progress and innovation in MAS is too rapid for the current military acquisition process. The result is decision making paralysis.

Research will justify the relevance of MAS in the context of the UK's National Security Strategy, and the character of future conflict. The RN's current approach to MAS will be deconstructed and compared with historical military transformations to analyze the importance of vision to the success of a program, the cultural and leadership frictions within the RN, and the influence of the commercial sector. The paper will consider the reality of financial constraint, and the intellectual capacity to implementing simultaneous change within the RN, before suggesting an alternate vision and approach to securing the future of MAS.

Acknowledgements

During my time in the Royal Navy I have served in, and alongside U.S. Commands on operational tours. Despite the disparity in scale of the U.S. and UK navies, I remain struck by our shared values, traditions and enduring national interests. Both nations continue to validate the political utility of an expeditionary navy. However, access to the littoral battlespace in the 21st Century will be increasingly congested and geopolitically contested. Maritime Autonomous Systems will be employed by all belligerents on both sides of the sea control equation. This thesis is borne from a drive to address the lack of consensus within the RN as to the utility of MAS, and in doing so, prepare for the future. MAS may provide the RN with a warfare competitive advantage that facilitates access and exploitation opportunities; a problem worth solving.

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Glossary

Anti-Access Area Denial (A2AD) – Anti-Access: Those actions and capabilities, usually long-range, designed to prevent an opposing force from entering an operational area. Area Denial: Those actions and capabilities, usually of shorter range, designed not to keep an opposing force out, but to limit its freedom of action within the operational area.¹ The term is becoming increasingly maligned in conceptual terms by senior U.S. Navy officers for over-stating the advantage of the defense.

Automated Systems – An automated or automatic system is one that, in response to inputs from one or more sensors, is programed to logically follow a pre-defined set of rules in order to provide an outcome. Knowing the set of rules under which it is operating means that its output is predictable.²

Autonomous Systems – An autonomous system is capable of understanding higher level intent and direction. From this understanding and its perception of its environment, such a system is able to take appropriate action to bring about a desired state. It is capable of deciding a course of action, from a number of alternatives, without depending on human oversight and control, although these may still be present. Although the overall activity of an autonomous unmanned aircraft will be predictable, individual actions may not be.³

Dirty, Dull, and Dangerous (3Ds) – Dull missions are ideal for unmanned systems because they involve long-duration undertakings with mundane tasks that are ill-suited for manned systems. Good examples are surveillance missions that involve prolonged observation. Dirty missions have the potential to unnecessarily expose personnel to hazardous conditions. A primary example is chemical, biological, and nuclear detection missions. Unmanned systems can perform these dirty missions with less risk exposure to the operators. Dangerous missions involve high risk. With advances in capabilities in performance and automation, unmanned systems will reduce the risk exposure to personnel by increasingly fulfilling capabilities that are inherently dangerous.⁴

Fighting Power – is the ability to fight and achieve success on operations. It is made up of an essential mix of three inter-related components:

- a. **Conceptual**: the thought process providing the intellectual basis and theoretical justification for the provision and employment of armed forces.
- b. **Moral**: the ability to get people to fight, individually and collectively.

¹ U.S. Department for Defense, *Joint Operational Access Concept*, (Washington, DC: Department of Defense, January 17 2012), 6.

² United Kingdom, Development, Concepts and Doctrine Centre, *United Kingdom Supplement to NATO Terminology Database*, 8th ed., (Joint Doctrine Publication 0-01.1, September 2001), A-1.

³ Ibid.

⁴ U.S. Department of Defense, *Unmanned Systems Integrated Roadmap FY2013-2038* (Washington, DC, 2014), 20.

c. **Physical:** the means to fight – a balanced, agile, maritime force at readiness and with warfighting at its core.⁵

Global Commons – The high seas, the air above it, and space constitute the physical global commons. To varying degrees, they are largely accessible by all actors and not subject to national jurisdiction – although they are all managed and controlled to some degree through international treaties and agreements.⁶

Innovation – changes the manner in which military formations function on operations; it is significant in scope and impact and provides greater military effectiveness.⁷

Intra-service Model – A school of military innovation that focuses on intra-service competition, specifically between branches of the same military service. It suggests that military services should not be considered unitary actors. Instead, innovation in modern military organizations tends to involve competition between established branches of a service and new branches that embrace new capabilities.⁸

Maritime Autonomous Systems Trials Team (MASTT) – Manned entirely by RN personnel, and consists of 20-22 persons, with dedicated facilities in Portsmouth, UK. The trials team have a specially adapted motor boat (Hazard) to launch and test 11 various REMUS and IVER Autonomous Underwater Systems, and an Explosive Ordnance Disposal Remotely Operated (underwater) Vehicle. MASTT is also trialing ACER, an open architecture combat system. The unit has a deployable containerized capability and is due to receive a Towed Sweep Unmanned Surface Vessel in the near future.

Mine Hydrographic Capability (MHC) – The RN has no future build program to replace its Mine Counter Measures (MCM) vessels on a like-for-like basis. MHC is the only alternative. MHC is strictly speaking not a vessel. However, it has already been conceptualized as a ‘down-threat,’ lost-cost hull, with a multitude of off-board systems. MHC has been designed as a transformational and incremental program that will update and subsequently replace the full existing MCM and Hydrographic capabilities to provide assured maritime freedom of maneuver, delivering minehunting, minesweeping and hydrographic mission systems (including remote controlled OBS) to legacy and future platforms.

Observe, Orient, Decide, Act (OODA) Loop – refers to the decision cycle developed by military strategist and U.S. Air Force Colonel John Boyd. This concept maintains that if someone can see what is happening in the battlespace, they can out think, out decide and

⁵ United Kingdom, Ministry of Defence, *British Maritime Doctrine*, 4th ed. (Joint Doctrine Publication, 2011), 3-1.

⁶ United Kingdom, Ministry of Defence, “Strategic Trends Programme: Future Operating Environment 2035.” *Development, Concepts and Doctrine Centre Strategic Trends Programme*, (HMSO, December 14, 2015).

⁷ Adam Grissom, “The Future of Military Innovation Studies,” *Journal of Strategic Studies*, 29:5, (24 Jan 2007), 907. The seminal work in this school is Stephen Rosen’s book *Winning the Next War*.

⁸ *Ibid.*, 913.

outperform the adversary. Boyd's theory was grounded in the importance of adaptation and explicitly based on organizational learning theory.⁹

Sea Control – The condition that exists when one has freedom of action within an area of the sea for one's own purposes, and if necessary, deny its use to an opponent, for a period of time in the subsurface, surface and above water environments.¹⁰

Strategic Defence Security Review – The UK Government's foremost document on defense strategy. Together with the National Security Strategy, it reviews the threats the UK faces, what capabilities the UK needs to respond to them, and how to configure the Armed Forces accordingly.

⁹ Frans P. B. Osinga, *Science, Strategy and War: The Strategic Theory of John Boyd* (London: Routledge, 2005), 80, 229–233, 237–239.

¹⁰ NATO, *NATO Glossary of Terms and Definitions*, AAP-06, (2013), 2-S-3.

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Abbreviations & Acronyms

Abbreviations and Acronyms	Meaning
A2AD	Anti-Access and Area Denial
ACER	Autonomous Control Exploitation and Realization
AUV	Autonomous Underwater Vehicle
DCDC	Development, Concepts and Doctrine Centre (UK)
DEFRA	Department for Environment Food & Rural Affairs (UK)
DOD	Department of Defense (U.S.)
EOD	Explosive Ordnance Disposal
FOE 35	Future Operating Environment 2035
FRO	Fleet Robotics Officer
FUUVU	Fleet Unmanned Underwater Vehicle Unit
ISTAR	Intelligence Surveillance Target Acquisition and Reconnaissance
MARCAP	Maritime Capability
MAS	Maritime Autonomous Systems
MASTT	Maritime Autonomous Systems Trials Team
MCM	Mine Counter Measures
MHC	Mine and Hydrographical Capability
MOD	Ministry of Defence (UK)
MUM-T	Manned Unmanned Teaming
OBS	Off Board Systems
ONR	Office of Naval Research (U.S.)
OPV	Offshore Patrol Vessel
ORBAT	Order of Battle (employable warfare assets)
REMUS	Remote Environmental Monitoring UnitS (a type of MAS)
RN	Royal Navy
ROV	Remotely Operated (underwater) Vehicle
SDSR	Strategic Defence and Security Review (UK)
SFPA	Scottish Fisheries Protection Agency
UAV	Unmanned Air Vehicle
UCAV	Unmanned Combat Air Vehicle
UOR	Urgent Operational Requirement
USN	United States Navy
UUV	Unmanned Underwater Vehicle
UxV	Unmanned Vehicle of any type

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Introduction

*“Vision without action is a daydream. Action without vision is a nightmare.”*¹

Successive UK governments have recognized the enduring importance of maritime power for Britain as an island nation and have directed the Royal Navy (RN) to retain and develop a powerful, adaptable, maritime warfighting force with global reach.² Across its storied history, the RN has combined the skill of a seagoing people with the promise of emerging technologies to create one of the world’s most effective maritime forces. From sail to steam, Dreadnought to aircraft carrier, and sonar to radar, the RN has always ridden the wave of new technology to increase its mastery of the seas. Securing future battlespace access while denying its use to an adversary is an enduring challenge to all navies. With the current rise of robotics and advanced intelligence, Maritime Autonomous Systems (MAS) offer a means to ensure the RN retains an effective expeditionary fighting advantage over its competitors.

MAS offers considerable operational potential to UK Defence. Yet, the RN’s MAS program is a case study in failed military innovation—a failure to convert vision into action. Nevertheless, with a few changes, the program can become a model for military innovation and provide the RN with critical access capabilities now and in the future.

Chapter 1 reveals why autonomous systems are crucial to achieving a maritime competitive advantage, thereby demonstrating why the MAS program is a problem worth solving. The RN must learn to innovate successfully in peacetime. Resourcing toward a capability vice threat is notoriously difficult. This section provides the background and

¹ Japanese proverb, non-attributable.

² United Kingdom, Ministry of Defence, *British Maritime Doctrine*, 4th ed. (Joint Doctrine Publication, 2011), 1-2.

context to the RN's decade-long interest in unmanned vehicles (UxVs) and MAS (2004-2014). The period is summarized as *action without vision—a nightmare*. The RN failed to deliver any sustained MAS operational capability despite continuous investment and assessment.

Finally, in 2014, the then First Sea Lord (1SL), Admiral Sir George Zambellas made the announcement, “You will all be clear on my intent as to what I want for the Navy...The Royal Navy will lead and win through the innovative and robust exploitation of Maritime Autonomous Systems.”³ Chapter 2 identifies the flaws in the RN's MAS vision. An effective vision provides organization energy and purpose. The 1SL's vision lacks clarity of direction and fails to motivate and unify organizational action. Bereft of justification, the vision leaves a gap in the program's approach. Consequently, despite the value of MAS, the program has struggled for legitimacy and remains under-resourced: *Vision without action is a daydream*.

The MAS program continues to fail for two specific reasons. The first lies with the aforementioned absence of strategic direction through vision. The failure to identify and agree on the real purpose of UxVs, and latterly MAS, resulted originally in an aversive set of program requirements. Minimizing the risk to life and making cost savings overshadowed the valid responsive operational requirement to efficiently increase competitive operational advantage over adversaries. Specifically, the MAS program may well mitigate the growing Anti-Access, Areal Denial threat and enable the RN to continue to operate in the global maritime commons for the good of the nation.

³ Admiral Sir George Zambellas, Royal Navy, First Sea Lord, Chief of Naval Staff. Keynote address to the Maritime Autonomous Systems Conference. QinetiQ Maritime Autonomy Centre, Haslar, UK 6 October 2014.

The second reason the program is failing is internal friction. Chapter 3 outlines how organizational capacity and cultural resistance, undermined by a lack of direction, have contributed to decision-making paralysis. The failure to identify and agree on the problem MAS is attempting to address led to a vision conceived ten years late. Further analysis of the RN's approach to MAS highlights the need for a champion with a compelling vision to build consensus.⁴ Without leadership showing the way, internal apathy towards MAS prevails.

The 2014 vision coincided with the creation of a new position within Fleet Headquarters, the Fleet Robotics Officer (FRO). The FRO is responsible for investigating how MAS might offer credible capability in the future. However, the office consists of one person and one person, no matter how gifted, does not constitute an organization with the capacity to implement the necessary change. The post is a solitary one, a single point of failure, without subordinates. The RN remains deprived of a transactional office responsible for turning the aspirational or conceptual aspects of MAS into hard, tangible realities for the future force.

