ATTACHMENT
SUBMISSION OF FRASER, HAMPSON, JUNOR AND QUINLAN

Aviation Safety Regulation Review

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Introduction

We are glad to have this opportunity to provide a submission to the Aviation Safety Regulation Review. We represent a team of academic researchers who have been investigating the aviation maintenance industry for the past three years on an ARC Linkage grant entitled *The Future of Aircraft Maintenance in Australia: Aviation Safety, Workforce Capability and Industry Development* (LP1101100335). Our industry partners (a central feature of the Linkage grant program) are made up of a broad mixture of employee, industry and training sector representatives:

- Australian Aerospace (Defence Contractor)
- Australian Licensed Aircraft Maintenance Engineers Association (ALAEA)
- Australian Maintenance, Repair and Overhaul Business Association (AMROBA)
- Australian Manufacturing Workers or union (AMWU)
- Flight Attendants Association of Australia (FAAA)
- Manufacturing Skills Australia (Skills Council)
- TAFE NSW
- Transport and Logistics Centre (TALC)
- Transport Workers' Union (TWU)

The purpose and outcomes of the project are described in the project documentation as follows:

> *This research will analyse sources of skill shortage in Australia's aircraft maintenance industry, and identify the safety risks of sending maintenance work offshore. It will compare these risks with the costs and benefits of building aircraft maintenance skills and careers and enhancing their contribution to national technological development.*

The Project has been approved by the University of New South Wales Human Research Ethics Committee and is being conducted in accordance with the principles of full academic independence.

In this submission we summarise a selection of our interim findings which are relevant to the terms of reference of the Safety Review. The timing of the Inquiry, with our final report still some months away, means that the comments we offer here need to be treated as tentative in parts. On the other hand, we have already published some of our findings on safety regulation, and these can be summarised here. We hope that the public interest in our research, and its potential relevance to the work of the Safety Review Committee, justifies it being released to them for consideration, even though we have not yet exposed it to the full academic validation process.

We note the Inquiry's terms of reference and objectives:

The principal objectives of the review are to investigate:

- *the structures, effectiveness and processes of all agencies involved in aviation safety;*
- *the relationship and interaction of those agencies with each other, as well as with the Department of Infrastructure and Regional Development (Infrastructure);*
- *the outcomes and direction of the regulatory reform process being undertaken by the Civil Aviation Safety Authority (CASA);*
- *the suitability of Australia's aviation safety related regulations when benchmarked against comparable overseas jurisdictions; and*
- *any other safety related matters.*

We propose to comment on the first, third, fourth and fifth of these terms of reference. Our main concerns under each of these TORs can be summarised in these terms:

> **TOR 1:** We have observed a climate of mistrust, ill-feeling and misunderstanding among many of the interest groups that make up the industry, and between several of these groups and CASA, which we believe has impeded resolution of many of the practical difficulties which arose in the implementation of the new air safety regulatory framework. Leaving aside the obvious factors of competitive strains on the industry and escalating industrial conflict, we think it likely that the way the EASA-based model was introduced quite suddenly, and with little prior explanation or consultation, disconcerted many stakeholders who had been adjusting over a decade or longer to the previous policy of working towards closer alignment with the US Federal Aviation Regulations (FARs), and contributed to this loss of trust. In any event, it suggests a need for CASA to work harder on its stakeholder relations.
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> **TOR 3:** Much of this submission focuses on the implementation and philosophical underpinnings of the new scheme, since this is a topic on which our research arguably has most to offer to the Review. We will work in considerable detail through three key concerns:
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> i. The implementation of the reforms has been uneven and beset by problems of transition, which we attribute once again to the speed

with which the program was introduced and developed, and to lack of stakeholder buy-in arising, in part, from the general perception that it represented an unexplained reversal of previous CAA/CASA and Australian government policy. Largely on account of these adjustment problems, the program has so far failed to live up to any of the justifications which were made for its introduction;

ii. Underlying the implementation problems are a number of significant philosophical and conceptual departures from the traditional Australian scheme, and possibly the accepted ICAO framework. Chief among these are
   - the emergence of uncertainty about the role, authority and standing of the LAME
   - the dilution and fragmentation of responsibility that accompanied the introduction of the A licence
   - consequential uncertainties about the compliance of the new scheme with the continuing ICAO regulatory framework.

iii. We analyse the conflicts that necessarily exist between the underlying prudential focus of the ICAO safety framework and the rules governing Australia's market-based vocational training system, to which much of the former responsibility of CASA is being shifted (especially as regards the all-important basic examination for the grant of an AME licence).

TOR 4: We focus on the contrast between Australia's relaxed approach to the supervision of overseas repair shops handling Australian work, and the stringent regulatory approach which public concern in the US has obliged Congress and the FAA to apply to offshore providers.

TOR 5: We draw attention to the current crisis of Australia's civilian training in aircraft maintenance skills, the inadequacy of the current supply to meet future Australian needs even in circumstances of maximum offshoring, and the predicted shortfall of skilled labour supply in most regions of the world which is likely not only to negate much of the cost advantage of offshore maintenance, but to affect the viability of relying on it as a primary means of meeting Australia's airworthiness requirements beyond the short term.

Term of Reference 1: Structures, effectiveness and processes of all agencies involved in aviation safety

The Australian aircraft maintenance policy network appears at present to be characterised by a high degree of conflict between interests, as well as by considerable mistrust and at times seemingly wilful misunderstanding and misrepresentation of others' positions. In our fieldwork we have encountered a pervasive climate of anxiety and suspicion. This affects the sector's capabilities for political organisation, as well as its accessibility for research. People are keen to speak, but vitally concerned with confidentiality. This is a particular research impediment since, although confidentiality is assured through the University Research Ethics process, interviewees are sometimes reluctant to sign Interview Consent forms or to agree to tape recording of interviews for fear of retribution. This makes it formally unethical to use what they say as evidence, leaving us in the position where much of our qualitative research must remain background knowledge only. However, we have conducted a survey of the population of Aircraft Maintenance Engineers, and another of (mostly) smaller MRO businesses, and many respondents to both reported concerns about safety and general management of aircraft maintenance. This bolsters the evidence of the interviews and other data we can ethically use.

The first concern we have noted across the industry concerns the less than inclusive nature of *CASA's consultation*. There is a perception that CASA consults with the large industry participants (particularly the major airlines), but smaller participants struggle to be heard, and that this imbalance of input often flows over into policies of the regulator. To some extent this is understandable, since large organisations are far more likely to employ dedicated government relations professionals and to have the resources to enable 'consultation' (e.g. to comment on policy documents and to develop position papers). On the other hand, other organisations complain of being denied entry to CASA's consultation process. A case in point is the implementation of the EASA-based suite of maintenance regulations, in which the Association which covers licensed aircraft maintenance engineers (ALAEA) was denied the opportunity to participate in the study mission which preceded the implementation of the EASA system. We consider this unfortunate since the union, while required like any other representative organisation to speak primarily for the self-interest of its members, did possess detailed and valuable first-hand knowledge of how the existing scheme worked on the ground, which could not be duplicated by any other party.

