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Sustaining Key Skills in the UK Military Aircraft Industry

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Summary

This study was conducted to assist the United Kingdom (UK) Ministry of Defence (MOD) in their development of a strategy and implementation plan for the military fixed wing aircraft sector. It was commissioned by the MOD's Fixed Wing Sector Strategy Board and was conducted between August and December 2009. The RAND study focused on the current health and future sustainment of key skills in the UK fixed wing military industrial base. Sustaining key skills within the UK's fixed wing industrial base presents a number of difficult challenges, particularly within the context of an overall reduction in demand for new programmes from the MOD.

What issues were RAND asked to research?

In 2005 the UK MOD laid out general principles and specific proposals regarding its approach to the UK's military fixed wing aircraft sector. These were published through the Defence Industrial Strategy (DIS), which confirmed the importance of air power within the strategic context, but highlighted a potential watershed in the military fixed wing sector. A key conclusion of the DIS was that in the face of anticipated decreases in the MOD's investment profile there would be a decline in new programme work for the sector. At the same time, the DIS acknowledged the requirement to retain design and engineering capabilities within the UK, along with the skills required to support and sustain fixed wing aircraft through life. In response to subsequent changes within the industrial and economic environment and to a

renewed focus on issues surrounding the fixed wing military industrial base, the MOD intends to develop a wider strategy and implementation plan for the sector during 2010. As part of this work, the MOD commissioned RAND Europe to explore which industrial competences are critical to the UK's military fixed wing capability, and to make an assessment of their future sustainment.

In order to achieve this overall aim, the RAND study had two specific research objectives:

1. to determine the key skills within the UK military fixed wing aerospace industrial base, covering the entire life cycle of military aircraft from design and development, production, maintenance to support and upgrade; and
2. to establish where those skills currently exist within industry and how they map to potential future workload from the MOD.

How did RAND study these issues?

A range of research methods was employed to meet the study objectives. In order to determine the key skills for the military fixed wing industrial base, we developed a taxonomy of competences that are directly relevant to military fixed wing activities, across aircraft types and through life cycle phases, as detailed in Table S-1. Quantitative and qualitative information was obtained from key suppliers through an extensive survey.

Qualitative information was obtained through semi-structured interviews with:

- MOD's key suppliers in the fixed wing and related sectors;
- industry representative groups;
- relevant stakeholders in the Department for Business, Innovation and Skills; and
- key personnel within the MOD.

Table S-1
Taxonomy of competences for the military fixed wing sector

Environment	Technology competence
Programme management	Project management
	Safety and airworthiness governance
	Fleet management
	Cost estimating
Operations	Flight operations
	Airfield operations
Logistics	Support management (‘intelligent provider’)
Cross-cutting engineering	Sustainability
	Survivability
	Software design
Platform engineering	Aerostructures
	Air vehicle dynamics
Powerplant engineering	Structure
	Fluid dynamics and combustion
	Materials
	Electrical systems
	Mechanical systems
	Control systems
Unmanned air system (UAS) engineering	Autonomy
	Operational governance
Systems engineering	Whole systems integration
	Air vehicle flight systems – electrical
	Air vehicle flight systems – mechanical
	Air vehicle avionics systems
	Mission systems/C4I
Synthetic environment	Synthetic environments

Table S-1—Continued

Environment	Technology competence
Integrated test, evaluation and acceptance	Ground test specialists
	Flight test engineering
Factory	Detail and installation design
	Production engineering
	Jig and tool design
	Composite fabrication
	Electrical installation technicians
	Specialist manufacture and machining
Field support	Training design and delivery
	Licensed engineers
	Aircraft maintenance technicians

These data were used to determine the key competences within the UK military fixed wing industrial base and to establish where those competences currently exist within industry.

Finally, the extent to which these key competences might be sustained in the future was assessed, using four different demand scenarios provided by the MOD. These scenarios bounded the possible future military fixed wing programme.

What were the main findings of the study?

What is the current demographic profile of the UK military fixed wing industry?