Beyond the lack of depth in the FRO, other limitations inhibit MAS progress. The RN's MAS Trails Team lacks any incentive to deliver meaningful operational objectives on a strict timeline. Meanwhile, military decision-making concerning MAS has become immobilized by rapid commercial innovation. The RN is mired in the decision cycle of Observe, Orient, Decide, and Act, (OODA) developed by John Boyd, failing to progress towards action. Leadership at the top of the organization has changed

⁴ The RN established the Fleet Unmanned Underwater Vehicle Unit (FUUVU) in 2004. The fact that the 1SL's vision for MAS came ten years after the establishment of the RN's first iteration of a MAS trials unit is telling.

without creating a legacy, prevalent throughout the organization, of a positive consensus towards MAS, which has inhibited progress even further.

The RN's ethos and culture remain dominated by its most prized asset, its people. Seemingly replacing people with robots naturally meets with inherent resistance. The sheer scale of technical, legal, and ethical challenges facing MAS supports a degree of skepticism. Intellectually, the RN's officer cadre remains divided as to the utility of MAS in war. Many remain concerned by the ease with which adversaries can overcome or exploit current systems. Theoretically, poor vision cascades down within an organization, undermining the commander's intent. However, critiquing the MAS program purely on this basis ignores the reality of financial constraint, and the intellectual limits of an organization consumed by *too much* change.

Chapter 4 explores the idea that the ambiguity of the MAS program may have been by design. The sheer quantity and volume of change across the RN since 2010 has overwhelmed the resources of the organization and its capacity for change. The RN's annual operating budget is approximately £12bn.⁵ Besides operating and maintaining the existing fleet, the 1SL remains responsible for safeguarding the procurement of future conventional strategic, and nuclear strategic assets.⁶ Large capability projects, such as the reintroduction of fixed-wing carrier aviation, dominated the intellectual and financial resources of the RN.⁷ Rather than a failure of vision per se, MAS may be a victim of

⁵ The RN receives approximately one third of the military component of the UK's £35.1bn Defence budget (2016).

⁶ The First Sea Lord delegates responsibility to the Fleet Commander for the provision of ships, submarines and aircraft ready to meet the operational requirements of the UK Government.

⁷ UK Ministry of Defence, "The Defence Equipment Plan 2015," https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/470058/20151022-Defence_Equipment_Plan_2015.pdf (accessed November 20, 2016). The entire Defence procurement budget averages £16Bn annually. In addition to the RN's annual operating budget of £12Bn, the RN

resource prioritization, and intentional change containment. The RN in this context can be regarded as an organization in survival mode.⁸

Notwithstanding the financial reality facing the RN, the vision remains in jeopardy, and apportioning blame provides no solution. Chapter 5 addresses the need to compromise the ideal roadmap for the introduction of MAS, balancing change and financial means to frame an achievable evolutionary process in conjunction with manned systems. The monetary constraints imposed by SDSR 2015 do not support the wholesale introduction of MAS.⁹ A new MAS vision alone cannot overcome the significant shortfall in investment. However, even an organization in survival mode should still prepare for the future and offer practical solutions. Internally, the RN must agree organizationally on what problem or challenge it wants MAS to solve. A consensus on the problem set, across the officer cadre, needs to be achieved over and above the agreement on the precise technical means of delivery.¹⁰ All is not lost. A window of opportunity remains to rectify the organizational failings while technical challenges are ironed out. Bridging the projected time gap between the planned end of manned equipment service-life and future in-service MAS could provide the opportunity for unmanned systems to mature technically.

A concession to utilize evolving MAS exclusively in a benign domestic operational environment could extend the operational life of current manned systems by

receives approximately £6Bn annually to support upgrades to existing platforms as well as procure new ones.

⁸ The RN is an example of an organization, which when not threatened with extinction, needs organizational slack in the form of money, people, and time to think beyond the immediate.

⁹ The Strategic Defence Review 2015 can be found at:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/555607/2015_Strategic_Defence_and_Security_Review.pdf. The full review fails to include automated and autonomous systems in the vision for Joint Force 2025.

¹⁰ In fact, discord while defining the means should be positively encouraged.

reducing their present commitment. Bringing MAS to market early may slow the adaptation process required within the MAS program to counter the likely responses of adversaries. However, a genuine mission set for MAS today would improve system credibility amongst detractors, and provide a funding line to facilitate further innovation. The missions associated with the UK's strategic nuclear deterrent, and the protection of the UK's Economic Exclusion Zone post-BREXIT, are ripe opportunities for MAS. The RN still has time to rectify a bad start.

Chapter 1 – Resourcing the Unknown

Predicting the Future: The Importance of the MAS Program

Predicting the future correctly and subsequently manning, training, and equipping an organization to be fully prepared for such eventualities has proven problematic historically. Michael Howard famously asserted that “...whatever doctrine the Armed Forces are working on now, they have got it wrong. I am also tempted to declare that it does not matter that they have got it wrong. What does matter is their capacity to get it right quickly when the moment arrives.”¹ The Maritime Autonomous Systems (MAS) program represents the means to operate more persistently and permissively at sea, particularly in the congested and contested environment of the littoral. The justification for a mature MAS program chimes with Howard’s warning. In the wake of uncertainty and unspecified future threats, MAS could provide the Royal Navy (RN) with global access to the battlespace. Competitive advantage in MAS should improve overall force adaptability allowing the RN to “get it right quickly when the moment arrives.”²

Theo Farrell agreed with Howard that, regardless of effort, it is virtually impossible for states and militaries to anticipate all of the problems they will face in war. Nevertheless, Farrell justly adds that it does not absolve the military of the responsibility to innovate and plan.³ Failing to conceive the future indicates short-sightedness and erroneously absolves organizations of the responsibility to plan in favor of chance.

¹ Michael Howard, “Military Science in the Age of Peace,” *Royal United Services Institute*, no.3 (March, 1974), 7. Howard points to uncertainty, but other than promoting adaptability and flexibility to absorb change offers no guidance as to how.

² Ibid.

³ Theo Farrell, “Introduction,” In *Military Adaptation in Afghanistan*, edited by Farrell, Osinga, and Russell, (Stanford University Press, 2013), 3. Theo Farrell is Professor of War in the Modern World at King's College London.

Importantly, as American historian Williamson Murray has argued, military organizations that display imagination and a willingness to think through the changes in peacetime have in nearly every case been those that have shown a readiness and ability to adapt and alter their prewar assumptions and preparation to reality.⁴

The *Future Operating Environment 2035* (FOE 35) is the latest attempt by the UK to conceive the future global environment.⁵ The document forms part of the UK's Development, Concepts and Doctrine Centre's (DCDC) Strategic Trends Program. DCDC is the Ministry of Defence's (MOD) independent think tank and aims to describe the characteristics of the 2035 operating environment to provide insights that can inform future defense capability development. The FOE 35 does not seek to predict the future. Rather, it describes the characteristics of plausible operating environments, resulting from rigorous trend analysis.

The projections within FOE 35 legitimize the MAS program as a requirement; future systems must be able to operate and survive, at range, against more sophisticated Anti-Access and Area Denial (A2AD) capabilities. Very long-term, inflexible procurement processes will no longer be sustainable for less conventional capabilities. The proliferation of military technology amongst potential adversaries means that UK key systems may be vulnerable to technical exploitation or capability overmatch.⁶ Accordingly, maintaining UK access to the global commons will be essential for ensuring

⁴ Williamson Murray, *Military Adaptation in War, Fear of Change*, (New York: Cambridge University Press, 2011), 313. Williamson Murray is an American historian and author. He served in the United States Air Force, taught at a variety of universities, worked as a consultant, and has authored numerous works on history and strategic studies.

⁵ United Kingdom, Ministry of Defence, "Strategic Trends Programme: Future Operating Environment 2035", *Development, Concepts and Doctrine Centre Strategic Trends Programme*, HMSO, December 14 2015, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/484861/20151203-DCDC_FOE_35.pdf (accessed October 10, 2016).

⁶ Ibid., 40.

global reach, national prosperity and the delivery of strategic effect.⁷ Military advantage will probably lie with the defense, with future A2AD capabilities overwhelming conventional forces. It, therefore, remains increasingly likely that the commander may need to exploit certain technologies and capabilities to fight merely to gain access to the global commons for deployment, let alone employment, of force.⁸

The character and environment of future conflicts may well be shaped by global resource limits and the disparity of wealth.⁹ The relationship these future conflicts will have with the military instrument of national power is less certain. Faced with such uncertainty, the RN continues to prepare for the war it cannot afford to lose. However, the RN must also invest in technologies necessary to endure the more likely scenario, one which future enemies will not fight against the UK's perceived traditional strengths. In either situation, the RN can be assured that freedom of maneuver in the domains of the maritime battlespace will remain an operational necessity for an expeditionary navy. While this projection of the future appears logical and convincing, it remains an arduous task to plan for the future by resourcing a capability to meet a *potential* threat.¹⁰ Therefore, besides countering historical enemies, monies must be spent to provide capabilities that increase the capacity to adapt to future enemies.

⁷ Ministry of Defence, "Strategic Trends Programme," 22. The high seas, the air above it, and space constitute the physical global commons.

⁸ Ibid., 43.

⁹ Albert Palazzo, "The Military Revolution of Limits and the Changing Character of War," *Small Wars Journal*, (October, 2013), http://smallwarsjournal.com/jrnl/art/the-military-revolution-of-limits-and-the-changing-character-of-war#_edn3 (accessed 30 October, 2016).

¹⁰ In a financial climate of constraint, it continues to be much easier to fund requirements based on an actual threat and a necessity to counter it.

Resourcing Threat vs Capability

The UK must innovate with less money and greater ambiguity about potential opponents.¹¹ Williamson Murray warned, “We appear to be entering a time of political change, strategic and technological uncertainty; a period where the threats seem more indeterminate.”¹² Reflecting the difficulty in resourcing such an indeterminate threat, Bryon Greenwald states that modernization normally costs more than a peacetime society is willing to spend when not directly threatened or aroused by passion.¹³ Knowing what must be done is certainly more conducive to innovation.¹⁴ Perhaps, in part, this explains the RN’s reluctance to resource MAS adequately.

In the absence of a conventional enemy, the RN must manufacture competitive conditions to legitimize spending and investment. However, the terms of the game are created in the shadow of current doctrine and capability, and thereby reflect previous successes and emphasize perceived core capabilities. With resources stretched, the RN has defaulted to a self-image circa 1975; the RN is determined to provide conventional deterrence and global power projection using a carrier task force and a continuous strategic nuclear deterrent delivered by submarines. Since 1975, however, the world has become increasingly multi-polar. Access to the maritime domain is no longer the privilege of the highly-industrialized few. Relatively low-entry costs and the proliferation of unmanned technologies make it possible for a \$50,000 unmanned vehicle (UxV) or

¹¹ Williamson Murray, “Innovation: Past and the Future,” In *Military Innovation in the Interwar Period*, edited by Williamson Murray and Alan Millett, 300-328, (Cambridge, New York: Cambridge University Press, 1996), 300.

¹² Ibid.

¹³ Bryon Greenwald, “Understanding Change: Why Military Organizations Succeed or Fail to Reform, Modernize, and Improve,” Joint Forces Staff College, (September 2010), 5.

¹⁴ Geoffrey Till, “Adopting the Aircraft Carrier: The British American, and Japanese Case Studies,” In *Military Innovation in the Interwar Period*, edited by Williamson Murray and Alan Millett, 191-226. (Cambridge, New York: Cambridge University Press, 1996), 226.

MAS to neutralize a billion-dollar warship. A seemingly blinkered approach to resourcing for conventional state-centric war demonstrates the organization is in difficulty; the RN is taking a view of the global commons as it would like it to be, rather than the way it is. Yet, the outlook was not always so gloomy. The RN utilized unmanned maritime systems, (the forerunner of MAS) fourteen years ago in a wartime environment under the Urgent Operational Requirement construct. The operational experiences gleaned should have provided the spark to future investment. But, the RN once again repeated the historical failures of the inter-war years and failed to operationalize a good idea when ahead of its competitors.¹⁵

Royal Navy Maritime Autonomous Systems - A False Start

The failure to operationalize technical change into transformational use is highlighted by the UK Government's response to unmanned system use during the 2003 Iraq war.¹⁶ After successfully operationalizing the Fleet Underwater Unmanned Vehicle Unit (FUUVU) during a period of war, the RN failed to recognize the opportunity for transformational change in littoral combat, and quickly reverted the FUUVU to research and development status.¹⁷ As the RN's history with the aircraft carrier and anti-

¹⁵ The RN largely ignored ASW lessons identified during WWI, preferring to view the submarine problem as a temporary aberration in warfare. Consequently, the RN was ill-prepared for the next war and the nation suffered huge merchant shipping losses to German U-Boats. Having invented carrier, catapult-launched aviation, the RN failed to recognize the significance to future warfare. Unlike Japan and the U.S., which each increased the size and scale of their carrier programs, Britain clung to a Battleship Fleet of decreasing relevancy.

