'Our future operating environment is likely to be highly dangerous, complex, ambiguous and contested. Air Force will maintain a capability edge through the pursuit of decision superiority, fully realised enabling systems, and whole of force integration.'

Plan Jericho

The Royal Australian Air Force is currently in the process of the most significant technological change in its history as it transforms into a fifth-generation air force. To meet these requirements Air Force has initiated Plan Jericho, a project of work aimed at confronting ‘the challenges posed by new capabilities, emerging technologies and our changing strategic environment’.¹ To deal with this broad scope of challenges, Plan Jericho outlines the requirement for the Air Force to ‘develop an innovative and empowered workforce’² as well as the need to ‘embrace innovative thinking and be prepared to rapidly harness the potential of emerging technology’.³ Concerns over a more contested military environment in which potential adversaries share similar technological capabilities provide an impetus for Air Force to innovate and improve. However, we currently have a gap in that the Air Forces’ more recent operational experience differs from the type of future contested air domain anticipated by Plan Jericho.

Recent operations have seen the Australian Defence Force and Coalition partners fighting against lethal, but technologically inferior, non-state actors which have countered their disadvantages through the use of low-tech, but deadly tactics and capabilities. Consequently, recent and current operations do not necessarily reflect the contested air environments envisaged under Plan Jericho. Indeed, it has been decades since the Australian Air Force embarked on operations without control of the air, often as a result of being a part of US-led Coalition forces. Becoming overly-focused on lessons from recent operations risks missing the opportunity to learn lessons from conflicts where Allied forces faced technologically-comparable, even at times technologically superior, state-based adversaries.

Whilst recent changes in technologies, platforms and capabilities are new, significant technological and capability transformation in warfare is not unprecedented. World War Two witnessed arguably the most significant period of technological and capability development and military deployment of new and adapted capabilities in human history. Radar, radio, jet engines, computers, signals intelligence, massed long-range heavy bombers, and dedicated special force units were just a number of technologies and tactics that transformed warfare and required new and novel approaches to both exploit and counter. This chapter considers

a number of case studies in air power and joint operations where military personnel and operations scientists were able to adapt new and existing technologies, coupled with new tactics and operational methods, to achieve decision superiority over formidable state adversaries. The space available allows really only a brief insight, but enough to highlight what I think are some pertinent and important lessons going forward.

RAF Fighter Command: Success through Foresight and Fear
In 1932, British Parliamentarian (and later Prime Minister) Stanley Baldwin uttered the phrase ‘the bomber will always get through’ in discussing the significant challenges facing nations from the threat of aerial bombing. This phrase, building on air power theories by Giulio Douhet, clearly had a significant impact. In 1936, the Royal Air Force (RAF) established Fighter Command, led by Air Marshal Hugh Dowding, to address the threat presented by bombers and the significant risk that they posed to the defence of Great Britain. At the time that Fighter Command was established, neither the Hurricane nor Spitfire had yet come into service, and the potential use of radar to locate aircraft was only in its very early stages of investigation. Harold Larnder, one of the operations research scientists involved in establishing what was to become the world’s first integrated air defence system (IADS) and ground-controlled intercept capability, emphasised that Luftwaffe bombers confronted Britain with ‘a technical problem for which they could see no solution’:

Basically the problem stemmed from the fact that no part of the British Isles lies further than 70 miles from the coast – a scant 17 minutes of flying time for the German bombers that were later to be used. …there was no means known at that time for providing the warning needed for defence against enemy air attack (i.e. warning and tracking of approaching bombers) that could extend sufficiently far beyond the coastline so that defending fighter aircraft would have time to take off, gain altitude, and engage the enemy before he could penetrate to most of the vulnerable centres.5

Radar offered such a possibility and through the initiative and support of only a handful of senior civilian and Air Force leaders (including Dowding), resources, personnel and funds were made available in an attempt to provide a solution to the problem. Work had started in December 1934 with the establishment of the Committee for the Scientific Survey of Air Defence headed by Sir Henry Tizard. Over the next few years, the potential of radar was identified and then developed. By September 1936, the first basic air exercise in connection with radiolocation was run.6 Within Fighter Command, with recognition of the real risk that German bombers presented, scientists were proactively welcomed and worked with. This led to the establishment of Operational Research, which was to become a new scientific field of research, emerged out of the specific military requirement to defend Britain against air attack and efforts to utilise the emerging technology of radar to address this problem.7