RAND sent the survey to key suppliers in the UK military fixed wing industry and related sectors in September 2009. Firms reported a total of 36,904 technical employees, of which around 29,000 worked exclusively or primarily on military fixed wing activities. Broadly speaking, about half of the total military fixed wing survey population are involved in design engineering activities (at various points in the

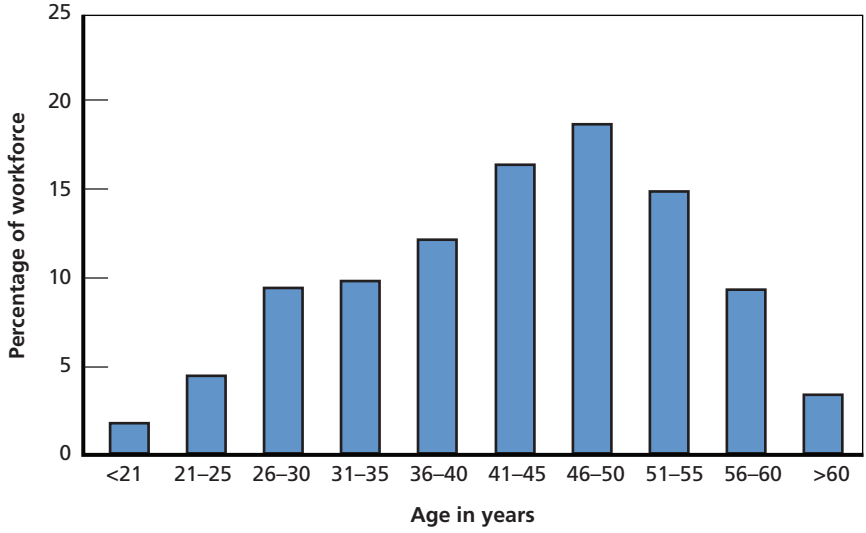
aircraft life cycle), with the other half of the survey population split between factory and routine maintenance activities.

The age profile for the workforce was somewhat skewed towards older workers, with more than 25 percent aged 50 years or above in 2009. However, the survey did not indicate any immediate age-related issues for the sector as a whole. Figure S-1 shows the overall age profile of the workforce that was included in the survey.

Specific competence groups had different age profiles, with the licensed engineer demographics being particularly skewed towards older workers. At least 20 percent of the current licensed engineer workforce was eligible to retire by 2020. Unless balanced by recruitment and development, this may present future issues due to the retirement of skilled workers.

The survey also asked how many years it takes technical skilled workers to achieve maximum level of productivity. On average, workers reach 50 percent productivity after 18 months and 90 percent productivity after 5.5 years. Most training and development of techni-

Figure S-1
Overall age profile of technical workforce in military fixed wing sector



cal workers is conducted by firms in-house, reflecting the specialised nature of many skills.

These findings on profile and productivity curves for the military fixed wing sector are comparable to the findings from previous RAND research into the UK naval industry.[1]

What are the key competences within the UK military fixed wing industry?

The taxonomy developed in this study was focused on the technical competences that are important to the military fixed wing sector. While there are synergies between the competences required for the military fixed wing industrial base and those present in the broader defence industry and civil aerospace sector, other competences are primarily (or solely) exercised by demand generated by the MOD fixed wing programme. Based on the assessment of survey and interview data, a number of key competences were identified that are both critical for the military fixed wing industry and sustained only through demand from the MOD customer. A set of key competences was identified for combat air and a set for air support (comprising air Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR), air-to-air refuelling and air transport), which are presented in Tables S-2 and S-3 respectively.

In addition, a number of low-population, highly-specialised subskills that are critical to the military fixed wing sector were identified. These subskills have very low population of workers within the MOD and industry, and consequently are likely to be at risk.

To what extent are key competences sustained by future workload from the MOD?

There is considerable uncertainty around the future MOD fixed wing programme, and this study was conducted prior to a strategic defence review that the MOD expects to conduct during 2010. Consequently,

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[1] Pung, H., Smallman, L., Arena, M.V., Kallimani, J.G., Lee, G.T., Puri, S., Schank, J.F., *Sustaining Key Skills in the UK Naval Industry*, 2008, MG-725-MOD, Santa Monica, CA: RAND Corporation.