¹⁶ United Kingdom. Government response to the House of Commons Defence Committee's report "*Lessons of Iraq*", May 14 2004, <http://www.publications.parliament.uk/pa/cm200304/cmselect/cmdfence/635/63504.htm> (accessed 7 October 2016). The Committee congratulated the RN for the success of the operation to clear mines from the waterway to Umm Qasr and urged the MOD to review, as a matter of urgency, the capability of the RN to undertake mine clearance operations in shallow and very shallow waters, given the likely need for increasing amphibious operations in the littoral. The Government responded: "We have already established the FUUVU with an interim capability. It completed training in January 2004 and deployed operationally to Iraq in support of the Iraq Survey Group."

¹⁷ FUUVU was formed in 2004 and was renamed the Maritime Autonomous Systems Trials Team (MASTT) in 2012. During the Iraq War FUUVU used a Shallow Water Influence Minesweeping

submarine warfare suggest, the failure to follow up on successful mid-war innovation is not new. The RN's failure to continue the promising developments it made with autonomous systems in the 2003 Iraq war is only the latest in a series of errors.¹⁸

Between 2004 and 2014, the RN gave no specific direction at the highest level as to the purpose and direction of MAS. In the vacuum, the requirement for MAS was developed, not by the RN, but by the industrial and scientific research communities. Hoping to encourage the RN to invest in unmanned and MAS technologies, both communities adopted a sales message focused on reducing the threat to military life. In the Mine Warfare field, the phrase "taking the man out of the minefield" became the main sound bite used to create justification for automated and autonomous systems. A logic based on the primacy of saving military lives failed to inspire and stimulate the war-fighting community of the RN whose principal concern remained operational effectiveness. Nevertheless, without oversight and interest from higher leadership, the idea prevailed for ten years. Office of Naval Research articles dating back to 2007 show that the reasoning for UxVs and MAS was pervasive on both sides of the Atlantic.¹⁹ Indeed, as recent as 2014, the Officer in Command of the RN's MASTT rationalized her philosophy: "[MAS] takes the sailor out of the minefield, but we are not taking them out

System (SWIMS). SWIMS was a modified remote-controlled Combat Support Boat that towed acoustic and magnetic signature generators. Developed via an Urgent Operational Requirement, this system is no longer in use, but various similar systems are under trial.

¹⁸ The RN failed to recognize the significance of enduring a technological change in the air and sub-surface domains during the inter-war period and its impact on future warfare. Anti-Submarine Warfare and carrier strike aviation were largely ignored until 1938, because of financial constraint and a cultural bias toward surface warfare.

¹⁹ Office of Naval Research, "Unmanned Vehicles Take the Man Out of the Minefield," Press Release, 2007, <http://www.onr.navy.mil/en/Media-Center/Press-Releases/2007/Unmanned-Vehicles.aspx> (accessed October 10 2016).

of the equation.”²⁰ The RN UxV/MAS trials team she commands has existed for a decade without a mandate to deliver operational capability. The reasoning for this lull and the barriers to successful change will be explored in Chapter 3. At this juncture, it is simply worth stressing the importance of addressing the MAS situation now. Even the most optimistic solution currently presented will leave the RN with a reduced MCM and Hydrographic Capability (MHC) for at least four years.

The Numbers Do Not Add Up

The RN currently has no future build program to replace its MCM or Hydrographic Survey vessels on a like-for-like basis. MHC is the only alternative. MHC is strictly speaking not a vessel, merely a capability. However, it is already conceptualized as a “down-threat,” lost-cost hull, with a multitude of Off-Board Systems (OBS). MHC is a transformational and incremental program that will update and subsequently replace the full existing MCM and Hydrographic capabilities to provide assured maritime freedom of maneuver, delivering minehunting, minesweeping and hydrographic mission systems, including remote controlled OBS to legacy and future platforms. MHC target date is for the first force elements to be in service by 2028 and the last by 2035. The current MCM vessels decommission between 2028-2031. Meanwhile, MHC faces survivability and resilience concerns while operating in hostile environments and is yet to be funded. Even if it is funded, *and* achieves the schedule, there *will* be a gap.

²⁰ Royal Navy, “Royal Navy Begins Testing ‘Remote Controlled Minehunter’” 16 April 2014, <http://www.royalnavy.mod.uk/news-and-latest-activity/news/2014/april/16/140416-remote-minehunter> (accessed September 7 2016).

Summary

The future is inherently impossible to predict. However, identifying likely trends can at least prepare states and societies intellectually. Trends will inform choice to address the expected global frictions based on resource limits, wealth disparity, and religious identity. It is equally important to recognize what will not change. Political leaders will still desire militaries to express freedom to maneuver within domains at a time and place of choosing. Success in combat often depends on efforts to shape favorable access conditions in advance. In this context, MAS may provide Dull, Dirty, and Dangerous mission sets beyond the capability of conventional forces. One trend the RN must be cognizant of is the rate of change between relative positions of advantage. The technical superiority MAS may enjoy will become ever shorter, requiring constant evolution. MAS will not be the “golden bullet”.

In 2003-4, the RN missed an opportunity to make a transformational change at the operational and technological levels in the wake of its initial technical edge.²¹ Post-Gulf War, the mine threat appeared less tangible, and a navy seemingly entrenched in continuous decline largely ignored the utility of automated systems and reverted to a traditional identity it was more comfortable with. Lacking sufficient resources to meet current commitments *and* future possibilities, the RN understandably chose the former. The risk of not doing so is visible and easier to quantify. Nevertheless, resourcing the unknown is exactly what must be done.

²¹ Murray, *Military Innovation in the Interwar Period*, explores the differences in innovating exploitation by six military powers. The essays within the book investigate how and why innovation did or did not occur and the relationship with strategic and operational performance in WWII. A simple schematic on page 268 lays out the relationship between the levels of change with strategy, operations, and tactics.

The gamble of hoping there is sufficient time to adapt the force when unexpected conflict arrives may prove foolhardy. The RN must learn the historical lessons of the interwar period and recognize fundamental changes in the means of warfare. Future war may not provide the time to adapt and overcome.

Instead of sweeping the problem under the carpet for following generations of officers to contend with, Admiral Zambellas identified the stagnation of MAS operationalization. In 2014, a charismatic and passionate First Sea Lord attempted to raise the profile of the MAS program by delivering a clear vision with direction and purpose. Despite the First Sea Lord's enthusiasm and noble intent, the vision proved to be meaningless.

Chapter 2 – A Flawed Vision

The Royal Navy will lead and win through the innovative and robust exploitation of Maritime Autonomous Systems.

—Admiral Sir George Zambellas

The Royal Navy's (RN) vision for Maritime Autonomous Systems (MAS) is without substance and reason. The purpose of the vision is to “lead and win.” But, lead who, and win what? If by means of MAS, why, how, where? By robustly exploiting? Does it mean the RN will maximize the military application of MAS? By being at the forefront of development and utilization of MAS, it is implied the RN will have the ability to defeat everyone. The point is, the vision is without purpose and direction, and is therefore largely meaningless.¹

The leadership and management expert John Baldoni reviews the nature and importance of purpose within an organization. Promoting the value of its understanding, he argues purpose forms the backbone of what an organization exists to do and upon which vision and mission are built. Baldoni argues that the central challenge for leaders is to bring people together for a common cause. “Purpose is the why behind everything within an organization.”² The current RN MAS vision is flawed because it is without purpose.

¹ Admiral Sir George Zambellas, Royal Navy, First Sea Lord, Chief of Naval Staff. Keynote address to the Maritime Autonomous Systems Conference. QinetiQ Maritime Autonomy Centre, Haslar, UK 6 October 2014. Admiral Zambellas is a retired Royal Navy officer. He was the First Sea Lord and Chief of the Naval Staff from April 2013 until he handed over duties to Admiral Sir Philip Jones in April 2016. His addresses to the Royal Aeronautical Society, and the Maritime Autonomous Systems conferences in 2014, provide the source to the thesis's conjecture that the UK MAS vision is flawed in nature.

² John Baldoni, *Lead with Purpose*, (New York: AMACOM, 2012), 3.

What the Vision Should Do

Visions provide an idealized representation of what an organization should become. Visions are symbols of change for harnessing the collective effort. Both findings from academic research and the practical experience of business leaders suggest a clear vision is essential to survival and success.³ The Panmore Institute provides company analysis that includes critiques of the vision and mission statements of high-profile businesses. Tesla's vision statement as an example⁴: "to create the most compelling car company of the 21st century by driving the world's transition to electric vehicles."⁵ This vision emphasizes the company's focus on renewable energy. The following components are significant in Tesla's vision statement:

- Most compelling
- Car company
- 21st Century
- The world's transition to electric vehicles

Tesla's vision statement effectively describes its business aims and is supported by their mission statement, which provides the how: "to accelerate the world's transition to sustainable energy."⁶

Purpose is integral to a vision; it defines where you want to go. The vision is a road-map to realization and a statement of what you want to look like when you get there.⁷ The current MAS vision is certainly aspirational: "The Royal Navy will lead and win," but it is also void without identifying why.

³ Roger Gill, *Theory and practice of leadership*, (London: SAGE publications, 2006), 111.

⁴ Tesla Motors was founded in 2003 by a group of engineers in Silicon Valley who wanted to prove that electric cars could be better than gasoline-powered cars. Tesla is not just an automaker, but also a technology and design company with a focus on energy innovation.

⁵ Panmore Institute, "Vision and Mission Statements," <http://panmore.com/tag/vision-and-mission-statements>, (accessed December 22, 2016).

⁶ Ibid.

⁷ Baldoni, *Lead with Purpose*, 7.

Moving Forward—Asking the Right Questions, Solving the Right Problem

The MAS vision needs a re-think. Moving forward the RN should at least consider if there are more viable alternatives to MAS. If the answer is no, a new vision must address *why* the RN needs MAS. The renowned British historian Michael Howard emphasized the need to focus on the right questions when considering a technical change.

The fundamental problem may not be, how we can provide more of X; how we can stretch our resources to provide additional quantities or develop a bigger and better X with longer range and better protection or greater speed. The basic question is, why do we need X anyway? What is its function? Is that function essential? Can it be performed more cheaply and effectively by other means?⁸

Dwayne Spradlin in Harvard Business Review agrees with Howard's assertion that recognizing the importance of defining the problem an organization is trying to resolve is most fundamental. Spradlin provides a model to understand the problem-definition process Howard is referring to: establish the need for a solution, justify the need, contextualize the problem, and write the problem statement.⁹ Having a clear vision and direction comes up as the top critical success factor for good leaders across all industry.¹⁰ Chapter 6 will propose a new MAS vision for the RN. However, before doing so, a fresh look at the problem is required.

Consensus of the Problem, Not the Solution

Problem consensus breeds organizational acceptance to the direction of travel. The projected means may not meet the desired ends. MAS may not be the solution to

⁸ Michael Howard, "Military Science in the Age of Peace," *Royal United Services Institute*, no.3 (March, 1974), 7.

⁹ Dwayne Spradlin, "Are you Solving the Right Problem?," *Harvard Business Review*, (September 2012), 85-86. Spradlin is the President and CEO of InnoCentive, an online marketplace that connects organizations with freelance problem solvers.

¹⁰ According to Laura Firth, psychologist and managing director of Reed Consulting, in an interview with Hashi Syedain, "Reed's Psychological MD," *World Business*, (January-February, 2007), 73.

congested maritime competition. Nevertheless, a consensus about the problem opens up avenues for the entire organization to explore and fulfill; ideas from unanticipated origins become possible.¹¹

In conceptualizing warfare utilizing MAS, the RN is currently prioritizing the wrong questions. Instead of focusing on competitive advantage, the MAS program has succumbed to the distraction of second-order consequences, specifically, reducing risk to personnel, buying back “mass” to appear more credible, and reducing through-life costs. At a Royal Aeronautical Society lecture in 2014, Admiral Zambellas promoted the primary advantages of MAS in terms of cost, and a means of increasing naval platform numbers.¹² In turn, the RN’s Fleet Robotics Officer (FRO), who is responsible for delivering the First Sea Lord’s MAS vision, duly addressed the National Oceanography Centre in 2015, where he once again promoted MAS as a means to buy back mass within the RN’s order Order of Battle (ORBAT), (i.e., grow the RN without more money). Citing Norman Augustine, a former U.S. aerospace CEO, the FRO suggested the RN would continue relative and absolute decline in naval force structures driven by the mathematical inevitability caused by uncontrolled defense inflation.¹³ The FRO cited a 2010 article in *The Economist*, which observed that to break from the structures of Augustine’s 16th Law and unaffordable cost trends, defense needed a “game changing technology” as “. . .when the battleship gave way to the submarine and the aircraft

¹¹ The Japanese and American navies innovating to extend reach and striking power across a vast ocean during the inter-war years is a useful example. Their respective visions played a major role in defining the problem. The solution became Carrier-Strike and Fleet defense.