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4 Refer to Hansard transcript, accessed on 12 Oct 2016 at: http://hansard.millbanksystems.com/commons/1932/nov/10/international-affairs#S5CV0270PO_19321110_HOC_284
7 Larnder 1984, p.466.
The RAF and operations scientists were dealing with entirely new technologies, coupled with new platforms (Hurricanes and Spitfires as they came on line) and training people in new skills (radiolocation tracking). This development of ground-controlled intercepts in which RAF fighter aircraft were provided with location guidance from the ground stations to enable them to locate and engage incoming Luftwaffe bombers was a matter of trial, error, learning and improvement. There was no complete IADS package of tools that came ready-to-use and ready-to-apply. Instead, the combination of new technologies, platforms and skills required a learning and iterative approach in order to maximise the capabilities of a system being designed, adapted and improved. We can see both the desperation and motivation in the testing and development of these technologies, processes and tactics in the following description of efforts during 1937 during which:

...the development of the fighter tactics for use with radar had begun, and the fighter crews were trained in their use, before radar itself was developed. If the R.A.F. had waited to work out fighter tactics until radar had been developed to a considerable degree there would not have been time to elaborate the new tactics and train the crews. Without the far-sighted development of tactics at Baggin Hill, the R.A.F. could not have efficiently utilized the advantage given to them by radar in the Battle of Britain.\(^8\)

The observation is profound in its implications; the RAF were actively developing and honing flying tactics prior to radar technology being available. This level of proactivity had strategic and clear outcomes. By the time of the Battle of Britain, RAF Fighter Command had used the very short time available from establishment to fighting the Luftwaffe in the skies over Britain to their best advantage.

Desperation appears to play a significant part in such creative solutions. Gary Klein argues that one way that we gain insight is through creative desperation, the situation dictates that we have to try something different.\(^9\) Instead of a ‘failure is not an option’ approach, it appears that the recognition of the real potential for failure actually encourages creative problem solving. The culture of desperation and genuine openness was reflected in another aspect of the interaction between military and civilians who worked together during the initial German raids over Britain. It was not simply delivering a technology and leaving it to operators to figure out, instead operations researchers were actively involved alongside military personnel in operations rooms during the earliest Luftwaffe raids on Britain. These new technologies and systems needed to be used by people, and the combination of all these had to be effective in operations to achieve an advantage over the adversary. Early raids gave the RAF and operations scientists the opportunity to learn from both successes and failures and incorporate these lessons into actual performance. As a consequence, the high levels of efficiency and successes of radar stations during the Battle of Britain were directly attributable to operations scientists analysing almost every failure to intercept daylight

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\(^8\) Crowther & Whiddington 1947, p.10.

\(^9\) Gary Klein, Leverage: How we spot opportunities, accessed on 22 October 2015 at: <https://www.psychologytoday.com/blog/seeing-what-others-dont/201406/leverage>
Luftwaffe raids from October 1939 onwards, and feeding these lessons learnt directly back into radar operations to improve performance.  

The development of the first IADS and ground-controlled intercept was a result of foresight and fear. We can contrast Fighter Command’s development of tactics with Bomber Command’s early years, in particular the difference in attitudes towards scientific support and objective performance measures perhaps best underlies the differences in culture.

Bomber Command: Theory meets Reality

If Fighter Command were fearful to spur themselves into action and seeking solutions over the fear of German bombers decimating Britain, Bomber Command had a different perspective which reflected in their early years. Britain’s Chief Scientist for Intelligence in the Air Ministry, R.V. Jones, observed that in the early years of the war Bomber Command was basking in the doctrine that the bomber will always get through and saw little need for scientific support. Contrasting the difference between operations research scientist at Fighter and Bomber Command up until late 1941, Jones noted that ‘at Fighter Command we were immediately welcome, and the Commander-in-Chief would readily see us; at Bomber Command it was more like visiting a gentlemen’s country club – we would be courteously heard and entertained but would leave with the impression that what we said would have little effect’. Indeed, though Bomber Command had not sought scientific support, they had actually been offered such assistance. In September 1939, the Director of Scientific Research actually sent an officer to Bomber Command, but recalled them within months due to insufficient requests for their services. At the same time as Fighter Command had scientists stationed within operations rooms, actively contributing to the development of radar, fighter tactics and ground-controlled intercepts, Bomber Command could find no use for such scientists. It was not as if Bomber Command did not have significant problems or challenges in achieving their mission at the time, principal amongst these was the ability to accurately navigate, locate and prosecute their targets.