Table S-2
List of key competences for combat air

Key competences
Safety and airworthiness governance
Survivability (including low observability)
Aerostructures
Air vehicle dynamics
Military specific powerplant
Autonomy
Operational governance
Whole systems integration
Mission systems and C4I
Synthetic environments

Table S-3
List of key competences for air support

Key competences
Safety and airworthiness governance
Survivability (excluding low observability)
Autonomy
Operational governance
Mission systems and C4I
Synthetic environments

our assessment of future demand for key competences in the UK military fixed wing industrial base was based on a set of four demand scenarios provided by the MOD. The MOD developed the scenarios to be relevant and plausible, yet sufficiently diverse in order to span the likely range of potential programme outcomes. In the near to medium term (2010–2020) the MOD scenarios focused on drawing out the dynamics around:

- pursuing a bespoke UK programme for an operational unmanned air system (OUAS), compared with acquisition of an existing off-the-shelf solution;
- undertaking a unmanned combat air system (UCAS) incremental technology development programme within the UK that is comparable to a traditional manned fast jet; and
- developing a non-traditional weapons-based UCAS to deliver deep strike capability – based around a reusable weapon rather than a platform.

In the medium to long-term (2020–2035) the scenarios focus on the implications of:

- further purchase of Joint Strike Fighter (JSF) compared with a bespoke UCAS programme;
- a JSF or UCAS programme compared with a split between these programmes;
- a bespoke 'traditional' platform-based UCAS programme compared with a 'non-traditional' weapons-based UCAS programme; and
- meeting future air ISTAR requirements through a common family of OUAS, compared with off-the-shelf purchase.

A summary of the key features of each MOD demand scenario is provided in Table S-4.

Table S-4
Summary of MOD military fixed wing demand scenarios

	Near term (2010)	Medium term (2020)	Long term (2035)
Scenario 1 ("Manned")	OUAS requirement met through bespoke medium-altitude long endurance UAS		
	No UCAS technology development programme		
		Combat air requirements met through further JSF purchase	
Scenario 2 ("Unmanned")	OUAS requirement met through bespoke long endurance UAS and expanded to provided a generic UAS family to meet all future air ISTAR		
	'Traditional' platform-based UCAS technology development programme		
		Combat air requirements met through bespoke UCAS	
Scenario 3 ("50/50")	OUAS requirements met through 'off-the-shelf' arrangement		
	'Traditional' platform-based UCAS technology development programme		
		Combat air requirements met through 50/50 split between further JSF purchase and bespoke UCAS	
Scenario 4 ("Techno Shock")	OUAS requirements met through 'off-the-shelf' arrangement		
	'Non-traditional' UCAS incremental development programme based around weapon rather than platform		
		Combat air requirements met through bespoke non-traditional weapons-based UCAS	

Sustainment of key competences: combat air

Sustaining key combat air competences in the future is largely dependent on whether there is a bespoke combat air programme that involves significant UK design and development activity. While in-service systems exercise some design engineering competences, this is insufficient to sustain the full range of key competences. Future sustainment of key combat air competences for each MOD demand scenario is provided in Figure S-2, using a traffic light assessment.

A UK bespoke UCAS or manned combat air project beginning with early concept work by 2015 would exercise the full set of key military fixed wing competences. Consequently, our assessment indicates that Scenarios 2 and 3 would provide sufficient demand to sustain key competences in the UK military fixed wing industrial base out to 2035, albeit at a reduced scale than historical numbers. Conversely, without a UK bespoke combat air project, key competences would be increasingly degraded from 2015 and not sustained beyond 2020. Off-the-shelf purchases of JSF (Scenario 1) or a weapons-based UCAS (Scenario 4) would not sustain the range of key combat air competences within the UK fixed wing industrial base.

Sustainment of key competences: air support

Compared with combat air, there are a smaller number of key competences for the air support domain. Platform competences (such as aerostructures and aerodynamics) are broadly transferable from the civil aerospace sector. However, mission systems and C4I competences are both unique to the military fixed wing sector and central to air ISTAR. In addition, autonomy and UAS operational governance are key competences for unmanned ISTAR aircraft. Future sustainment of key air support competences for each MOD demand scenario is provided in Figure S-3.

Under Scenario 1, demand from Nimrod MRA4 and from a UK bespoke OUAS would be sufficient to sustain key skills for air support to around 2020. Beyond 2020, sustaining a coherent set of key skills for air ISTAR becomes more challenging. The risk to key competences would be likely to increase in the period to 2025, with some competences being lost around this point.