¹² Admiral Sir George Zambellas, Royal Navy, First Sea Lord, Chief of Naval Staff. 2014. Naval Aviation – The Future. Lecture, Royal Aeronautical Society, University of Southampton, UK March 12.

¹³ Commander Steven Prest, Royal Navy, Fleet Robotics Officer. Maritime Autonomous Systems. Lecture, National Oceanography Centre, Southampton, 24 February 2015.

carrier.”¹⁴ However, it is apparent, neither First Sea Lord nor the FRO seemingly considered that by developing drones able to fight “autonomously in high-threat environments, costs would rise, making them much more expensive and less expendable.”¹⁵ The logical conclusion therefore is, Augustine’s law will one day strike the drone as surely as it has already done with conventional systems.¹⁶

This leads the debate back to the supposition that the future of MAS is best served by promoting their contribution to operational effectiveness.¹⁷ The Research and Development (RAND) political scientist Adam Grissom argues that innovation changes the manner in which military formations function on operations; it is significant in scope and impact and provides greater military effectiveness.¹⁸ The military historian Bryon Greenwald agrees that the assessment of whether the innovation improves effectiveness is necessary. “Assuming that a change does occur to alter the ways wars are fought—such as the airplane and [submarine]—the issue becomes one of recognition and acceptance.”¹⁹ That recognition starts with a vision statement of direction and purpose. The acceptance

¹⁴ The Economist, “The Cost of Weapons: Defence Spending in a Time of Austerity,” *The Economist* (28 August 2010). <http://www.economist.com/node/16886851> (accessed 10 October 2016). Norm Augustine was the President and CEO of Lockheed Martin before his retirement. He codified the rules of defense contracting in his book, *Augustine’s Laws*. The 1980’s book is a satirical pseudo technical commentary. Among the 52 subjective truths, laws XV, and XVI have influenced the reasoning behind why the RN should adopt MAS.

¹⁵ The Economist, “The Cost of Weapons: Defence Spending in a Time of Austerity.”

¹⁶ Ibid.

¹⁷ U.S. Department of Defense, *Unmanned Systems Integrated Roadmap FY2013-2038* (Washington, DC, 2014), 20. The U.S. DOD’s unmanned vision paper provides a different perspective to the same problem. The DOD’s opening assertion is important to highlight: “...there are no requirements for unmanned systems within the Joint force, but some capabilities are better fulfilled by unmanned systems.” The paper goes on to describe how unmanned systems are the preferred means for Dull, Dirty, Dangerous (D3) mission by providing persistence, versatility, survivability, and reduced risk to life. Although the U.S. vision for unmanned systems considers comparative through-life cost-benefit savings, and the risk to human life, the unmanned systems roadmap remains focused on acquiring military competitive advantage over conventional means.

¹⁸ Adam Grissom, “The Future of Military Innovation Studies,” *Journal of Strategic Studies*, 29:5, (24 Jan 2007), 907.

¹⁹ Bryon E. Greenwald, “Understanding Change: Why Military Organizations Succeed or Fail to Reform, Modernize, and Improve,” Joint Forces Staff College, (September 2010), 6.

is a matter of shaping internal and external audiences. Internally within the RN, it is attributable to the corporate attitude towards such systems. Externally, it should shape industry's response to provide technical solutions.

Summary

The previous chapter highlighted the difficulty in predicting the future. The vision, therefore, becomes even more central to success when the trending threat is ill defined. The MAS program is competing for funding amongst a myriad of seemingly worthy projects. The program must win the narrative of why it is crucial to future warfare in order to flourish. The current MAS vision is fuzzy and fails to communicate with clarity and sound logic.²⁰ The vision should highlight the main *purpose* of MAS.

The main purpose of MAS is not to keep military personnel safe. Nor is it the fact that manned systems and defense inflation are increasingly unaffordable in meaningful numbers. The problem MAS is attempting to address essentially relates to sea control: gaining and maintaining access to non-permissive environments, doing it more effectively than manned systems, and at a time and place of one's choosing. U.S. Navy Chief of Naval Research, Admiral Winter, captured the rationale of MAS and UxVs in 2016 during a UK naval exercise of entirely unmanned systems. With regard to future naval possibilities Winter said, "Autonomy will enable our naval forces to stay longer, see farther, understand more, decide faster, do more, adapt more quickly and when necessary be more lethal."²¹

²⁰ John P. Kotter, and Dan S. Cohen, *The Heart of Change*, (Harvard Business Review Press, 2002), 83.

²¹ Rear Adm. Mat Winter USN, Chief of Naval Research, "Unmanned Warrior Exercise Combines Technology and Talent", blog posted - inside the Navy (October 8, 2016), <http://navylive.dodlive.mil/2016/10/08/unmanned-warrior-exercise-combines-technology-and-talent/>

Even in the absence of a specific, obvious threat, the RN needs a vision that can offer clearer direction. Former U.S. Secretary of Defense, Robert Gates, found that getting the right priorities established was a necessary precondition to successfully leading change. Gates quoted Yogi Berra, summing up the importance of direction. “If you don’t know where you’re going, you will wind up somewhere else.”²² Change, not inherently good in itself, must solve a problem, the right problem, to be valuable.

Identifying the problem will help rectify the MAS vision statement, the first step in setting the RN MAS program moving in the right direction. Getting the rest of the organization to agree is a different matter. The RN is stretched to capacity financially and intellectually.

²² Robert Gates, *A Passion for Leadership: Lessons on Change and Reform from Fifty Years of Public Service* (New York: Knopf, 2016), 38. Gates is a U.S. statesman, scholar and university president who served as Secretary of Defense from 2006-11. Gates served for 26 years in the Central Intelligence Agency and the National Security Council, and was Director of Central Intelligence under President George H. W. Bush. After leaving the CIA, Gates became president of Texas A&M University and was a member of several corporate boards.

Chapter 3 – Barriers to Change

The RN has confused activity in the field of Maritime Autonomous Systems (MAS) with progress. Until 2014, the Royal Navy's (RN) hierarchy had adopted a wait-and-see approach, abdicating innovation in the field to the commercial sector. In doing so, it failed to recognize that *something* was going wrong. Consequently, the organization remains without a procurement process tolerant of technology that rapidly mutates; obsolescence is occurring before decisions materialize. Years of scant progress have passed with little objection from an organization predisposed to suppress unmanned technology.

Confusing Activity with Change

Activity is a good thing; it means personnel engage with problems and are willing to work long hours. Sadly, there is no direct correlation to positive development. As defined by Baldoni, progress requires clear goals. In the absence of a requirement or an incentive to progress, the organization stagnates. Others would argue that the MAS Trials Team (MASTT) is not a Fleet asset and is therefore not required to support operations. Here lies the failure to recognize that low expectations will deliver low outputs. Without ends, there can be no deficiency.

As a case in point, the RN's Fleet Unmanned Underwater Vehicle Unit (FUUVU), the precursor to the MASTT, received the Hydroid REMUS 600 Autonomous Underwater Vehicles in 2007, well ahead of its U.S. counterparts.¹ However, in contrast

¹ In September 2007, the MOD announced: The [Royal] Navy is to receive the Remus 600, an unmanned underwater vehicle which will enhance the mine countermeasures capability of the Fleet. . . . and is intended to enter [full] service in 2009. <http://www.defense-aerospace.com/articles-view/release/3/86170/royal-navy-orders-new-uuv-for-minehunting.html> (accessed November 17, 2016).

to the UK, the U.S. quickly chose to conduct much of its operational evaluation of the vehicle in theatre between 2012-2014. Expediting assessment of the technology and making the positive decision to employ it within an existing threat region, led to its in-service operational use by the U.S. Navy (USN) in 2015.² Meanwhile, the RN's REMUS 600s remain under operational evaluation after ten years of use.³

The RN MAS program serves as an example of failed organizational learning. John Boyd's Observe, Orient, Decide, Act (OODA) model is particularly valuable because it is grounded in adaptation, and maintains that if someone can see what is happening in the battlespace, they can out think, out decide, and outperform the adversary.⁴ Boyd emphasized that the loop in Figure 1 is actually a set of interacting loops that are to be kept in continuous operation.

² Megan Eckstein, "Navy Seeking Unmanned Underwater Advances to Field Today, to Inform Next Generation Sub Design in 2020s," USNI News, posted October 31, 2016, <https://news.usni.org/2016/10/31/navy-seeking-uuv-advances-to-field-today-to-inform-ssnx-design-in-2020s> (accessed October 30, 2016). REMUS 600 is designated as Kingfish, Mk18 Mod 2 by the USN. The 2012-13 operational evaluation process was conducted by contractors, alongside USN personnel. The Kingfish was also successfully deployed from an operational USN submarine in 2015. Julia Bergman, "Navy deploys first underwater drone from USS North Dakota," The Day, posted July 20, 2015, <http://www.theday.com/article/20150720/NWS09/150729918> (accessed November 30, 2016).

³ As in the inter-war years, technical change has not led to transformational use.

⁴ Frans P. B. Osinga, *Science, Strategy and War: The Strategic Theory of John Boyd* (London: Routledge, 2005), 80, 229–233, 237–239.

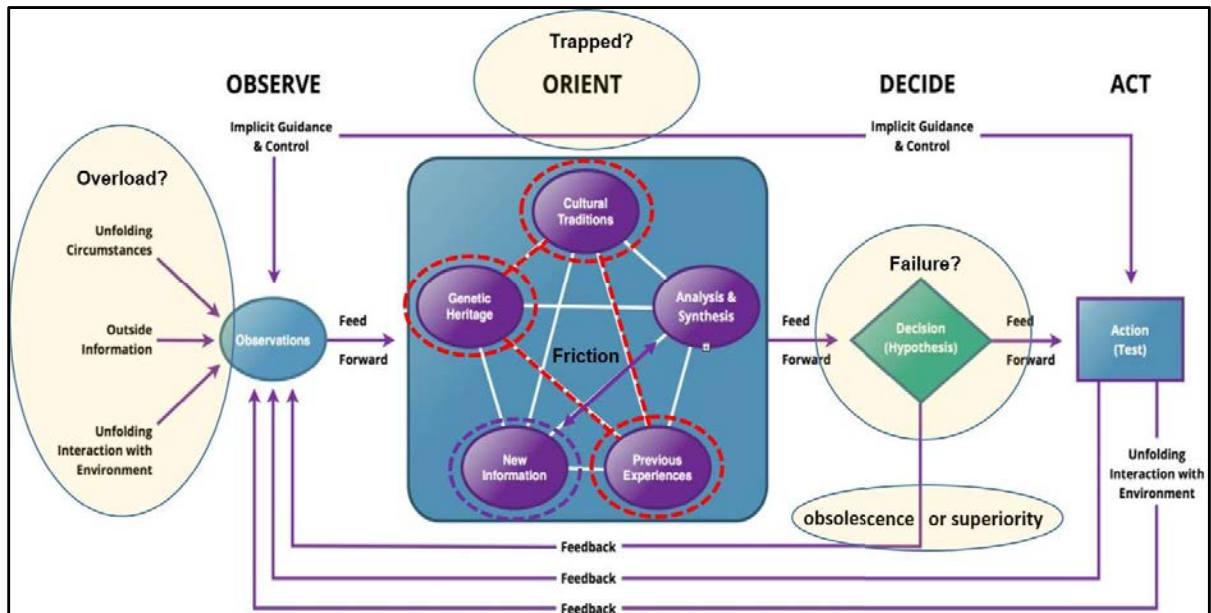


Figure 1. Boyd's OODA Loop sketch – with overlays⁵

It would be most obvious to observe that the RN's MAS program has failed to move beyond the decide phase, seemingly trapped in a stasis of permanent orientation. The internal causes are: no credible vision; no measurement of success; and no organizational desire to choose. However, the issue is compounded by external *speed*; the commercial sector's rate of technological progress and innovation in MAS is too rapid for the current military acquisition process. Before decisions are even conceptualized, obsolescence or superiority act upon the market, forcing the RN to abandon its procurement strategies. The result is decision-making paralysis. Alas, perhaps the situation is even worse.