During late 1941 things began to change. There were two important reasons for this change: increasing numbers of bombers were being shot down with the loss of aircrew and aircraft and the new rapidly-turned around aerial photography showed that bombers were rarely finding their targets. However, aerial photography results were not initially welcomed by Bomber Command leadership. As Taylor Downing observes:

For many months, photographic reconnaissance of sites that had been bombed continued to show that the damage caused was negligible. This was not what the chiefs of Bomber Command wanted to hear and they did not believe it could be true. They came up with a variety of reasons to disprove the photographic evidence. The photographs were of too small a scale to be able to spot the damage. The photo

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interpreters did not know what they were looking for. Some damage assessments came back with a note in the margin saying simply: ‘I do not accept this report.’

Despite this technological advantage, the unwelcome news initially prompted this to be disregarded because it did not fit with Bomber Command’s desired reality. What photographic reconnaissance did enable was to close the feedback loop that aerial bombing required, namely the ability to objectively evaluate performance. Using photographic reconnaissance, the Butt Report of August 1941 concluded that a series of raids on the Ruhr resulted in only one-tenth of the RAF bombers finding their way even within 5 miles of their targets. One estimate was that 90 percent of bombs dropped in 1940 and 1941 (some 44,737 tons) probably missed their targets entirely and had no effect at the cost of human life and skill as well as aircraft. Ultimately, due to the weight of evidence of the poor performance of strategic bombing coming from outside their Command that Bomber Command eventually became open to scientific advice and, as Jones argues, by the end of the war they had similar strong relationships with both Fighter and Bomber Command.

Paul Kennedy, in his book *Engineers of Victory*, argues that it was aerial photographic reconnaissance, rather than the more inconsistent Enigma intercepts, that provided the key information source for the evaluation and improvement of aircraft bombing ‘because it was consistent, technical, and objective.’ The improvement of this aerial capability provided key to the improvement of the application of aerial bombing. But only once Bomber Command reluctantly accepted the results, and only in conjunction with additional improvements, technologies and organisational strategies, of which people were central in design, implementation and adaptation. The importance of the combination of technologies and people in achieving outcomes was emphasised in *Science at War*, a 1947 review of the impact of scientific thinking in the British war effort. Tellingly taking the example of aerial bombing of targets, the Government publication observed that:

Organization and the mode of tying things together is often more important than improvements in individual weapons. Technical excellence may be wasted by strategical nonsense. For instance, very accurate bombing is no use if you bomb the wrong targets, through failure to choose or find the right ones.

The idea that the bomber would always get through, that success was inevitable, appears to have had a significant influence on thinking and mindsets within Bomber Command. The result was the waste of lives, platforms and weapons at a time when Britain could least afford it. Perhaps most disturbing was that the Britain’s requirement for accurate navigation systems for strategic aerial bombing had been identified as early as World War One but entirely ignored during the inter-war period. Indeed, there was much evidence and data pointing to

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16 Crowther & Whiddington, 1947, p.50.
18 Kennedy 2013, p.138.
19 Crowther & Whiddington 1947, p.117.
the requirement for accurate navigational aids. As Randal Wakelam noted, between 1937 and 1939, there were 478 cases of aircraft being forced down because the pilots had become lost, and this was within the United Kingdom.\textsuperscript{21} Despite this, it was not until 1938 that an air navigation office was established within the Air Ministry, with one observer noting that ‘The Air Staff simply did not appreciate the need for accuracy in navigation, but merely assumed that their bomber crews had such an ability’.\textsuperscript{22} There had been efforts to raise awareness of the problems of navigation, but these were ignored by Bomber Command who assumed that their aircrew had the necessary skills to accurately navigate their way to targets.

Operation Overlord: Failure as a genuine possibility

Operation Overlord, the Allied plan to conduct a contested amphibious landing in occupied France, required an ability for naval, land and air forces of multiple nations to operate as a coordinated joint force on a scale and scope never before achieved in human history. The size of the Allied invasion force assembled in England eclipses any operation since, including some 4,000 ships, 11,000 planes, and nearly three million armed forces personnel.\textsuperscript{23} Yet, the history of amphibious landings against prepared and well-armed adversaries had been one of very mixed success. Disasters such as the Dieppe raid in 1942 resulting in significant loss of life and equipment (for the Allied armies, navies and air forces involved) had made it undeniably obvious that failure of Operation Overlord was a realistic possibility. Even up until the D-Day landings (and for some time after) the possibility of failure was a genuine concern. If there was any doubt to then-Major General Dwight Eisenhower’s recognition of the potential for failure of Operation Overlord, his message penned on the eve of the landings to be released in case the landings were unsuccessful, reveals a man deeply conscious of the possibility of operational defeat.\textsuperscript{24}