Secondly, some participants have referred to a *'command and control' culture*, backed up by the issuing of penalty notices ('getting pinged') which seem more focused on securing compliance than achieving safety, and in which there may be an element of arbitrariness and inconsistency in the enforcement of regulations.

Thirdly, and counterbalancing the accusations of excessive arbitrariness in some aspects of regulation, we have heard numerous concerns about *weakening of the inspection system* in other areas. Our interviewees have suggested that over time there has been a reduction in the number of inspectors, and changes in the nature of the inspection process – a movement from inspecting 'real' shop floor processes to an emphasis on desktop audits and checking paperwork. These changes are of particular concern considering the amount of the restructuring that has occurred, and continues to occur, in the industry – in particular the outsourcing and offshoring of heavy maintenance. How has CASA's supervisory regime responded to the increase in the number of sites at which maintenance is conducted, particularly their offshore location? We return to this below.

Fourthly, the *volume of regulatory documentation* surrounding such processes as the implementation of the new EASA suite of maintenance regulations is daunting. Many in the industry simply do not have time to read it, and some of it strikes us as confusing, and even verging on contradictory. We will return to this point as well.

Term of Reference 3: The outcomes and direction of the regulatory reform process being undertaken by the Civil Aviation Safety Authority (CASA)

Our project has investigated the implementation of the EASA-based suite of CASRs affecting aircraft maintenance – parts 42, 66, 145 and 147. We have interviewed former and current CASA officials, employers, LAMEs, training providers and others. Without presuming to attempt an evaluation of the RRP (which our project was never intended to do, and which we would hardly be competent to perform), we confine ourselves to making several points that appear important to us based on what our interviewees have told us, and on our own reading of the regulatory material. We expect these points would appear in any thorough evaluation of the CASA RRP.

Aims of the RRP

The intentions and expected outcomes of the CASA RRP were set out, among other places, in the 2010 Regulatory Impact Statement (CASA, 2010). In that paper, it was claimed that the implementation of the EASA suite of maintenance regulations would allow increased international labour transfer through mutual recognition of skills, qualifications and licences between Australia and the various jurisdictions of Europe, as well as other international EASA-approved maintenance repair and overhaul organisations (MROs). It would also aid in attracting MRO work to Australia. It would help overcome work demarcations between holders of licences in the five former licence categories – Airframes, Engines, Electrical, Instrument and Radio – and thereby improve the labour 'flexibility' which was represented as necessary to meet the highly technical demands of modern aviation systems. It was also claimed that the costs of training and gaining licence privileges would not increase (CASA, 2010:8-10).

In practice, since new licences began to be issued at the end of June 2011, none of these promises has been fulfilled, and on some of them the situation has actually gone backwards. Specifically:

- we have received reports that new-system Australian licences were not being recognised in Europe and in some other jurisdictions[1];
- far from overcoming the demarcations, the new licences have left many experienced LAMEs confused about the range of their authorisations, and present barriers to recovering even their old standing (let alone broadening their scope of activity);
- on the industrial front, aspects of the new framework (notably the Category A licence) threaten to set off a new turf war among unions;
- the need to address training gaps which did not previously exist has exposed

[1] It was observed that the new licences did not make explicit reference to ICAO Annex 1 – something which in itself raises questions about how far the new licences are ICAO-compliant.

a large apparent increase in the cost of both gaining and updating licences, accompanied, as so often in reform programs of recent years, by further cost-shifting from the employer and the public purse to the individual;

- finally, although CASA originally promised that the entire framework for the new system would be in place by 2010, some important aspects (notably the design of a licence for General Aviation maintenance) remain in limbo even at the time of writing.

Clearly, then, the scheme has encountered embarrassing implementation problems, which mean that so far it remains less effective in meeting its declared high-level objectives than the scheme it replaced. We are inclined to attribute these problems to the suddenness with which the EASA model was introduced and the consequent lack of time and prior planning (on the part of both the agency and its clientele) to sort out the implementation issues in advance. The transition to the EASA model took many in the industry by surprise, given the investment of time and effort that had been put over many years into plans to align the Australian regulations more closely to the American FARs. We have not been able to get a suitable explanation for the shift. We suspect the abrupt change of direction and lack of preparation go a long way towards explaining the transitional difficulties encountered in Australia by comparison with some other countries (for example, the UK appears to have been better prepared for the transition in certain respects).

But before going on to these transitional problems, we want to draw your attention to a range of more ‘philosophical’ issues concerning ICAO compliance, risk, and the role of the licence.

Issues of principle: the status of the licence

The EASA regulations appear to shift the responsibility for risk away from the regulator and reallocate it around other arms of the system, in such a way that key accountabilities may be obscured. Our interviewees have complained that there is a degree of inconsistency and confusion in the CASRs, and between the various explanatory documents, the Manuals of Standards and Guidance Material. We can vouch that they are certainly difficult to comprehend. We suspect that there is some inconsistency in the EASA system itself on which they are based, which may reflect different political agendas. This is a wider issue than can be canvassed here, although we hope eventually to broaden our inquiry to investigate it.

A crucial case in point is the role of the licence. The safety literature (e.g. Reason, 1997; 1990) asserts the need for engineering professionalism to hold sway in the final instance in the tension between ‘protection’ and ‘production’; between profits and safety – in particular over the decision when to return a plane to service. ICAO documentation (ICAO, 2011; 2003) attributes this role to the Annex 1 licence holder. In this view, the licence is evidence of technical expertise and ‘professional’ status, and of the licence holder as an agent of the ‘socially protective’ state, bound by professionalism to stand up for public safety and security when corner cutting may undermine safety. Chapter 4 (4.2.2.1) of

Annex 1, on personnel licensing, tells us that:

> *the privileges of the holder of an aircraft maintenance licence shall be to certify the aircraft or parts of the aircraft as airworthy after an authorized repair, modification or installation of an engine, accessory, instrument, and/or item of equipment, and to sign a maintenance release following inspection, maintenance operations and/or routine servicing (ICAO, 2011, Ch 4, also see ICAO 2003:vii.)*

Although the CASRs seem to affirm the importance of the ICAO Annex 1 licence holder (e.g. see CASA 2011d 145.A.30(k) p. 6), it is not clear that all part 66 licences meet the requirements, explicit and implicit, in ICAO Annex 1 (particularly the new Category A licences) and its supporting documentation [of particular significance here is the ICAO Training Manual (ICAO, 2003) which specifies training content for particular licence responsibilities].