Such is the acceleration of the commercial MAS sector that the RN and its supporting Ministry of Defence elements are overwhelmed, even in the early stages of observe and orient Constant information, and insufficient means to process and

⁵ John Boyd, "The Essence of Winning and Losing," Summary Briefing, January 1996, slide 4., <http://danford.net/boyd/essence.htm> (accessed November 17, 2016).

understand, results in industry receiving little direction. Therefore, unsurprisingly, industry is still at the stage of just building “stuff.” Without a requirement, industry is building things the RN *might* want, or is simply adapting current commercial systems to military use to broaden potential markets. Organizationally and intellectually out-matched, the RN has largely ceded the conceptual use of MAS to the commercial sector.

Abdicating Innovation

The RN’s unbalanced MAS commercial relationship with industry is defining the military requirement inaccurately, in some cases by over-specificity. In pursuit of the cheapest means of technical innovation, the RN has effectively yielded vehicle research and development to the commercial sector in two domains. The RN is convinced commercial surface and sub-surface vehicles are generic means of transportation, suitable for military adaptation. This approach constrains creative innovation within the military, and has undoubtedly shaped the solution and its employment. The commercial sector has already framed the technological future before the military purpose and requirement have been truly defined. Although inherently difficult to prove, arguably creative alternatives have been denied space to flourish by the insistence of a commercial means of delivery. Surface and sub-surface MAS vehicles will look and work entirely to the commercial sector’s desired purposes. Such external pace is causing stagnation in the “Observe” and “Decide” repositories of the MAS OODA loop. Moreover, it is internal cultural friction in the “Orient” that is shaping the *way* the RN observes, the *way* it decides, and the *way* it acts.

A Cultural Wall

Williamson Murray describes military culture as the sum of intellectual, professional, and traditional values of an officer corps.⁶ Internal culture is pivotal to how the RN views the external environment and how it analyzes responses to perceived threats. While noted security analyst Francis Hoffman contends “culture is not a driver or a prescriptive barrier,” in essence he too agrees; “military culture serves as a prism for how to view problems and frame acceptable solutions.”⁷ British maritime doctrine details the culture and beliefs of the RN. The document contains core legitimizing concepts and rationalizes the employment of maritime force. Ironically the same document hides in plain sight a credible reason for why the MAS program has suffered a decade of meager progression.

British maritime fighting power is derived from three inter-related components: the *conceptual*, the intellectual justification for the employment of armed forces; the *moral*, the ability to get people to fight; and the *physical*, the means to fight.⁸ The *conceptual* challenges, the underlying principles, and legal use of autonomous systems are outside the scope of the thesis and continue to be addressed by others. Regarding the *physical*, MAS is a technical and financial challenge. However, by far the largest barrier to empowering MAS innovation and its implementation into the RN, is the emotional, human dimension. The *moral* component of fighting power is the most significant

⁶ Williamson Murray, “Innovation: Past and the Future,” In *Military Innovation in the Interwar Period*, edited by Williamson Murray and Allan Millett, 300-328, (Cambridge, New York: Cambridge University Press, 1996), 313

⁷ Francis. G. Hoffman, “Learning While Under Fire: Military Change in Wartime” unpublished Ph.D. dissertation, War Studies Department, School of Social Science and Public Policy, (King’s College, London, March 2015), 59.

⁸ United Kingdom, Ministry of Defence, *British Maritime Doctrine*, 4th ed. (Joint Doctrine Publication, 2011), 3-1.

contributor to culture. The *moral* is composed of leadership, management, morale, and ethos. Here lies a point of friction, humans place great value on such functions within an organization, robots do not. Consequently, beyond the implementation phase, these components are utterly irrelevant to the future utilization of MAS.

The RN's ethos is fundamental to its core sense of identity, and developed over centuries from both defeats and great victories. The ethos encompasses leadership, professionalism, courage, determination, loyalty, respect, discipline, good humor, and teamwork—a can-do attitude.⁹ Reputations are built upon ethos, and it is what institutional traditions are enshrined in. Fundamentally and collectively, few really want to implement MAS transformation with any sense of urgency. The entrenched and reasoned view of officers is that the RN's greatest asset is its people—above all else success depends upon it. It is, therefore, unsurprising in the absence of a significant specific threat that the RN has fallen back on historical, comfortable assumptions and “ignored, misrepresented, or manipulated information and innovations that contradict its most cherished beliefs.”¹⁰

Assuming that a change does occur to alter the ways wars are fought—such as the airplane and submarine—the issue becomes one of recognition and acceptance.¹¹ Having stressed the importance in Chapter 2 of agreeing on the problem, the RN must also accept and *want* to solve the problem. Like most organizations, the RN maintains a number of core competencies central to the success its current vision of the operating environment. Ships, submarines, aircraft, and Royal Marines provide warfighting capabilities, but also

⁹ Ministry of Defence, *British Maritime Doctrine*, 3-9-11.

¹⁰ Andrew Hill and Stephen Gerras, “Systems of Denial,” *Naval War College Review* 69, no. 1 (Winter 2016), 111. The framework explains why organizations persist in their comfortable assumptions, despite changes to the global operating environment.

¹¹ Bryon E. Greenwald, “Understanding Change: Why Military Organizations Succeed or Fail to Reform, Modernize, and Improve,” Joint Forces Staff College, (September 2010), 6.

a means to support conflict prevention, provide security on the high seas, partnership assurance, and humanitarian assistance. The danger, as Daniel Levinthal remarks, is that bureaucracies cling to such competencies and task sets, even in the face of obvious obsolescence or failure.¹² The RN is stove-piped into warfighting streams for reasons of organizational efficiency and concertation of expertise. Each stove-pipe competes for relevancy and finance. Each particular area sets its best staff officers against one another. When a new means of warfare, such as MAS, offers improved potential across a number of fields, rare agreement breaks out, the outsider is a threat to all. The three methods of denial offered by Andrew Hill and Stephen Gerras are at play concerning MAS: killing the messenger, questioning the data, and resisting refutation through constant theoretical change.¹³ The 2015 Strategic Defence and Security Review (SDSR) provides public evidence.

The latest SDSR sets out how the UK Government will deliver a vision for “a secure and prosperous UK, with global reach and influence.”¹⁴ The document includes specific resource allocation with prescribed military force composition out to 2025. The SDSR is perhaps an insight into the psyche of a government not wanting to upset its military organization’s sensibilities concerning manpower. Equally, the SDSR provides the observer with a synopsis of how each military arm views itself when forced to make tough financial choices. As evidence of the RN’s failure to drive MAS innovation, the

¹² Daniel Levinthal and James March, “A Model of Adaptive Organizational Search,” *Journal of Economic Behavior and Organizations*, Vol.2, Issue 4, 1981, 307–333. A model of organizational change through adaptive search for new technologies. It permits the exploration of simultaneous organizational adaptation in search strategies, competences, and aspirations under conditions of environmental instability and ambiguity. When the environment changes faster than the organization can adapt, superstitious learning can occur.

¹³ Hill, “Systems of Denial,” 130.

¹⁴ United Kingdom, HM Government, *National Security Strategy and Strategic Defence Review 2015: A Secure and Prosperous United Kingdom*, (HMSO, 2015), 10.

SDSR makes *no* reference to autonomous or unmanned maritime systems. Sidelining MAS as an anomaly in favor of the institutionally comfortable core manned systems could lead to shock in war.¹⁵ The lack of investment may deny capacity and time to adapt to the inevitable failure to predict the next war.

Summary

The RN is likely to continue the model of commercial adaptation; it is the cheapest form of innovation. However, the RN lacks the intellectual capacity to fully understand those adaptation possibilities, and realize the potential before obsolescence. Meanwhile, industry continues to pass sub-systems and new sensor upgrades to the MASTT without a mandated operational goal nor end.

The RN's culturally prized asset is its people. UK maritime doctrine reinforces their importance, yet, people present the largest conceptual and organizational barrier to the transition of MAS use, particularly within the surface flotilla communities.¹⁶ The RN focuses its organizational energy on maintaining the status quo and improving what it already does. It knows what it does well and is determined to continue to do those things.¹⁷ There must be institutional views and interest in developing a new form of war.¹⁸ Rather than generating more internal friction, the proponents of MAS must seek to complement and enhance existing tasks and mission capabilities, and for now, not

¹⁵ Hill, "Systems of Denial," 109-132. The anomaly in this context is an idea, or concept, seemingly at odds with the status quo of an organization.

¹⁶ There is fear within the RN's surface community that MAS will result in fewer manned surface assets rather than be procured to complement and enhance existing capabilities.

¹⁷ Hill, "Systems of Denial," 111.

¹⁸ Murray, "Innovation: Past and the Future," 312.

threaten the stove-pipes.¹⁹ Nonetheless, the military must and does innovate.²⁰ So perhaps there are other forces at work? Chapter 4 investigates the idea that the delay in operationalizing MAS is intentional.

¹⁹ To the Frigate and Destroyer communities, MAS is the equivalent of the submarine in the inter-war period.

²⁰ Stephen Rosen states that peacetime innovations are possible, but the process is long.

Chapter 4 – Failure by Design

A poor vision from leadership cascades down through an organization and undermines the leader's intent. While addressing the present vision, it would be remiss not to consider the vision's ambiguity as being by design.

Containing Change

“An organization sustains success when its strategy and resources align.”¹ When resources do not match ideas, is actively containing change the best the Royal Navy (RN) can do? There is a certain resonance between the British examples of interwar carrier aviation and Maritime Autonomous Systems (MAS) innovation. Referring to carrier aviation in the inter-war period, historian Geoffrey Till suggests the British “deliberately adopted a policy of ‘waiting to see’ or leaving it to the Americans and Japanese.”² Now, as then, the motivation was fiscal—a lack of alignment between available money and ideas. The transformational use of MAS within the RN would undoubtedly benefit from an empowering new vision, clear objectives and purpose, and internal consensus. However, idealism must also meet reality. The UK's finances cannot support all of the ambitions of Ministry of Defence (MOD). Although 2% of UK Gross Domestic Product remains apportioned to defense, Augustine's law continues to whittle away the ability of each Service to buy mass. Technological inflation far exceeds the Consumer Price Inflation rate.³

¹ Andrew Hill and Gerrass Stephen, “Systems of Denial,” *Naval War College Review* 69, no. 1 (Winter 2016), 110.

² Geoffrey Till, “Adopting the Aircraft Carrier: The British American, and Japanese Case Studies,” In *Military Innovation in the Interwar Period*, edited by Williamson Murray and Allan Millett, 191-226. (Cambridge, New York: Cambridge University Press, 1996), 198.

³ According the Office for National Statistics, the annual CPI was 0.6%, August 2015-16. Released in January 2016, the closest comparable UK Defence inflation figures are for 2014/15, Defence high value contract inflation was 2.4%.

The sheer quantity and volume of change and transition across the RN has overwhelmed the resources of the organization. With only 22,000 RN personnel at his disposal, Admiral Zambellas stood responsible for the roadmap to reacquire a conventional strategic capability while safeguarding the UK's strategic nuclear deterrent.⁴ Large procurement projects, such as the Queen Elizabeth Class aircraft carriers, F-35 fighter jets, new replenishment ships and attack submarines, and a replacement frigate program have left the RN's purse empty. Meanwhile, in the backdrop, the RN cannot man its existing fleet, never mind its future liability. As a result, the RN is forced to place 15% of its major surface warships into "extended readiness" to meet its current commitments.⁵ No wonder little else can be achieved other than supporting operations and maintenance costs of existing platforms. Finding the right strategy to support technical change and transformational application of MAS successfully has become superfluous. Outside of the aforementioned core procurement projects, the RN is in survival mode, reducing costs, preserving capital, and trimming commitments. It is a short-term strategy, intended to clear the path for the RN to live another day, but it does not support a long-term growth strategy.⁶

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/495248/20160128_Defence_Inflation_Statistical_Notice_1415-O.pdf

⁴ United Kingdom, Ministry of Defence, "Royal Navy and Royal Marines Monthly Personnel Situation Report for 1 November 2016," (HMSO, December 9, 2016),

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/575182/20161201_FINAL_-_RN_RM_Monthly_Situation_Report.pdf (accessed December 28, 2016). The Naval service is currently running at 3% under its liability at 29,400 personnel. This equates to approximately 22,000 RN, and 7,000 Royal Marines.

⁵ Save the Royal Navy, "Why the Royal Navy has just been cut by another 2 ships," entry posted March 30, 2016, <http://www.savetheroyalnavy.org/why-the-royal-navy-has-just-been-cut-by-another-2-ships/> (accessed December 12, 2016). The 15% figure equates to: 1 of 6 destroyers, 1 of 13 Frigates, 1 of 2 Landing Ship Docks. HMS Ocean, the third 'amphibious' designated ship is due to be decommissioned in 2018. HMS Queen Elizabeth will not be operationally ready until at least 2020.