It appears that genuine recognition of the real potential for operational failure, similar to Fighter Command, spurred efforts at innovation and deliberate and dedicated efforts at overcoming likely challenges. The inability of Allied tanks and armoured cars to get off the beaches of Dieppe led to the development of a diverse range of purpose-designed tanks and armoured vehicles able to operate on sand, breach enemy defences, and overcome obstacles. These vehicles, dubbed Hobart’s Funnies, were credited with helping Allied personnel get off the beaches of Normandy. General Sir Percy Hobart, who oversaw the development of these vehicles, was credited with having the genius of being open to ideas — a willingness to listen to anyone; “if you had a good idea, he’d listen to it” irrespective of whether it came from a civilian or military person, and regardless of their rank or status.\textsuperscript{25} Perhaps this openness was because of his own experience of being forcibly retired as a star ranking officer early in World War Two, reportedly for his unconventional ideas on armoured warfare, only to enlist as a lance corporal in his village’s defence volunteer unit, and soon after being reinstated to star


\textsuperscript{22} Wing Commander HR Allen quoted in Wakelam 2009, p.16.

\textsuperscript{23} Figures quoted at United States National Archives and Records Administration, accessed 09 October 2016 at: <https://www.archives.gov/education/lessons/d-day-message/>

\textsuperscript{24} Available online via the United States National Archives and Records Administration, accessed 09 October 2016 at: <https://www.archives.gov/education/lessons/d-day-message/images/failure-message.gif>

rank at Churchill’s direct intervention.\textsuperscript{26} Interestingly, it appears that the Prime Minister only became aware of Hobart’s situation when Captain Liddell Hart published a newspaper article under the banner ‘We’ve Wasted Talent’. The fact that Hobart’s funny would come to play such an important role in the Normandy landings reflected not only the brilliance behind their design but also the ability to be effectively integrated with existing technologies, platforms and people to help towards achieving overall operation success.

In recognition of the enormous difficulty of the task at hand, and the requirement to develop a robust and successful plan, the need to engage with experts – at whatever rank they were to be found – was apparent. The ability to engage experts was not only reflected in the choice of headquarters staff and planners but down to those expert in weapons and tactics that would be required for the success of Operation Overlord. Major James Goodson, a US citizen who had flown in the RAF and then in United States Army Air Force (USAAF) was a recognised Fighter Ace. In addition to 15 kills of enemy aircraft in aerial combat he also earned the nickname ‘King of the Strafers’ for his successful destruction of 15 Luftwaffe aircraft on the ground during attacks on enemy airfields. Goodson provided the following insight into a meeting he had been called to attend alongside other officers, including fellow Majors, Captains and a Lieutenant:

\begin{quote}
We had a meeting at Debden with Eisenhower... and all the brass to discuss our role on D-Day. It was an eye-opener to me, I realised why Ike had been chosen to be supreme commander over more senior generals. It was a lesson in leadership and motivation. He went around the table and asked for everyone’s input. No officer was too junior, no comments were too inappropriate not to be listened to. Only once did Eisenhower cut anyone off. When someone said: ‘Ike, I’ve got a great idea,’ he replied, ‘It’s too late for great ideas. We now have to make sure the plans we have work.’\textsuperscript{27}
\end{quote}

The willingness of Eisenhower to have his plan questioned, challenged and critiqued by mid-ranking and junior officers is insightful. The risk of failure was enormous, so it appeared far better that the plan be critiqued by those who would have to do the fighting rather than waiting to give the enemy the final say. This ability of the senior leader to draw out the expertise, ideas and suggestions from across rank levels is reflected in Paul Kennedy’s conclusion on the Allies successes across numerous operational challenges in the Second World War. Kennedy makes the following insightful observation:

\begin{quote}
In sum, the winning of great wars always requires superior organization, and that in turn requires people who can run those organizations, not in a blinkered way but most competently and in a fashion that will allow outsiders to feed fresh ideas into the pursuit of victory. None of this can be done by the chiefs alone, however great their genius, however massive their energy. There has to be a support system, a culture of encouragement, efficient feedback loops, a capacity to learn from setbacks, an ability
\end{quote}