Figure S-2
Sustainment of key combat air competences

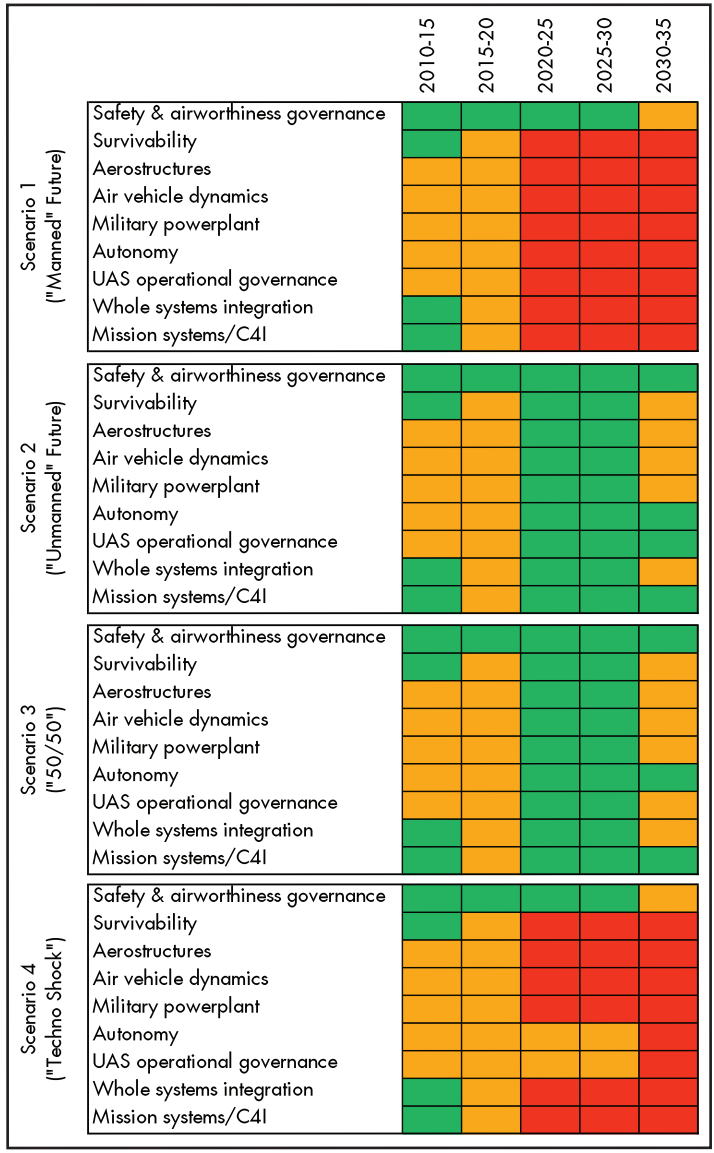
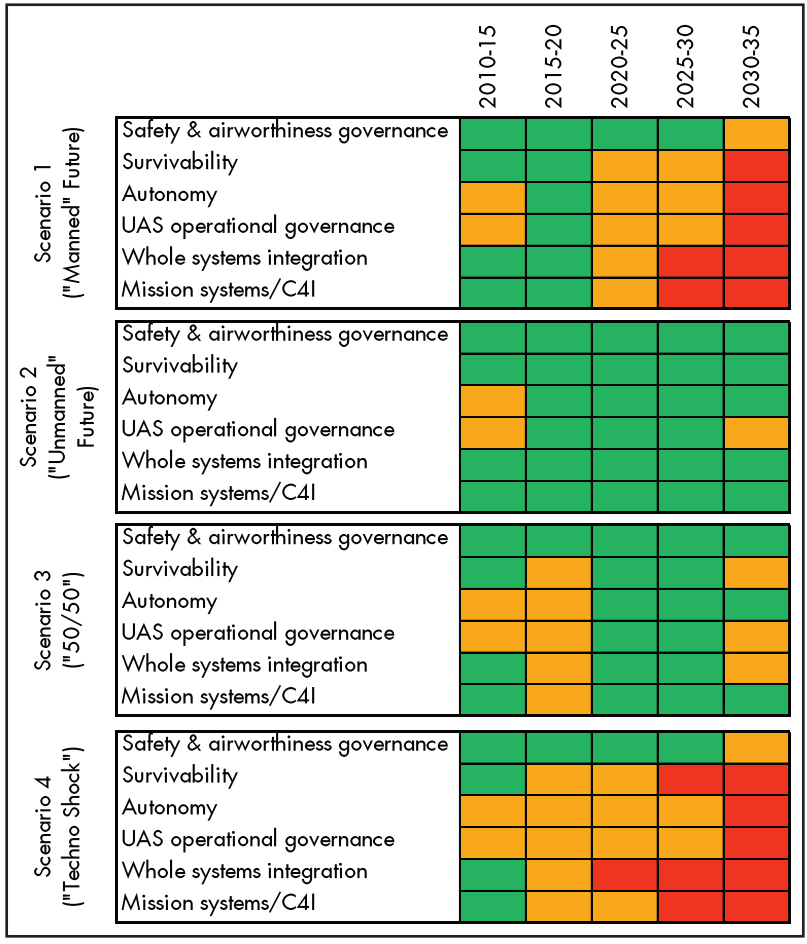