There is a technical issue here – of Australian compliance with the ICAO SARPs – which is beyond our competence to determine. On the one hand, we believe that the intention of the ICAO documentation is to provide standards for training and competence below which nations cannot fall if they are to maintain ICAO compliance. ICAO does conduct periodic inspections to assess compliance. On the other, there seem to be 'escape clauses' in ICAO documentation, such as '… to the satisfaction of the Licensing Authority' (ICAO, Annex 1, 4.2.2.1 (c)). Also, Article 38 of the Convention allows Registering States to indicate variance from ICAO standards. We are not aware that CASA has indicated such variance, although we do believe there is a *prima facie* case that in certain respects the new licensing regulations may not be ICAO compliant. Therefore, we suggest, it might be good for the Safety Review Committee to examine these issues.

The new CASRs do seem to undermine the role of the B level licence – for example with the new significance attached to 'company approvals' (see below). The use of terminology like 'certifying staff' rather than 'licence holder' leaves open the possibility that non-licence holders may become 'certifying staff'. The new Cat A licence (see below) arguably does not signify the possession of the technical expertise necessary to release a plane to service, at least according to the principles of safety, which require engineering expertise to override managerial expediency in the final instance.

Company Approvals

Part 145 specifies a role for the Aircraft Maintenance Organisation (AMO) in 'approving' a licence and qualification holder to perform the work for which they are qualified and licensed. In Australia, part 145 AMOs now (as a condition of CASA approval) have to develop an 'exposition' which explains, *inter alia*, how they exercise this approval process (CASA 2011d).[2] As the part 145 MOS says,

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[2] From one point of view, this could be seen as just the codification and formalisation of a process which is part and parcel of an employment relationship. When an employer employs a licence holder, s/he is in effect 'approving' the person to do work for which they are qualified, and in the normal course of events managerial prerogative allows the employer to specify that a licence holder shall exercise the privileges of their licence in ways they 'approve'. However, the new system requires that

> *An AMO must specify standards (including, but not limited to, qualifications and experience) in its exposition for the competence of individuals involved in any maintenance, management or quality audit task and must ensure these individuals meet the standards for a task that they are authorised to perform (CASA 2011d, 145 A 30 d, p. 4).*

This raises, for us, question marks over the status of the qualification and licence, if the employer is required to take responsibility for them. We are unsure about the implications in terms of liability in the event of a safety incident or worse. We also expect there might be implications for insurance companies that have not been explored.

Part 145 also specifies that the AMO can authorise employees for '*specialist maintenance*' tasks or procedures. These are listed in the part 145 MOS and include non-destructive testing, welding, borescope inspections, composite repairs, in-flight entertainment equipment, and 'other maintenance as approved by CASA as specialist maintenance' [CASA 2011d 145.A 30 (f) p.4)]. At least one AMO reportedly adds to this list tasks such as aircraft structural repair, including composites and sheet metal; on-wing engine inspections; and specialist repairs. These maintenance procedures are signed for by 'certifying employees' who cannot issue 'certificates of release to service'.

We have not done the research to know how these 'approval' powers are being used across a number of companies. But it is only realistic to expect that the rest of the industry will not take long to fall in behind influential first movers. The maintenance exposition just referred to adopts the terminology of 'Non-Licensed Certifying Staff' (NLCS) and 'Production Examiners' to denote those whom it approves to certify for the completion of a stage of maintenance – work which may have formerly been done by CAR 31 licensed engineers at or approaching part 66 'B' level.

The Category A licence

The part 145 MOS also allows a company to authorise Cat A licence holders 'to perform maintenance certification and *issue certificates of release to service* under the scope of the approval' [CASA 2001d, 145.A.30 (g) 2 (ii) (*emphasis added*)]. We raise as a question whether this is compliant with ICAO Annexes, and relevant manuals. Giving powers to sign Certificates of Release to Service (CRS) to a person holding Certificate II level qualifications, we suggest, may not be in the spirit of the ICAO affirmation of the importance of the Annex 1 licence holder – however well it conforms to the letter of the ICAO documentation. Unlike the B licences, which are designed to be underpinned by a Diploma, the A licences are designed to be underpinned by a Certificate II qualification (CASA, 2011a, b). There are concerns that the knowledge base of the Cat A/Certificate II licence/qualification is insufficient for defect detection, as well as to fulfil the role requirements of a licence holder as envisaged in ICAO documentation.

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an employer take responsibility for an employee's 'competence' in a different way, and to a different extent, than formerly.

From the operator's point of view, the obvious advantage of the Cat A licence is that it enables them to redistribute some work from the B licence holders to the less expensive Cat As, as well as to 'certifying staff' who are not licence holders[3]. Our reading of the regulations suggests that the scope of Cat A work can expand beyond the core set of tasks listed in an appendix to the CASR Part 145 Manual of Standards (CASA 2011d), since the same appendix creates the potential for CASA to specify additional tasks (item 3q). This is potentially significant in view of the trend to 'bundle' maintenance tasks from C and D checks and schedule them into line maintenance (e.g. an overnight stay enforced by a curfew). There are concerns that Cat A licence holders may find themselves performing tasks that are out of their depth, especially if their training and experience do not extend beyond the specified 600–800 hours, and that they may miss vitally important indications of defects.

Experience reported to us from other countries (particularly in Europe) is that there has been a rise in the number of Cat A licence holders working in line maintenance. However, caution must be exercised in drawing inferences about the qualifications and knowledge base these Cat A licence holders possess, as the licences sit within a variety of qualification and training systems, and the quantity of training given to a Cat A licence holder can vary considerably between them. Some Cat A licence holders, for example in Germany, might have been through a 3-year apprenticeship. Equally, some might have less training than the 800 hours specified in the EASA regulations.

CASR Part 42

CASR Part 42 divides the administration of maintenance between a CAMO (Continuing Airworthiness Maintenance Organisation) which administers maintenance programs, and the AMO which executes them (CASA, 2011b). The CAMO certifies for 'completion' of maintenance and for 'airworthiness', while the licence holder – or 'certifying employee' – signs off for completion of a *stage* of maintenance. Our European informants report instances of CAMOs signing the 'Release to Service', notwithstanding that this practice is illegal. Knowing exactly what is legal requires the eye of a regulator, who can understand the specialised meanings attached to the specific terms – it is unrealistic to rely on such expertise existing on the shop floor. Such practices potentially breach the key safeguard which requires a person who actually has witnessed or supervised the performance of 'safety-critical' maintenance to sign off that it has been performed to standard. Eroding clarity in these vital functions is not in accord with good safety practice.

[3] The ALAEA covers B level licence holders, as it historically has all licence holders, but a FWA ruling has allocated coverage of A licensees to the AMWU and other unions who cover most of the work now done by Cat A - *except* the actual signing of the CRS.