\textsuperscript{26} Prime Minister Churchill’s written rebuke to the War Office for overlooking Hobart’s talents is worth highlighting: ‘I am not at all impressed by the prejudice against him in certain quarters. Such prejudices attach frequently to persons of strong personality and original view. ... We are now at war, fighting for our lives, and we cannot afford to confine Army appointments to officers who have excited no hostile comment in their careers.’ Winston Churchill quoted in Paul Kennedy 2013, p.269.

to get things done. And all this must be done in a fashion that is better than the enemy’s. That is how wars are won.\textsuperscript{28}

Even in an environment of enormous technological advancements, it is the very human aspects of listening, learning, encouraging and empowering people across rank levels that appeared critical to the Allies military success in World War Two.

Lessons
Even a brief consideration of the application of air power and joint operations in conflict with technologically-similar adversaries provides some key insights for Air Force and the ADF. The genuine fear of failure appears to be a good driver of insights, innovations and a willingness to listen to outside perspectives. In contrast, overconfidence seems to lessen the openness to internal or external critique. Even a brief consideration of Fighter Command and Operation Overlord appear to reinforce the argument that a fear of failure drives problem-solving and innovation. In contrast, overconfidence in one’s abilities and performance can lead to a blindness to actual failure, even in the face of evidence of shortcomings. In 1940, following the surrender of French forces, it was observed that ‘[a] naïve belief in invincibility may have some value in morale, but, as experience in France has shown, it is a dangerous guide in strategy.’\textsuperscript{29}

Another apparent lesson is that environments for ideas and innovation do not just happen; leaders have to actively develop and encourage suggestions and critique in the way that Dowding, Hobart and Eisenhower actively or openly welcomed feedback, ideas and suggestions. Scientists had to be welcomed, ideas discussed, and environments where people are genuinely listened to are not an accident, but a deliberate creation by leaders. In contrast, talent can be overlooked or wasted, such as with the initial assistance of operations science at Bomber Command or Percy Hobart’s removal from service.

In the examples given, as with the observations from numerous Allied successes during World War Two, solutions were cumulative and iterative. Successful operations against a technologically-capable state-adversary were the result of a combination of factors of which people were central. It was people, military and civilian, who were responsible for applying and adapting existing or new technologies to a defined problem in a more effective manner than the adversary. The importance of a combination of technologies, ideas and tactics to defeat a comparable adversary suggests a warning against the idea of ‘magic bullet’ solutions. The iterative nature of developments in air power and joint operations also highlights that technologies and processes do not come with pre-ordained solutions to evolving challenges. This leads to the idea of out-learning adversaries.

Ultimately, conflict is a battle of opposing forces. Writing just two years after the end of the Second World War, Crowther and Whiddington made the argument that ‘[o]ne reason why Hitler failed is that he was out-of-date.’ Whereas the Allies had developed Operations Research and brought scientific analysis to the performance of operations, Hitler held onto a more romantic view of conflict, supported by myth and emotion over facts.\textsuperscript{30} How do we out-

\textsuperscript{28} Kennedy 2013, p.372.
\textsuperscript{29} Anonymous, Science in War, 2\textsuperscript{nd} Edition, Penguin, London, 1940, p.33
\textsuperscript{30} Crowther & Whiddington 1947, pp.119-120.
learn our adversaries? Where this was more effective was where leaders, commanders and operators were realistic in their appreciation of failure. What this suggests is the importance of learning, that is, an ability to out-learn an adversary in the application of air power and conduct of joint operations. This ability to out-learn is, however, based on a realistic understanding of the situation, acknowledgement of failures, and a recognition of the genuine potential for failure.

Conclusion
The establishment of the world’s first integrated air defence system by RAF Fighter Command working together with scientists demonstrates that we can be proactive; Air Forces and military forces can learn and develop capabilities without needing to first lose lives, platforms or battles. This is an incredibly positive observation and one with direct relevance to Plan Jericho. However, success does require a genuine recognition of the real potential for failure, proactive actions by decision-makers, the importance of outside expertise, and the requirement for developing environments in which ideas and suggestions are actively encouraged from all rank levels. None of these lessons are necessarily easy to implement and might not even guarantee success against a formidable adversary. Nevertheless, a recognition that failure is a genuine option appears to offer at least the potential for genuine innovation and the opportunity to out-learn our future adversaries which history suggests might just provide the basis for victory over technologically-comparable adversaries.