⁶ Martin Reeves, Claire Love, and Philipp Tillmanns, "Your Strategy Needs a Strategy," *HBR*, (September 2012): 78.

Robert Gates highlights the need for the leader to understand the importance of time, and the timing of change. Drawing on his own experiences, he also observes that too much change is paralyzing. It is reasonable to assume that Admiral Zambellas understood the limitations of his organization and the brevity of his own tenure as First Sea Lord. Time to commit fully to a MAS transition proved implausible in both organizational and personal capacity terms. It is, therefore, plausible that Zambellas actively chose a vague vision for MAS. The vagueness represents the fact that the RN has no idea how to structure itself to maximize the utility of MAS. Equally, it acknowledges the proverbial need to stick a toe in to test the bath water. If allies and competitors are pressing ahead in MAS, the RN must at least maintain interest. The RN cannot afford to be wrong about MAS.

Hedging our Bets - What if we are Wrong?

As Patrick Gray fittingly points out, many new technologies do not have well-established practices for success. This requires organizations to either wait for someone else to write the rules and risk being left behind, or determine how to succeed through what is largely a process of intelligent trial and error, categorized by fast-failure. Conceptually, most leaders understand the need for failure. Without failure there can be no innovation, learning, or transition within an organization, and the organization that never fails often stagnates.⁷ However, learning to accept failure is much more difficult for the RN in the current climate.

⁷ Patrick Gray, "Fast Failure: The Secret to Fostering More IT Innovation than your Competitors," TechRepublic, article posted September 10, 2015, <http://www.techrepublic.com/article/fast-failure-the-secret-to-fostering-more-it-innovation-than-your-competitors/> (accessed December 28, 2016). Patrick Gray works for a global Fortune 500 consulting and IT services company and is the author of Breakthrough IT: Supercharging Organizational Value through Technology.

In terms of MAS, innovation is managed in a near zero-cost environment. Long-term investment in one area for future capability must be cut from existing capital. For example, more MAS will likely mean fewer ships. The consequences of asserting the future utility of MAS wrongly are much more significant than the potential failure of a start-up in Silicon Valley. The RN cannot simply start again. Once the ship-building industrial base is eroded, a structural reversal becomes uneconomical and takes a generation to re-invigorate.

Consequently, it seems reasonable to remain non-committal and out-source the fast-failure to others in the commercial sector and spend what little resources are available on unique military applications of MAS. In the 1950s, the U.S. Nuclear strike program, when faced with technical uncertainty, chose to spend more of its research monies on basic research and less on programs leading to specific weapons.⁸ Similarly, if the RN is currently unable to think about MAS operational requirements adequately, then perhaps it is wise to delay. Otherwise, “the best technology and the biggest budget in the world will only produce vast quantities of obsolete equipment.”⁹

Affording Change: A Cost-Saving Illusion

A senior RN officer at a 2014 MAS Conference said, “Unlike the introduction of submarines and carriers, defence does not have a monopoly over the new MAS technology and indeed is behind industry in the exploitation of these systems creating a high risk of proliferation, and asymmetric exploitation by our adversaries.”¹⁰ Some

⁸ Stephen Rosen, *Innovation and the Modern Military: Winning the Next War* (Cornell University Press, 1991), 246.

⁹ Michael Howard, “Military Science in the Age of Peace,” *Royal United Services Institute*, no.3 (March, 1974), 5.

¹⁰ Comment made at the MAS Conference, Qinetiq, Haslar, UK, 6-8 October 2014. Non-attributable due to the NDU Non-attribution policy available at http://www.ndu.edu/Portals/59/Documents/AA_Documents/AA%205.00.pdf accessed December 27, 2016.

conclude the investment may not be worth it if the adversary can make such systems obsolete by modest low-tech means. In any event, overcoming the enemy's response is likely to lead to further expensive technical counter solutions and systems of systems dependency. Considerations such as stealth, resilience to a contested electro-magnetic environment, navigational safety, and mission profile will all contribute toward the optimum solution.¹¹

As MAS become more complex, they may suffer the same cost/complexity law (Augustine's 16th law) they profess to break.¹² The greater the level of autonomy, the greater the probability the unit cost will increase. The fewer systems one can purchase, the more survivability becomes critical. The need for improved survivability will result in even higher capability costs without the option to revert to manned alternatives.

Arthur C. Clark's *Superiority*, written in 1951, is a fictional parody and serves as a warning to technologically advanced militaries.¹³ In the tale, the more advanced society fails to transition technical achievements into operational, and ultimately technological levels within its force. Meanwhile, rising unit costs prevent the superior force from having sufficient concentrations to overcome the less advanced nation. The seemingly lesser nation prevails by using proven and affordable technology in overwhelming numbers. As Stalin reputedly said, quantity has a quality all of its own.¹⁴

¹¹ U.S. Department of Defense, *Unmanned Systems Integrated Roadmap FY2013-2038* (Washington, DC, 2014).

¹² The problem of declining budget power in the presence of Augustine's Law and stagnant spending, is not exclusive to the UK and Europe. In the 2014 U.S. Quadrennial Review, the Chairmen of the Joint Chiefs of Staff stated "With our 'ends' fixed and our 'means' declining, it is imperative that we innovate within the 'ways' we defend the Nation."

¹³ Arthur C. Clark, "Superiority," *The Magazine for Fantasy and Science* (August 1951).

¹⁴ It is worth noting the parody is not exclusive to the MAS program, it applies across defense. The F35 program is a prominent example.

Even if MAS are irrefutably proven to be a cheaper alternative to manned systems of the future, it does not necessarily make them any more affordable within a limited and prioritized budget. The RN is not starting with a blank canvas, without existing force structure. The RN must operate and maintain equipment designed over twenty years ago in order to defend the nation's interests now. In contrast, the budgeting costs of MAS are heavily front loaded. Assuming continued rapid technical change, MAS equipment will have a relatively short in-service life before technological advancements make existing systems obsolete. Therefore, the MAS program will require a more persistent investment stream than current conventional assets.¹⁵ Assuming overall funding is fixed, the conundrum of how to implement a systematic change to MAS usage without reducing funding to already stretched conventional assets remains. The struggle for resources is a central part of any bureaucratic leader's job.¹⁶ The next chapter offers recommendations.

Summary

There is a fatalist logic to RN's approach to MAS; it is understandable but remains suboptimal. The RN can do better. Periods of budget constraint are unparalleled opportunities for leaders to implement changes, to make structural and cultural reforms, to increase efficiency, and to reallocate resources to new priorities.¹⁷ Salami-slicing budgets to maintain a full-spectrum navy means each component gets a thin cut. As former U.S. Secretary of Defense Robert Gates maintains, "It is a formula for institutional mediocrity and is the antithesis of reform and striving for excellence."¹⁸

¹⁵ Which refers back to decision-making cycle difficulties expressed in [Chapter 3](#).

¹⁶ Robert Gates, *A Passion for Leadership: Lessons on Change and Reform from Fifty Years of Public Service* (New York: Knopf, 2016), 187.

¹⁷ *Ibid.*, 188.

¹⁸ *Ibid.*, 196.

“We have no money, so we have to think” – A phrase first used by Earnest Rutherford and later paraphrased by Winston Churchill is synonymous with the RN’s attitude to financial adversity. Unwittingly, the RN’s ‘can do attitude’, so central to its ethos, is detrimental to acknowledging the magnitude of the transition to MAS use. The reality facing the RN is: you have no money, so you have to *choose*.

Chapter 5 – What Now?

As a former Director of the Central Intelligence, President of Texas A&M University, and U.S. Secretary of Defense, Robert Gates is an authoritative source on the practical implementation of change within bureaucracies. Gates draws on his own experiences to recommend what a successful leader should do to implement change. Highlighting the importance of building consensus, Gates warns against bold agenda speeches with no substance, no strategy, and no follow-up plan. Therefore, the first recommendation is a new Maritime Autonomous Systems (MAS) vision, a vision with purpose.

A New MAS Vision

The **Royal Navy** will efficiently exploit **Maritime Autonomous Systems (MAS)** to provide **capabilities beyond manned systems**. MAS will **shape** the **multi-domain battlespace**, providing **sustainable** fighting **power** and **reach** within **hostile environments**.

- Who: the Royal Navy (RN).
- What: MAS.
- When: intentionally absent – to imply from *now* on.
- Where: hostile environments, climatic and/or competitive.
- Why: to provide improved capabilities in hostile environments beyond the viability of manned systems at a reasonable cost - supporting a greater range of political choice.
- How: by shaping to advantage the air, land, sea, subsurface, seabed, cyber, electromagnetic, and space domains in the battlespace which extends from the sea.

Leading the Way and Evolution

MAS will not be implemented through revolution; it will be gradual.

“Evolutionary innovation depends on organizational focus over a sustained period rather

than on one particular individual's capacity to guide the path of innovation.”¹ However, both Rosen and Gates argue that the visionary leader is the most fundamental agent of change. Without such leadership, Rosen, in particular, is cynical of peacetime innovation in the military. He argues that “in bureaucracies, the absence of innovation is the rule, the natural state.”² In the case of MAS both observations are relevant, ignition and longevity are required.

Creating a Legacy

Roger Gill's *Theory and Practice of Leadership* provides a compressed critical review of the major theories and current practice that attempt to explain the importance of leadership.³ Rather than perceiving leadership as largely about influence, Gill advocates thinking of leadership in terms of showing the way. Henry Kissinger defined leadership as the art of taking people where they would not have gone by themselves. Regarding MAS, leadership is about developing a shared sense of destiny. Such a top-down approach is necessary given the inherent cultural resistance aforementioned in Chapter 3. Here, Admiral Zambellas deserves enormous credit for initiating and championing the first entirely unmanned multi-national exercise, especially since it occurred after his tenure. Zambellas threw down the gauntlet to industry in 2014, challenging them to bring their wares to Unmanned Warrior 2016.⁴ Yet, unlike Hugh Dowding, who successfully

¹ Williamson Murray, “Innovation: Past and the Future,” In *Military Innovation in the Interwar Period*, edited by Williamson Murray and Allan Millett, 300-328, (Cambridge, New York: Cambridge University Press, 1996), 309.

² Stephen Rosen, *Innovation and the Modern Military: Winning the Next War*, (Cornell University Press, 1991), 5.

³ Roger Gill, *Theory and Practice of Leadership*, (London: SAGE publications, 2006), 57-61, 108-160. The book presents a review of the nature and importance of leadership and the major theories that attempt to explain it. Gill founded the first Research Centre for Leadership Studies in the UK. An independent consultant on leadership, he is a visiting Professor at Durham Business School, Durham University, UK.

⁴ Unmanned Warrior, is a research and training exercise designed to test and demonstrate the latest in autonomous naval technologies while simultaneously strengthening international interoperability. The first

operationalized radar before WWII, Zambellas lacked both the time and an imminent homeland threat to necessitate rapid innovation.⁵ Due to short appointing cycles, direct, long-term interaction with the MAS project by any flag ranking officer is unrealistic. Zambellas instead made a clear attempt to create a legacy through Unmanned Warrior. But, without Zambellas's passion, will it endure? Exercise design frequently changes and is notoriously subject to personality. Information Warrior, another first, is penned for 2017 with a further Unmanned Warrior provisionally set for 2019. Their realization is key to improving the cohesion of purpose between the Ministry of Defence (MOD), industry, and the RN's MAS vision. A vision provides direction and purpose. Creating a legacy is necessary for the successful evolutionary transition to MAS integration within the RN. A legacy requires a vision and consensus to support it.

Building Consensus

The role of the leader is to map a realistic path and build popular support. Building consensus behind the vision is fundamental to its realization. Figure 2, offers a collection of top-down initiatives to generate largely bottom-up consensus building effects.

Unmanned Warrior took place over six weeks during October 2016 as part of Joint Warrior, a semiannual UK-led training exercise designed to provide NATO and allied forces with a unique multi-warfare environment in which to prepare for global operations.

⁵ Alan Beyerchen, "From Radio to Radar: Interwar Military Adaption to Technological Change in Germany, the United Kingdom, and the United States," in *Military Innovation in the Interwar Period*, ed. by Williamson Murray and Allan Millett (Cambridge, New York: Cambridge University Press, 1996), 287. For example, the development of radar in Britain was "a definite solution to a pressing problem, radar in the U.S. began only as a vague answer to uncertain threats."