Implementation Issues

Part 66 licensing and the Australian Training System

The new licensing system has interacted with the training system in unexpected ways, in part because the transition appears to have been rushed and/or under-resourced, and in part because of 'philosophical' differences between aviation training and the way training is conducted in the Australian Training System (ATS).

The former CAR 31 system rested on Certificate IV qualifications, plus evidence of experience and theoretical knowledge assessed by CASA. There were five categories of privileges (Airframe, Engine, Electrical, Instrument and Radio) with type privileges for large complex aircraft and their systems. Equivalence between CAR 31 licences and the much broader part 66 licences was sought through exclusions (CASA 2011a). Whereas the CAR 31 system had clearly identified what a person could sign off on, the part 66 instruments effectively meant that the bearer was authorised to sign off on everything *except* specified items for a list of aircraft and systems specific to that licence holder. The resulting licence documents were considerably longer (some up to 30 pages), and some interviewees reported lack of clarity as to what their privileges were as a result. One could imagine this being particularly serious in an employment relation if there was disagreement over the scope of an employee's privileges.

The full B1 licence requires competence in Airframe, Engines and Electrical categories. Former CAR 31 licence holders with privileges in Airframe and Engine (perhaps with Group One endorsements) were not issued with 'full' B1 licences, but with B1 licences with Electrical exclusions (a pattern that seems quite common). This meant a 'training gap' to achieve the full licence. This was potentially an added cost burden to the licence holder.

Equivalence of Training?

Another problem arose over equivalence of required training hours for the two sets of qualifications. The EASA syllabus sets a high number of training hours – 2400 hours plus type training – to achieve the overall high level and broad scope of academic knowledge required for licences (B1 and 2) with a potentially corresponding broad scope of privileges. In Britain, the implementation of the EASA system, with its high training hours requirements, was deemed 'not sustainable within the framework of existing training institutions' (Watson, 2006:322). Something similar may be the case in Australia. The CASA syllabus is almost a duplicate yet, to simplify slightly, the Australian system of government support for training allocates approximately 1280 funded training hours to Certificate IV level, with arrangements that vary state by state, e.g. for the gap between Certificate IV and Diploma. [As mentioned, this leaves an increasing cost to be borne by the individual, although that is not the point at issue here.]

On the face of it, the training hours requirements are not equivalent, although we do acknowledge this is not an 'apples with apples' comparison. It appears that many of the EASA hours consist of supervised practice and simulation training that in the Australian system takes place mostly within the apprenticeship system on the shopfloor, and are therefore partially or not at all registered in the 1280 hours. Be that as it may, one can understand a recruiter or policy maker in another country taking a dim view of a perceived shortfall in training hours. We have not done the precise country-to-country comparisons that would enable resolution of this issue, although we understand (and it would be surprising if this were not the case) that the EASA suite of maintenance regulations interacts with different national training systems in different ways, with diverse results.

Shift of CASA's former functions to the Australian Training System (ATS). [4]

A more fundamental problem (which really belongs under the last major heading) lies in the conceptual incompatibility between the purposes of certification in safety-critical occupations and the set of assumptions which has increasingly governed what we will refer to simply as the Australian vocational training system (ATS) - after having passed through a range of more fanciful acronyms since the Training Reform Agenda of the early 90s. While this conflict has been causing difficulties in some areas of aviation for many years, the current CASA reform program takes the encroachment of the ATS into its traditional responsibilities one step further. By 2015 CASA will have shifted not just the basic vocational training but the assessment of theoretical knowledge and experience for licensing purposes to the ATS. Organisations that deliver category training towards a licence, or that provide 'assessment services' for RPL, for 'gap training' or for purposes of exclusion removal, must now be registered with the National Vocational Regulator (NVR), as well as approved by CASA under part 147 (CASA, 2011d).

Ever since the new approach to the structure and funding of training was first mooted, training experts in both Australia and the UK have identified two major flaws in the model, which have increasingly resulted in poor outcomes in practice over the last two decades (see for example ACCI, 2008; SEWRSBERC, 2000), but remain in place because adherents of the system still regard them as strengths: its competency-based assessment structure, and its reliance for the provision of training services on a market model in which the person in need of training was commonly expected to play the role of customer. A brief excursion into theory is required to explain how these conflict with the underlying requirements of LAME certification.

The problem with the market model, as it is generally applied in Australian VET, is that markets for information (of which markets for training form a subset) carry a high risk of failure. The basic economic theory of markets rests on the

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[4] Note on terminology: a shift in the regulation of vocational training has meant a change in the acronyms . Formerly, what we here refer to as the ATS would have been called the Australian Quality Training Framework (AQTF) – a complex of institutions and regulations within which training and assessment practice was embedded. In 2013, the institutions were changed, with a new National VET Regulator (NVR) known as the Australian Skills Quality Agency (ASQA) taking over the role of Registration of Training Organisations, and administering the Standards which govern their registration.

assumption of perfect knowledge on both sides of the transaction. However, markets for knowledge are characterised by *information asymmetry*, since the buyer is in the market precisely because she does not know about the good which the provider is selling. This leads to what is technically called *adverse selection*, where the market can be virtually guaranteed to exclude the best-quality providers because the customer, having no means of discriminating between sellers on the basis of quality, generally has little choice but to make the decision on the basis of price – a situation which Akerlof (1979) characterised as the "market for lemons". That this is more than just a theoretical conceit is shown by the often alarming variations in the quality of training options across many areas of the Australian VET market, and also by the way large parts of the training industry have become fragmented and dominated by very small, undercapitalised providers who lack the flexibility to develop new knowledge as industrial processes change, the capacity to share their learning with other trainers, and the planning horizons which would allow them to anticipate evolution in the nature of demand.

Adverse selection can be largely avoided if there is a knowledgeable buyer (e.g. an employer buying in training services for its staff) or a knowledgeable intermediary such as a State training board or a regulator who can act as a filter between the providers and the end customers, constraining the scope for decisions to be made purely on the basis of price. In some ways the market mechanism works best when a large knowledge-based firm either buys in the services directly, or rules on which qualifications it is prepared to accept when its employees present them. In a more diversified industry sector, it is normally necessary for a government authority (or sometimes a professional association) to play the role of the knowledgeable intermediary.

In a general sense, this role is played across the ATS by the National Vocational Regulator (NVR), and the procedures for registering training providers as RTOs. However, in practice these requirements are minimal and generally applied to matters of procedural and documentary compliance (e.g. the formal qualifications held by trainers) rather than actual performance, leaving the way open to a degree of variation in the quality of the output is which is wider than desirable when the outcomes are critical to public safety.