Figure S-3
Sustainment of key air support competences



To a large extent, key air support competences are transferable from the combat air domain. Consequently, key competences are likely to be sustained under Scenarios 2 and 3 through demand from a bespoke UCAS programme. Scenario 2 also exercises all key competences through the expansion of a bespoke UK OUAS programme into a family of air ISTAR aircraft. Scenario 4 has little demand in terms of air support; however, the non-traditional UCAS would be likely to exercise some competences in the development of a relatively simple unmanned aircraft, although demand for key skills would be relatively small and focused on autonomy and operational governance.

What conclusions and policy implications can be drawn?

The key conclusions and findings are focused on the UK MOD but will be of interest to the wider military fixed wing enterprise. Addressing the implied challenges is likely to require cooperation and collaboration between the MOD and its key suppliers.

- **In 2009, the UK military fixed wing industrial base was relatively healthy in terms of experience, age profile and experience across relevant competences.** Overall, the military fixed wing industry has sufficient breadth and depth to deliver the MOD fixed wing programme out to 2015, although declining employment in the sector is indicative of an industry readying itself for leaner years.
- **There is insufficient activity in the funded MOD programme to sustain all key combat air competences for design engineering beyond the end of the 2010–2019 decade.** The full range of design engineering competences for a combat air programme currently exists within the UK military fixed wing industrial base. However, this industrial capability will be increasingly eroded in the period between 2010 and 2019 in the absence of any intervention from the MOD.

- **In particular, the option for the MOD to develop a UK bespoke combat air programme (UCAS or manned) is unlikely to be preserved much beyond 2015.** Our analysis indicates that a bespoke UK programme that commences with early concept work in 2015 and scales up to major design and development around 2020 would be required in order to sustain the key design engineering competences for combat air. Without such a programme it is likely that key competences for combat air will be progressively lost from the military fixed wing sector in the period from 2015.
- **Looking further ahead, without significant new development activity it is likely that there will be increasing challenges in sustaining key competences required to upkeep, update and upgrade the in-service fleet within the 2020–2029 decade.** Design engineering competences are required during the in-service phase for spiral development and in-service updates; and to address emerging design issues. However, the capability of the military UK fixed wing industry to respond to in-service requirements is likely to be increasingly limited without new programmes.
- **A bespoke UK OUAS programme is unlikely to be sufficient to sustain a full range of competences required for a bespoke UK UCAS programme.** There is a set of competences specific to combat aircraft which would not be exercised through even the most complex air ISTAR programme. While key competences such as autonomy and mission systems could be sustained through a bespoke OUAS programme, the combat air-specific aspects of, for example, aerostructures or survivability, would not be sustained.
- **Key competences for air ISTAR (e.g. mission systems and C4I) are fragile in the absence of a bespoke programme in the short to medium term.** However, platform competences for air support (air ISTAR, transport and aerial refuelling) are likely to be sustained through civil aerospace.

- **Manufacture and routine maintenance capabilities are likely to be sustained through the medium term under all MOD scenarios.** The MOD scenarios imply ongoing demand for manufacture and maintenance from the UK industrial base throughout the 2010–2035 time period.
- **The MOD should develop a coherent strategy across capability areas and aircraft domains to take account of industrial synergies between programmes.** Should the UK commission a bespoke UK air ISTAR programme without a bespoke combat air programme, there would be significant budget implications, as overheads would require funding from the air ISTAR programme. For example, mission systems competences that are germane to both the combat and ISTAR domains would need to be sustained solely by the ISTAR programmes. Furthermore, should the UK commission bespoke programmes in both combat air and air ISTAR, there are likely to be benefits in aligning the programmes in order to provide a continuous stream of work for people working on common competences.