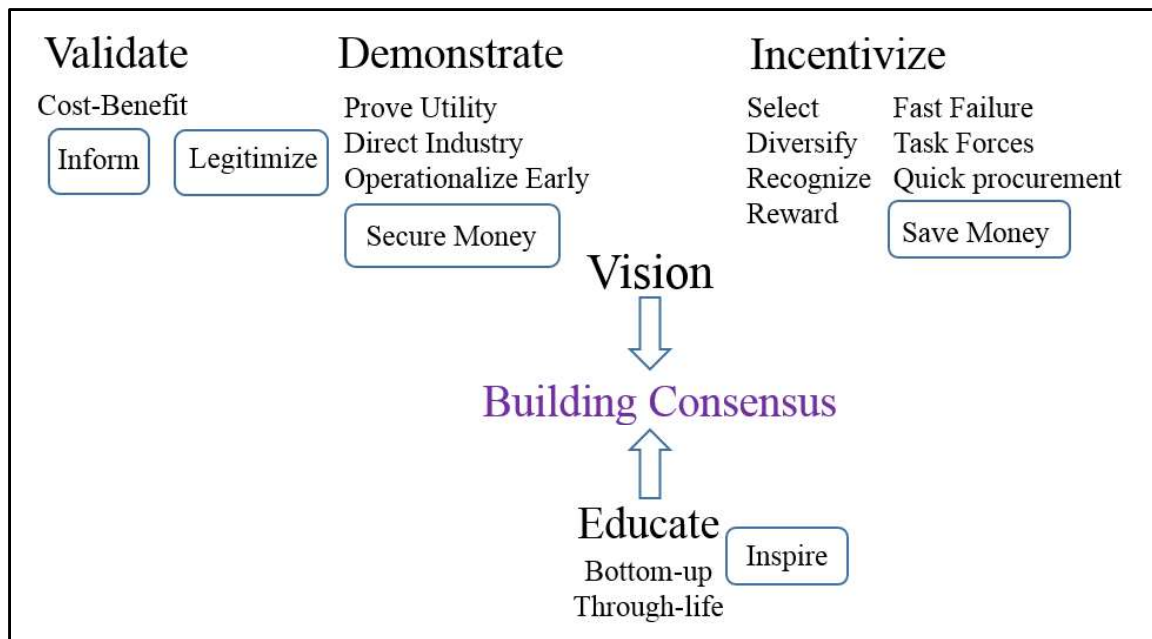


Figure 2. Building consensus⁶

While the Fleet Robotics Officer (FRO) has relationships across the defense science and commercial communities, he is not an organization. As a single entity, he does not have sufficient capacity to overcome the decision paralysis discussed in Chapter 3. The reality of stretched finances requires a very British way; a comprehensive, indirect approach not just to operations, but also to change and transition.

Educate

The most strikingly obvious consensus building methodology is to mandate through-life education in MAS. First, in the science and utility of MAS, thereafter, the exploitation of opportunities in both defense and attack.⁷ The effectiveness of such a long-term education initiative will be difficult to quantify, and will not afford any

⁶ After reviewing the leading literature this author created Figure 2. To map the process for building consensus.

⁷ Officer Cadets to receive science & technology instruction and engage in theoretical warfare exploitation discussions/forums at the naval college (Dartmouth). Thereafter, officer career courses to normalize Manned Unmanned Teaming (MUM-T), and to develop tactics to exploit the utility and weaknesses of MAS.

meaningful support to a vision already in jeopardy for at least a decade. However, at little cost, it is certainly worth doing.

Validate - How much?

Preparing to meet the threats of the future is “...much like decisions about insurance: we know we need some, but not so much as to inhibit life today to cover some distant prospect that may not occur.”⁸ A senior RN officer speaking at the MAS Conference in 2014 said the RN may still need to “understand where it was going to divest to pay for MAS and also where MAS might best mitigate the risk of this disinvestment.”⁹ Therefore, the RN should consider authorizing a cost-benefit analysis assessment of MAS by an external authority. It will be difficult, perhaps expensive; it must take no longer than six months, but it is necessary. Hard economic facts concerning the introduction of MAS into the RN ought to be projected. The financial implications of synergizing MAS with existing manned systems, or indeed replacing them entirely with MAS, requires articulation to build consensus toward the vision. Any exhibited savings could nurture support internally and broaden consensus across the arms of the RN.

As discussed in Chapter 2, solving and agreeing on the right problem is central to the successful transition to MAS assimilation. The arguments concerning the ability to buy back mass and through-life cost saving needs to be settled because they prevent consensus.¹⁰ Bryon Greenwald emphasizes the importance of building support within the military by “using the irrefutable logic of their ideas backed by empirical evidence....”¹¹

⁸ Rupert Smith, *The Utility of Force: The Art of War in the Modern World* (New York: Knopf, 2008), 14.

⁹ Non-attributable due to the NDU Non-attribution policy available at http://www.ndu.edu/Portals/59/Documents/AA_Documents/AA%205.00.pdf accessed December 27, 2016.

¹⁰ This certainly needs to be achieved before whole swathes of manned capability are irretrievably removed as in the case of MCM.

¹¹ Bryon Greenwald, “Understanding Change: Why Military Organizations Succeed or Fail to Reform, Modernize, and Improve,” Joint Forces Staff College, (September 2010), 19.

Indeed, there is no certainty that the eventual transformation to MAS will be significantly cheaper than the current manned systems, and the idea that MAS will buy back mass could be flawed. If MAS does not prove to be cheaper than manned alternatives, the decision simplifies: either MAS enhances operational capability sufficiently to justify the investment, or it does not. In either case, it will at least clarify the debate. The central argument made in the summary of Chapter 2 is that the premise for MAS should have always been based on one of improved capability. In light of financial constraints, a bold decision to move funding to the future may yet be required.

Substantiating the effectiveness of MAS, even if monies remain difficult to secure, will at least justify a financial resource choice. Thereafter, it is not enough to simply create a new vision and provide new organizational structures. An innovative field which threatens the ethos of a centuries old organization must be seen, and must be demonstrated on operations

Demonstrate

The 2016 Unmanned Warrior exercise provided an operational demonstration of industrial technical progress. The exercise created synergy between the military and the commercial sector and should lead to a better understanding of what the military requirement is and, in turn, what is feasible and affordable. (See Figure 3.) Observing a lesson from history, exercising is not the only way to demonstrate the importance of new innovative technology. A bolder means is to demonstrate by actually doing a mission, and in doing so learn operational lessons as well as technical ones. The British were more successful developing radar in WWII because they conceptualized more effective

operational ways to employ their equipment.¹² Creating and resourcing a MAS organization that meets a current need will also identify new opportunities for use.

To guarantee the flow of financial resources, the RN must find a valid current mission for MAS, an application that demonstrates, even on a small scale, the effectiveness of the innovation.¹³ An organizational structure to support cultural change is not enough. A senior RN officer, with significant development and project delivery experience, highlighted the importance of speed and cost in order to realize MAS integration. He stated, “there is a key need to turn the MAS vision into a reality, quickly and without a ten-year £100m equipment program.”¹⁴ In the

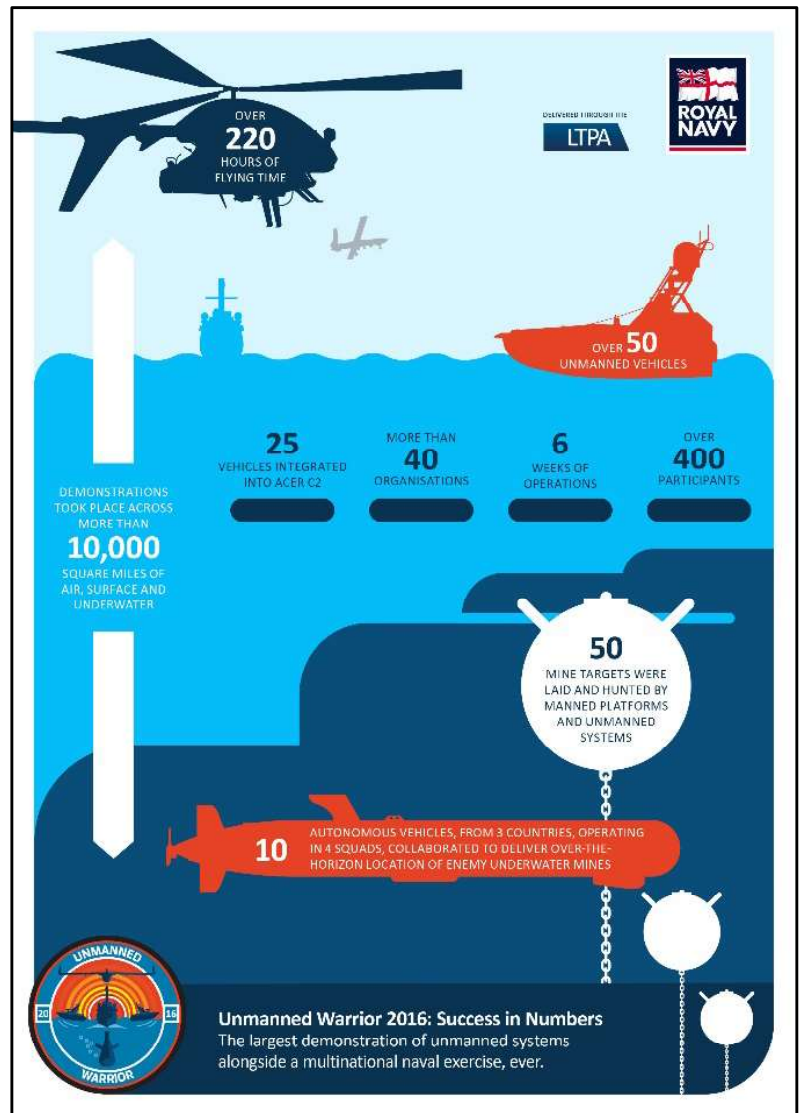


Figure 3. Infographic to show some of the key statistics and achievements of Unmanned Warrior. Helen Jackson, “Unmanned Warrior 2016 – Success in Numbers,” Qinetiq blog, entry posted December 15, 2016, <https://www.qinetiq-blogs.com/blog/2016/12/15/unmanned-warrior-success-in-numbers/>

¹² Alan Beyerchen, “From Radio to Radar: Interwar Military Adaption to Technological Change in Germany, the United Kingdom, and the United States,” In *Military Innovation in the Interwar Period*, edited by Williamson Murray and Allan Millett, (Cambridge, New York: Cambridge University Press, 1996), 274-275.

¹³ Hill, “Systems of Denial,” 129.

¹⁴ Non-attributable due to the NDU Non-attribution policy available at http://www.ndu.edu/Portals/59/Documents/AA_Documents/AA%205.00.pdf accessed December 27, 2016.

near-term, MAS needs to compete for resources internally within the RN. The 2012 operationalization of the REMUS 600s system in the Arabian Gulf by the U.S. was not critical to operations in the region at the time. Coalition organic assets were sufficient, yet REMUS increased resilience through redundancy within the Order of Battle (ORBAT), and off-set the use of aging platforms. The system's operational presence influenced the warfighting culture amongst sailors and gave appropriate technical feedback and learning for future system development. Arguably, the credibility of REMUS operationally has led to the further allocation of resources to other future U.S. MAS.

MAS needs a "Dull" achievable mission now to secure an operational funding line and gain organizational respect.¹⁵ Surveying and maintaining free access to key ballistic missile submarine routes contributes to safeguarding the UK's strategic nuclear deterrent. Vital UK trading harbors must also remain open to commerce to ensure economic prosperity. Both these key standing military tasks could be fulfilled by autonomous or automated means, to a higher degree of accuracy, with reduced human resources *today*.¹⁶ With minor personnel and off-the-shelf equipment uplifts, a re-structured Maritime Autonomous Systems Trials Team (MASTT) replacement could conduct these tasks within a year of implementation while continuing to test equipment. Coordination with the RN diving community, who also operate Autonomous Underwater Vehicles (AUVs), would make sense, providing an interim means of mine disposal until

¹⁵ The U.S. MQ-25A Stingray (X-47) is another good example of operationalizing immature technology in order to buy time and attract financing. The Stingray was originally conceived as a carrier borne unmanned long range bomber. It will now instead fulfill a tanking requirement while technology matures, and resources align with aspirations. <https://news.usni.org/2016/07/15/official-mq-25a-stingray-title-navys-first-carrier-uav> (accessed December 26, 2016).