In the case of aviation, CASA has hitherto provided a second layer of quality control through its own powers to approve or reject a training provider under part 147. However, a major loophole has emerged in this layer of protection because of the obligation of mutual recognition which is imposed on RTOs under the NVR Standards for Continuing Registration (SNR 23.2), which requires them to accept credentials from any other RTO in the same subject at the same level, e.g. for purposes of advanced standing. This means that part 147 organisations, since they will now all be obliged to comply with this requirement for registration as an RTO, will have no choice but to recognise partial qualifications from training organisations which have not met the requirements for registration under part 147.

A third line of defence against poor standards has traditionally been provided by professional registration and licensing mechanisms, which have always been seen as a different kind of certification from the educational credentials on which they are based. For example, when a person comes up before a State Psychology Board for registration as a psychologist, the possession of an appropriate degree is only one of the prerequisites; the applicant must also satisfy requirements for supervised practice, obtain satisfactory reports from the practice supervisor, provide proof of ethical conduct, etc., with the final authority resting with the Board rather than the qualifying institution. In many cases the process has involved a separate examination tailored to the specific requirements of practice in the profession concerned, as opposed to the basic knowledge which could be applicable to a range of occupations. This is still quite common practice in Australia, a well-known example being the Australian Medical Council which sets its own exam for overseas candidates seeking registration as medical practitioners, even if they hold a degree which is recognised in Australia for purposes of academic equivalence.

For a long time CASA has provided this function through an examination known as the CASA Basics which had to be passed by anyone seeking an AME licence. This test has always had a fairly strong theoretical basis, and traditionally involved essay-based questions, although in recent years it has changed to a multiple-choice format, apparently to comply with EASA practice (Haas, 2008: 609). Besides providing an assurance that anyone exercising signoff privileges had the minimum practical knowledge required for the job, the Basics exam guaranteed a core of theoretical and background knowledge providing a suitable basis for the further learning required to obtain supplementary privileges and endorsements including, under new system, the removal of exclusions.

Under the current proposals, CASA proposes to devolve this function wholly to RTOs. Aside from the obvious saving in CASA staff time, it is very difficult to see any justification behind this move, as to the best of our knowledge there has never been any complaint about the examination itself or its administration by CASA. We would argue that such a shift involves a significant departure from safe practice, as the Basics exam has up to now represented the one effective barrier against the encroachment of deteriorating standards which have marked so much of the private VET sector in recent years.

This distinction between educational credentials and professional certification brings us to the second major flaw in the system: the competency-based model. It needs to be recognised that we are dealing here with two contradictory meanings of the same word. In the language of public safety, "professional competence" (even where the "profession" in question is actually at the trades or technician level) has always implied a capacity to make independent informed decisions in circumstances which are not easily predicted in advance. Critical to this adaptive capability is the possession of a sufficient base of theoretical and background knowledge to be able to adapt existing routines and learned behaviours to unprecedented circumstances. In CBT language, on the other hand, "competence" (or "competency", as we prefer to call it for the sake of making this distinction clear) has come to mean the ability to perform a routine, repeatable, discretely observable operation or demonstrate a defined generic behaviour on a single occasion, under observation. The behaviourally based philosophy behind CBT actually makes a virtue of doing away with "unnecessary theory" – something which we acknowledge is often as congenial to the student as it is beneficial to provider's budget.

We cannot emphasise too strongly that the one does not guarantee the other. Competencies certainly have their uses, especially in the early stages of training where practical skills and routines need to be internalised before more complex learning can take place, and in those cases where it is essential for safety to perform a specific operation "by the book", just as workplace-based assessment is a necessary complement to the assessment of book learning. However, the MRO environment (at any rate at the leading edge of aircraft technology) is moving rapidly from one characterised by routine checks and operations to one where the critical skills involve the ability to detect and troubleshoot unexpected failings and come up with appropriate responses. In other words, the element of professional competence is assuming greater prominence (a development effectively acknowledged in the shift from a Certificate III or IV to a diploma), and "competencies" in the CBT sense are steadily losing their relevance to its effective exercise.

A more strictly practical consequence of the paradigm shift is that like so much "reform" of the last three decades, it involves a further shift of the cost and risk towards the person with the least market power, namely the individual trainee. In the past, larger employers at least were prepared to bear a share of the cost of apprenticeship because it provided a net benefit to their operations which was not fully captured by the qualified employee, while public authorities were generally willing to contribute to the cost (especially on an infrastructural level) because there was an overriding public benefit which could not be appropriated by either the individual or the employer, particularly where the skills were critical to public safety. The "reform" process has seen a steady decay in this sense of shared responsibility, with the result that aspiring aircraft engineers at the very beginning of their career face a massive cost barrier – estimated in the case of a B licence at $60,000 or more – which adds to the disincentive created by the well-publicised collapse of employment security in the occupation, and can only accelerate the decline in recruitment which will be addressed in more detail in the final section of this submission.

The Case of General Aviation

Concern at the delays and uncertainty regarding the final shape of GA licensing seems to be widespread, and there is disagreement as to the desirable shape of the final licence structure. Our fieldwork in GA reveals frustration at the increasing regulatory load and a climate of pessimism regarding the future. It is not too strong to say that GA regards itself as the 'forgotten child' of aviation, with complaints that emerge from time to time in policy documents and attempts to mobilise the industry and to gain the ear of government.

The new maintenance regulations may limit the supply of skilled people into GA, while increasing the paperwork requirements on small organisations that lack the resources to meet them. Our survey of Australian MROs (in which small shops serving the GA sector were over-represented) showed relatively low levels of apprenticeship activity. Among the 66 businesses which responded, there were some 90 apprentices, but 38 of them were employed by only two businesses, while four businesses together accounted for slightly more than half the total. Well over half our respondents (30 out of 66) employed no apprentices at all, while another 12 had only one. Although we do not have historical data to show whether apprenticeship has declined in the GA sector, some of the longer-established proprietors have given the impression in interviews that they are reluctant to take on apprentices compared with 20 or 30 years ago.

Maintaining an increasingly antiquated GA fleet undoubtedly benefits from the experience held by older AMEs – many of them nearing or well past retirement age – which is not being replaced as they leave the industry. Many GA employers complain that they can no longer find qualified AMEs who have the kinds of manual skill demanded by traditional mechanical work. To some extent this can be viewed as the perennial disagreement between employers and training providers over whose responsibility it is to provide opportunities for the 'supervised practice' that develops both hand skills and diagnostic competence. But it could also be seen as a failure of Australia's training system to develop formal teaching methods that can develop the kind of hands-on skills which previous generations of apprentices could once have been trusted to pick up before they even started their apprenticeship, either in secondary technical schools, or informally through hobbies like servicing their own bicycles or maintaining, rebuilding and modifying old cars. Australian training does not rely extensively on simulation and 'supervised practice' on real planes – this is no doubt a deficiency, when compared with the well-developed and coordinated European systems (particularly the German).

The Diploma underpinning the B level licences requires longer and therefore more expensive training periods, delivered on a fee for service basis, at the beginning of a person's career when they are less well equipped to pay for them, and salaries in GA do not generally provide much incentive for undertaking such a costly investment when compared with more secure trades. By contrast the CAR 31 system could accommodate the special needs of GA and provide a career structure with less extensive entry-level knowledge requirements and more opportunities for ongoing learning and incremental acquisition of desired licence privileges through self-study. It is reasonable to assume the changes will lead to a further increase in recruitment difficulties.

There seems to be general agreement that the part 66 system is designed for the large plane RPT sector, and is not well suited to the special needs of GA. In Europe special licences have been developed for work on small planes and aircraft. A B3 licence covers people who sign for maintenance work on small planes (up to 2000kg) and a B4 licence has been approved by EASA, although the European Parliament in 2010 did not ratify it.

CASA too has sought to develop a B3 licence, and put in place consultation committees to agree on the content. But it abruptly halted the consultation process, leaving the question of small plane licensing in limbo, while the implementation of the EASA suite continued in the RPT sector. Then in 2012 it reopened consultation around a new small plane maintenance licence (CASA, 2012).

The new licence, CASA proposed, would be underpinned by a qualification at Certificate III level in 'Mechatronics'. We have seen no evidence that this has gained widespread industry acceptance. Indeed, there are now several other proposals for small plane licensing contesting the CASA proposal. It seems that, notwithstanding any particular proposal that is in the field at present, there does seem to be a need for a qualification and a licence that requires less theoretical knowledge for the GA small plane sector.

A consequence of the development of a small plane licence would be segmentation in the occupation. This horse may already have bolted, and in any case increasing divergence in technology between small and large planes exacerbates differences between the sectors in terms of maintenance work. While individual L/AMEs may have developed their skills to allow them to transition between GA and RPT in a certain sector of the occupation, establishing the validity of those skills/qualifications and the suitability of licence categories is a different issue. The old CAR31 system would allow people to acquire a more specialised and focused set of skills and licence privileges, and make the transition from GA to RPT – and vice versa in the once unlikely circumstance that they would want to, in face of the salary differentials.

A specific transition problem arose from new requirements for certifying for certain electrical maintenance. For some GA operations, this meant that people who until then were certifying for certain electrical work under a special CASA dispensation that allowed holders of airframe and/or engine privileges to sign 'outside' the formal scope of their licences were now not entitled to do so. This increased the amount of licensed labour required to sign for certain maintenance operations – i.e. employers may have had to 'buy in' the services of a LAME who held electrical privileges. Although this restriction has since been rescinded, it did add to the impression that the transition to part 66 was not orderly.

The quantity and nature of regulation of GA operations tempts many who can to 'escape' by lightening their planes sufficiently to get under the weight limit of 680kg so as to be covered by the Recreational Aviation scheme. Another danger of which we have some anecdotal evidence (naturally unattributable) is the rise of 'informal' maintenance and practices such as the use of two sets of maintenance records – one recording the 'real' maintenance done on the aircraft, and another fictitious one in case an audit takes place.

Conclusion

This analysis of the CASA RRP, which is currently the section of our project where our findings are most advanced, has involved an exhaustive discussion of some highly technical issues. This is more or less unavoidable because so many of the pitfalls in the new scheme lie hidden in details of the implementation mechanisms and the wording of the various instruments. We hope that precisely because of its comprehensiveness, this coverage will assist you not only in taking an overview of the workings of the scheme, but in providing a context for making sense of representations from individuals within the industry who necessarily see only one part of the complex problem.

Term of Reference Four: The suitability of Australia's aviation safety related regulations when benchmarked against comparable overseas jurisdictions

Safety Oversight of Offshored Maintenance

One of the central issues of our research is the offshoring of maintenance. While there can be very good economic and technical cases for offshoring maintenance, it needs to be acknowledged that the quality of offshore MRO vendors – as in any industry – varies. On the one hand, in a 2013 survey of airline maintenance practices carried out by the US private consultancy Oliver Wyman (Spafford and Rose, 2013:10), 22% of North American respondents, and 16% across all the countries included in the sample, reported that they sent their maintenance offshore for reasons other than price – primarily quality, turnaround time and established relationships. On the other side of the argument, most aircraft operators (specifically including Qantas) acknowledge that their primary reason for sending maintenance offshore is the lower price, primarily due to much lower labour costs.

The main risks in this practice stem from two unavoidable features of the cost-quality tradeoff involved. One is the accountability problems resulting from *incubation*: it generally takes a very long time, at least in fixed-wing aircraft, for even quite serious errors in maintenance to show up in critical faults or accidents. The other is *information asymmetry*: the short-term costs of different maintenance options are generally known with some certainty, whereas the likelihood of a maintenance-related accident is unknown and hard to quantify even in probabilistic terms, since in advanced countries today it usually lies below the threshold of statistical inference. The risk of information asymmetry is also heightened, both for the maintenance customer and for the aircrew and travelling public who will be the first to suffer the consequences of a miscalculation, when the operator is dealing with providers in newly industrialised countries which lie outside the informal information networks characterising even the most competitive domestic MRO industry (Haas, 2008: 614)

This asymmetry leads to a further problem of adverse selection, of the kind already referred to, where the opportunity for a recovery in the current quarter's trading figures has to balanced off against an increasing probability of a major accident, with fatal consequences for the business as well as for human life, which might or might not occur at some unknown time in the future - possibly only once the aircraft has been sold on and become someone else's worry.

Both risks are especially strong in a highly competitive and uncertain market where the imperative for rapid response to transient crises of profitability almost inevitably dominates the decision-making of airlines, at the expense of strategic or prudential considerations. Most people, we believe, would see this as a fair description of the present state of the Australian passenger aviation industry, implying that neither competition nor the self-interest of individual carriers can be relied on to guarantee that safety receives appropriate priority. In such a hyper-competitive environment (whatever naïve enthusiasts for the free market might argue), the role of the regulator becomes more rather than less vital.

In the pages that follow, we concentrate our account on the issue of the safety oversight of offshored maintenance – particularly heavy maintenance.[5]

We have interviewed a number of people involved, in one way or another, with offshored maintenance. Interviewees have described how contract maintenance tends to be done to a price, and while such a contract may include specified repairs, the 'unscheduled' issues (discovery of unexpected cracks and corrosion) that always come up can cause problems, since they may be outside the scope of the contract. Engineering supervisors from the offshoring airline may uncover evidence of unsafe work necessitating rework. The result can be pressure to renegotiate the contract, but equally there can be pressure to conceal the faulty work, since it can cause the time the plane is out of service (a crucial cost item) to be extended. This can cause strained relations between the supervising engineers from the offshoring airline, and the contractor – but sometimes also between the engineers and their own employer.