¹⁶ There are 7 maritime Military Tasks (MT) which contribute to UK national security. The suggestion is MAS could contribute to safeguarding the UK's continuous at sea nuclear deterrent through route survey operations, and by ensuring key military and commercial harbors remain unbarred contribute to the defense of the UK and its Overseas Territories.

existing unmanned means are adapted for off-ship use.¹⁷ The major second-order effect of such a proposal is the generation of choice for the Navy Board.¹⁸ A national MAS mission now could allow for a small reduction in Mine Counter Measure (MCM) vessel numbers without detriment to the UK's commitment to maintaining the sea lanes of the Arabian Gulf. Alternatively, the provision would de-stress the taut operational program of the MCM vessels and increase the likelihood the remaining force can remain credible until maturity of the Mine and Hydrographical Capability (MHC).¹⁹

Political upheaval brings unexpected opportunities. The UK is due to leave the EU at some point after May 2019. As a result, the UK's Economic Exclusion Zone will no longer be open to EU fishers and will require significant policing.²⁰ The RN, on behalf of the Department for Environment Food & Rural Affairs (DEFRA) and the Scottish Fisheries Protection Agency (SFPA) are responsible for UK fishery protection.²¹ The RN will have six Off-shore Patrol Vessels (OPVs) by 2020 to add to SFPA's three. This will not be enough to police such a large, inhospitable area, especially since RN OPVs are no

¹⁷ RN divers are the only operational unit with MAS. One of the diving force elements has the use of 8 AUVs (REMUS 100). Ironically, the vehicles are surplus from the MHC trials program and are not fully funded Fleet assets.

¹⁸ The Navy Board is the body responsible for running the Royal Navy. Members are responsible for assisting the First Sea Lord in discharging his responsibilities as Head of Service and RN Top Level Budget Holder. Principal among these is to ensure that the Navy is fit to fight and can deliver the military capability required to defend the UK and its interests. <http://www.royalnavy.mod.uk/our-organisation/senior-naval-staff/first-sea-lord/navy-board>

¹⁹ Chapter 1, The Numbers Do Not Add Up: The projection is for a reduced MCM capability for a minimum of a four years from 2031. This proposal may offer the opportunity for further life-extensions of current manned systems.

²⁰ The study by the University of the Highlands and Islands' NAFC Marine Centre discovered that boats from other EU countries on average caught 58% of the fish and shellfish landed from UK waters between 2012 and 2014. This equates to around 650,000 tonnes of fish and shellfish worth more than £400 million per year, most of which was caught around Scotland. In contrast, UK fishing boats fishing elsewhere in EU waters landed on average 90,000 tonnes of fish and shellfish, worth about £100 million.

²¹ The RN's Fishery Protection Squadron patrols the fishery limits of England, Wales and Northern Ireland - an area that covers over 80,000 square miles of sea and stretches up to 200 miles from the coastline and extended up to 200 miles (320 km) from the coast, or to the meridian line with other states' waters, where the distance between the countries is less than 200 miles.

longer exclusively used for fishery protection. The projected stretch provides the perfect opportunity for the concept of Manned and Unmanned Team (MUM-T).²² A network of wide area surveillance UxVs and MAS could provide ISTAR for effective and efficient vessel interdiction.²³ The provision of such technology would be at the expense of DEFRA and the SFPA not the RN, providing a backdoor means of developing MAS technologies. A national MAS MCM mission, and a MAS Intelligence Surveillance Target Acquisition and Reconnaissance (ISTAR) contribution to fishery protection could provide the Navy Board a means of addressing the problem of how to invest in the future while maintaining day-to-day operations.²⁴

Incentivize

In the interim, the principal function of the naval hierarchy is to choose credible leaders at lower levels and generate alternative career paths to abet MAS innovation.²⁵ Driven from the top down, the RN may wish to consider advocating, empowering, and incentivizing more subordinates, utilizing small task forces, and creating goals with specific deadlines. Afterall, “*People* not systems implement an agenda for change.”²⁶

Stephen Rosen’s observations resonate with the RN’s MAS program. He proposes that innovation begins from the top down. “The senior officer develops a new theory of victory and explains the character of the next war and what officers must do to win it.”²⁷

²² U.S. AH-64E Apache helicopters have operationalized MUM-T with the MQ-1C Grey Eagle UAV (ISTAR) in order to maximize combat effectiveness. <http://breakingdefense.com/2015/01/mum-t-is-the-word-for-ah-64e-helos-fly-use-drones/>

²³ Among the UxVs utilized in the ISTAR role at Unmanned Warrior 2016 was the British Army’s Watchkeeper 450 (UAV).

²⁴ Investment in MAS now to make through-life cost savings while simultaneously paying for the through-life costs of existing systems.

²⁵ Rosen, *Innovation and the Modern Military*, 105.

²⁶ Robert M. Gates, *A Passion for Leadership: Lessons on Change and Reform from Fifty Years of Public Service*, (New York: Knopf, 2016), 98.

²⁷ Rosen, *Innovation and the Modern Military*, 20.

Inevitably new ideas meet cultural friction and specifically negative competition between branches that are personified by existing technologies. In the case of MAS, the Navy Command hierarchy must find internal allies. Mid-ranking officers with excellent conventional credentials, such as command tours, need to be converted to a mode of warfare that includes MAS. In return for adherence, these officers need to be incentivized through promotion opportunities. Rosen reasons that “power is won through influence over who is promoted to positions of senior command.”²⁸ Similarly, Murray argues, “Innovation demands officers in the mainstream of their professions, with some prospect of reaching the highest ranks, who have peer respect, and who are willing to take risks.”²⁹

Besides attracting and directing talent, creating conditions for “accountability is essential to any successful reform effort.”³⁰ Accountability provides motivation and reduces ambiguity. Under the direction of the FRO, a series of small, diverse task forces with constrained specific objectives and limited time would provide a basis to measure success and reward individuals as necessary within officer appointing cycles.³¹

A desire to incentivize need not be purely internal. As mentioned in Chapter 3, the RN largely ceded MAS innovation to the commercial sector. The potential benefit is frugal innovation through adaptation but, at the cost of influence and control. Given the implications of accepting this path, and the existing protracted procurement system, it makes sense to try to exercise a degree of control and direction over another source of

²⁸ Ibid., 20. Because the military is a disciplined, hierarchical bureaucracy.

²⁹ Murray, “Innovation: Past and the Future,” In *Military Innovation in the Interwar Period*, 326.

³⁰ Gates, *A Passion for Leadership*, 124.

³¹ Alan Lafley, Roger Martin, Jan Rivkin, and Nicolaj Siggelkow, “Bringing Science to the Art of Strategy,” *Harvard Business Review (HBR)*, (September 2012), 60. Without diversity it is difficult to create creative possibilities.

innovation: academia. Partnership programs can spread financial burden, and may relieve the RN of any monetary contribution.

The RN should consider harnessing Government-led initiatives such as “Advantage through Innovation” to attract autonomous innovation.³² The initiative aims to maintain the military edge of the UK’s Armed Forces into the decade ahead and beyond. It is a plan to harness the talents of academic and industry experts, especially small and medium-sized enterprises, to create new disruptive capabilities. Beginning in 2017, the Government has committed £80m per annum for ten years.³³ Better still, autonomy is the theme of the first round. There is an opportunity here to draw on potential solutions from outside the defense supplier base. If the RN organizes specific MAS problem sets into small projects and advertises them within the initiative, there is promise to reap the outcomes at little expense. According to Hill and Gerras, such widespread experimentation increases the probability that the RN will find a subset that improves understanding—by creating a space for planned and unplanned variance.³⁴ While there is still time, the RN should engineer at least one competitor to the established view of what MHC will look like.

A model worthy of emulation is “Hacking4Defense,” a U.S. innovation program associated with Stanford University.³⁵ The program aims to apply lean start-up methodologies to overcome peacetime, decades-long, acquisition and procurement

³² United Kingdom, Ministry of Defence, *Advantage through Innovation: The Defence Innovation Initiative*, (Ministry of Defence, September 16, 2016), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/553429/MOD_SB_Innovation_Initiative_Brochure_v21_web.pdf (accessed November 17, 2106).

³³ *Ibid.*, 1.

³⁴ Andrew Hill and Stephen Gerras, “Systems of Denial,” *Naval War College Review* 69, no. 1 (Winter 2016), 126.

³⁵ More information can be found at: <http://hacking4defense.stanford.edu/>

cycles. In just ten weeks, student teams of four take actual national security problems and learn how to apply lean startup principles, to discover and validate customer needs, and to continually build iterative, minimal viable products (prototypes) to test whether they understood the problem and solution. Teams take a hands-on approach requiring close engagement with actual military, Department of Defense (DOD), and other government agency end-users.³⁶

³⁶ The latest batch of Hacking4Defense team presentations is available at: <https://vimeo.com/169155566>. The presentations include proposals for: asymmetric drone defense, an underwater positioning system for U.S. Special Forces, and a more efficient satellite constellation for equatorial coverage.

Conclusion

The ever evolving character of war demands constant attention. The future is impossible to predict, but is likely to involve “simultaneous and connected challenges – contested norms and persistent disorder.”¹ Frail states will become increasingly incapable of retaining order. Projected scientific and technical advances will probably lead to greater parity among a range of actors, allowing potential adversaries to challenge UK interests more effectively. While the distribution of power may continue to diversify away from the state, the core nature of power will endure: to impose one’s will through freedom of maneuver and the projection of fear. In this respect, the Royal Navy (RN) has understandably continued to fund conventional expeditionary means. The carrier program, in particular, continues to absorb the majority of the RN’s intellectual, fiscal, and workforce capacity. Tackling change on too many fronts can lead to paralysis. Yet, Maritime Autonomous Systems (MAS) and unmanned vehicles are likely to be central to gaining access and shaping the conditions of the maritime battlespace that manned systems will enter. Expeditions require access.

In times of peace, the RN can afford to be wrong for a limited, but unknown period. The financial challenges facing the RN present an opportunity to make organizational and structural changes. Despite the unavoidable leadership churn at the top of the RN, a new MAS vision ought to give purpose and direction. Top-down internal initiatives would incentivize the best to participate and promote, leading to bottom-up support. Successful innovation requires specific alignment of service leaders, mid-

¹ U.S. Joint Chiefs of Staff, *Joint Operating Environment 2035: The Joint Force in a Contested and Disordered World*, (Washington DC: Joint Chiefs of Staff, July 14 2016), 52.

ranking officers, and institutional arrangements to protect the longevity of innovation.² Outsourcing fast-failure *with* direction and utilizing lean start-up methodologies in small task forces could offer a way of overcoming the long procurement cycle. Meanwhile, giving MAS a domestic mission now will justify financing and legitimacy through demonstration, and buy the Navy Board time to consider existing manned systems. However, while “Dull” maybe the answer now, the rationale must not be because MAS will never be fit for the “Dirty” and the “Dangerous” missions. Organizational self-awareness of any compromise during the evolution phase is essential to prevent a lowering of the aspirational bar. Created concessions, however well intended, have a habit of becoming accepted norms. The combat capability enhancement and economic efficiency arguments of the MAS vision (if true) must not be diluted.

Combined, the aforementioned elements build a new norm, a consensus behind MAS utility. If change is situational, transition is psychological; it is the process people go through as they come to terms with a new reality.³ MAS transition starts with an ending—the vision of how the future should look.

² Stephen P. Rosen, “New Ways of War: Understanding Military Innovation,” *International Security*, (Summer, 1998), 134-68.

³ William Bridges, *Managing Transitions: Making the Most of Change*, (Cambridge, Mass: Da Capo, 2003), 3-10.

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A Politics and Economics undergraduate, Commander Ashley Spencer commissioned into the Royal Navy as a Surface Warfare Officer in 2000. His early career was spent almost entirely at sea. In the wake of 9-11, he deployed for extended periods to the Arabian Gulf (AG), Mediterranean, and the Black Sea.

Ashore, he has had the good fortune to experience both variety and excitement. Prior to command, his sub-specialization as a Mine Clearance Diver committed him to Joint land-based operations in Iraq and the UK. As a junior officer, he also served in the U.S.-led UN Military Armistice Commission in the Republic of Korea. Witnessing politics in action, he spent much of his time in the Demilitarized Zone, and regularly participated in low-level staff officer meetings with DPRK army representatives at Panmunjom.

Ashley became a Principal Warfare Officer in 2009 and saw service in the AG in defense of the Iraqi oil terminals. During the voyage home, he was directly involved in the evacuation of civilians from Benghazi, Libya. Thereafter, he completed the Advanced Mine Warfare course and joined Combined Task Force 52 as the U.S. 5th Fleet's lead MCM planner responsible for developing theater MCM contingency plans. He then commanded a Mine Counter Measures Vessel, deploying once again to the AG. The ship was at the forefront of the UK's contribution to Coalition Forces in the region ensuring free and unfettered use of the sea lanes in one of the world's critical stretches of sea for international commerce.

Ashley's last appointment was Deputy Commander Operational Sea Training. He worked with his team to train Royal Navy personnel to the exacting benchmark expected of a world class navy, as well as providing training to UK allies and other navies. Selected for further sea command, Ashley will return to the UK in summer 2017.