Interviewees have also described the use of non-approved tools in foreign MROs, for example screwdrivers, angle grinders and pocket knives for paint removal – all practices which can scratch the aircraft skin, leading to fatigue fractures. We assume Panel members are aware of this sort of thing, which has been well documented in other parts of the world. It serves to underscore the importance of the battery of measures that can ensure safe practice in offshore MROs.

We argue that the American experience provides a benchmark of sorts against which Australian practice can be compared. We also suggest that the inspection regime for some of the overseas MROs to which Australian airlines offshore much of their maintenance needs strengthening. We suspect this has resource implications in terms of the costs of inspection which, we would argue, should be paid by the AOC holders which offshore maintenance, as a generally 'softer' inspection regime almost certainly contributes to reduced costs – at some expense in terms of safety.

What makes the US an interesting comparator for Australia is that the Federal Aviation Authority (FAA) is subject to political supervision and accountability in ways that Australia's CASA is not. The FAA has to account periodically for its regulatory performance to agencies like the Government Accountability Office and the Department of Transportation (especially the Office of the Inspector General which audits agencies within the Department). These regularly impose performance standards on the FAA. Also, Congressional committees responsible for transport play an active oversight role including reviewing progress in the

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[5] Much of the following appears in two papers we have written on the subject, which have been published, or accepted for publication. Quinlan, et al, 2013, 2014 forthcoming.

implementation of recommendations.

The FAA was recently compelled by US Congressional legislation to tighten up its regulatory and supervisory practices. This follows debate over the consequences and implications of a large growth in aircraft maintenance outsourcing and offshoring following deregulation in 1979. In some cases, this was accompanied by an increase in unsafe maintenance practices in the emerging MRO vendors, and the early disasters with ValuJet (particularly flight 592 in July 1995) indicated the presence of serious problems with the oversight of outsourced maintenance. We do not propose to list a number of incidents of this nature, or to explore the politics of offshoring. Suffice to say that a big problem in the US was airlines offshoring heavy maintenance to 'uncertificated' (i.e. unapproved, unregulated and uninspected) shops.

Since the 9/11 Commission Act of 2007, Congress has effectively prevented FAA from granting new certifications. New rules mandated by Congress, and announced in the *FAA Modernisation and Reform Act, 2012*, require the FAA to

- regulate that all 'covered' maintenance work be performed by certified repair stations by 2015
- establish a safety assessment system for all part 145 stations; and
- inspect them annually.

The FAA thus announced new rules in 2012, requiring all airlines to

- develop policies and procedures for contract maintenance acceptable to the FAA
- include them in their maintenance manuals
- provide the FAA with a list of all persons contracted to undertake maintenance; and
- maintain surveillance of contract maintenance providers to ensure they comply with the carrier's maintenance program.

It remains open to question whether enough resources will be provided to the FAA to fulfil these requirements. We have found that there is a political constituency in America for the full costs of increased inspection to be sheeted home to the airlines, and it is claimed this may affect the economics of offshoring.

Turning to Australia, we have found the regulatory oversight of offshored maintenance to be a little opaque. Unlike the US, Australian airlines are not required to register with any public agency when they offshore their maintenance, and so there is no publicly available register of offshoring – the extent of which, therefore, remains unknown.

CASA's formal position on the regulation of offshored aircraft maintenance is that

> *The introduction of Part 42 of CASR establishes that a registered operator is responsible for the continuing airworthiness of an aircraft used for Regular Public*

> *Transport (RPT) as described under CAR 206(1)(c). Further Part 42 of the CASR has set up legislative requirements under clause 42.295 of Subpart 42 D - Maintenance which states that all aircraft involved in RPT Operations must be maintained by a Maintenance Organization that is approved by CASA under Part 145 of CASR (CASA, 2013 – e mail communication to one of the authors).*
>
> *All offshore maintenance work for aircraft conducting RPT operations is governed under the requirements in Parts 42 and 145 of CASR. Any offshore organisation conducting maintenance work for an RPT aircraft has to go through* an identical process as applicable for a domestically located organization *(ibid, emphasis added)*

We wonder if this is exactly accurate. CASA claims that the approval process for offshored MROs is based on EASA regulations, and is therefore the same as for a domestic approval. We note that CASR part 145 allows for person employed in an AMO outside Australia to certify for maintenance (appropriate to their privileges)

> *if the person holds an ICAO Annex 1 Aircraft Maintenance Licence that has been issued by the NAA of the country where the location is (CASA, 2011d, 145.A.30(k) 2, p. 6)*

This leaves the certification of maintenance and the release to service of an Australian registered aircraft hostage to the training and licensing procedures of another country. We wonder how consistent this is with the Australian safety program, as well as ICAO requirements that the State of Registry be responsible for the safety of maintenance performed on aircraft even in another country (detailed below). We also note that it *is* consistent with prior patterns of offshoring regulatory responsibility, described below. We assume much hinges on the extent of other countries' ICAO Compliance, and therefore on the stringency of the ICAO inspection regime.

Moreover, this approach leaves aside the crucial question of *ongoing inspection* to ensure good maintenance practice. There are grounds to suspect that, due to resource constraints, CASA is not able to inspect overseas MROs with sufficient frequency – at least comparable to the new FAA requirements. We therefore suspect that the supervision regime of offshored MROs (and the organisations to which they may outsource) cannot guarantee safety – or even 'compliance'.

The nature of 'occasional' inspections and audits is yet another question. Our interviewees have expressed to us the view that overseas inspections tend increasingly to focus on documented process rather than actual practice, rarely extend to the shop floor, and are content with 'paper' 'desktop' audits which may fail to uncover deleterious shopfloor practice.

There is a trend towards delegating the approval and, one presumes, the inspection of overseas MROs to overseas NAAs. Australia has a long tradition of accepting at face value other countries' NAA approvals of MROs to which Australia offshores its maintenance (e.g. under CAR1998 Div5 Reg 44 ZN). It is our understanding that this regulation is unusual by international standards, in the reliance it puts on other countries' NAAs, and is under review. Yet it appears as if CASA is going to further extend the 'delegation' of the safety oversight of offshored maintenance to overseas NAAs.

In June 2005 Australia entered into a Bilateral Aviation Safety Agreement (BASA) with the US, superseding reciprocal recognition of airworthiness certificates that had been in place since 1975.[6] Since then, CASA has sought to implement further BASAs. It has worked with China 'to examine each other's aviation safety regulations in order to establish a MoU on airworthiness certification', which was signed in June 2013. It has nearly completed the same process with Canada and Hong Kong, and both were expected to have been completed by the end of 2013. The European Union, however, is 'unable to move on an arrangement on safety until approval has been provided by the European Commission' (CASA, Annual Report, 2013, p. 57). However, CASA and the Civil Aviation Authority of Singapore (CAAS) have reached such an agreement, and CASA has recently (July 2013) announced a 'technical agreement' between Australia and Singapore.[7]

> ***10.1.1*** *Part 42 of CASR requires Australian aircraft and aeronautical products to be maintained by a maintenance organisation appropriately approved in accordance with Part 145. Part 42 also contains a provision to allow the acceptance of a maintenance organisation located in Singapore.*
> ***10.1.2*** *By signing the TA, CASA acknowledges that maintenance organisations, approved in accordance with SAR 145 and qualifying under the terms of the TA are considered equivalent to an Australian AMO approved under the Part 145.*

It is unclear to us how this accords with the Chicago Convention and the ICAO documentation which flows from it, which makes a NAA (in this case CASA) responsible for the safety of aircraft which are registered to it.

> *The State of Registry also has the responsibility to make certain that every aircraft on its register is maintained in an airworthy condition throughout its operational service life. Therefore, effective continuing airworthiness requirements are most important. Although methods of discharging the foregoing State airworthiness responsibilities may vary, and in some cases, may involve the transfer of certain tasks to authorized organizations or other States. Such arrangements do not relieve the State of Registry from its overall responsibility (reference Annex 8, Part II, Chapter 4, Continuing Airworthiness of Aircraft, 4.2.3, State of Registry.) (ICAO 2013:20).*

The Australian State Safety Program documentation echoes this clearly, stating that 'CASA is responsible for the safety regulation of both civil air operations in Australian territory and Australian aircraft operating outside Australian territory' (Australian Government, 2012:14). It is a matter for inquiry how exactly CASA discharges this responsibility, and whether this responsibility can reasonably be 'offshored' along with the maintenance that it regulates.

A concluding point takes us back to the implementation of the EASA suite of maintenance regulations. We have established that there is some variation

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[6]http://www.CASA.gov.au/wcmswr/_assets/main/airworth/international/faaaustraliaea.pdf
[7] http://CASA.gov.au/wcmswr/_assets/main/lib100046/145c05.pdf

between ‘the EASA system’, and ‘the Australian version of the EASA system’ – a particular concern, already mentioned, is the quality of the training that underpins the qualifications and therefore the licences. There is also considerable variation in the ways that EASA regulations are implemented in different countries in Europe – particularly with respect to the workings of their national training systems. It would be surprising if this were not the case in our region, and if there were not significant variation in the ‘EASA systems’ and approvals that govern the MROs to which Australia outsources. We know of no research or inquiry into the extent and nature of the implementation of EASA regulations in, for example, the Philippines, Malaysia, China, Hong Kong or Singapore. This suggests to us that it cannot be assumed that these regulatory systems – to the extent that they are ‘harmonised’ with the EASA regulations – are ‘equivalent’ to our own, or to some master EASA blueprint (from which our own system is a deviation).

This, to us, puts into question the rationale for accepting other countries’ NAA approvals of MROs operating in their territory. This could be underscored to the extent that governments are involved in promoting the MRO industry – this could constitute a conflict of interest between thoroughness of safety regulation and cost competitiveness of an export industry – exactly the sort of conflict of interests that safety regulation can do without.

Term of Reference 5: Any other safety-related matters

It is inevitable that most of the attention of this review will be directed to the regulatory structures and institutions, and we have focused our input with that in mind. However, we also need to draw your attention to a more fundamental issue which is equally if perhaps less directly linked to safety and makes up the second major theme of our project.

This is the supply of skilled labour. Even the most effective and efficient regulatory scheme will fail unless enough properly qualified people are available to put it into effect. Our research so far has reinforced the view already expressed by the ICAO, IATA and a number of other authoritative international sources that most regions of the world face a growing shortfall of skilled AME labour over the next 20 years. In Australia's case, the capacity of the training system to respond has been so badly degraded that it is arguably time to describe the situation as a crisis.

What follows is (appearances notwithstanding) a fairly summary outline of the findings still emerging from a very complicated research and modelling process. As there is no space here to go into the detailed working by which we arrived at the estimates below, we are inevitably requiring you to take them on faith to some extent, though we would be more than happy to explain how we got to these conclusions if you think it would be helpful.

Equally, we must point out that any such projections of future demand, especially in an industry experiencing the current levels of instability, can only be very approximate, since they are highly sensitive to a large number of factors which cannot be confidently predicted. The apparent precision of what we set out below should not be mistaken for accuracy; it is simply a matter of quantifying projections and converting them into visualisations for the sake of making it clear how large the challenges are, even if our quantification is at best of an order-of-magnitude nature.

At least four reasonably credible sources have made detailed projections of the world demand for new aircraft engineers (i.e. additional to the current workforce, and hence requiring to be trained up to professional entry level over the period in question). It is difficult to compare these estimates exactly, since they cover different time periods, and each covers a different segment of the global fleet. (It should be borne in mind that none of these, nor any of the others we have consulted, make full allowance for GA.) Table 1 below sets out the most important.

2018	IATA 2008 (main-route RPT only)	405,000
2026	IATA 2008 (as above)	739,000
2030	ICAO 2009 (excludes most GA)	818,451
2031	Boeing 2012 (jet airliners >90 seats only)	601,000
2032	Boeing 2013(as above)	556,000

Table 1
Estimates of future world demand for qualified AME labour

It will be seen that the IATA and ICAO estimates fall within the same order of magnitude, bearing in mind their different coverage and the different time periods involved. Both sets show strong growth in demand concentrated in the period between now and the early 2020s, but continuing to rise through to the 20-year horizon generally applied in such projections. The Boeing figures are substantially lower (especially in terms of personnel per aircraft), and the degree of change between the 2012 and 2013 estimates – especially in the absence of any information on how they were calculated – provides a reminder that they need to be treated with a degree of caution. Nevertheless, they are important because they are based on proprietary information not available to the other sources, and can be confidently treated as the lower boundary of the range of credible predictions.

Of the three sources, the ICAO figures are generally regarded as the most credible, given their relatively comprehensive coverage, the degree of consultation that went into their preparation, and the relative transparency of the process by which they were arrived at. They are based on the assumption of an average requirement of 20 qualified engineers (five of them licensed) for each jet-powered passenger or cargo plane in service, and three (two of them licensed) for each plane in the remaining category (consisting mostly of turboprops or twin-engined piston planes in commercial service, but excluding helicopters).

Obviously these are very broad averages (suggesting, for example, that an A380 requires the same number of qualified workers to maintain it as an F100), and it is not clear how far they provide for expected reductions in the average maintenance requirements of the commercial fleet over the next two decades, though the fact that they are considered to be valid over a 20-year period suggests some such provision must have been made. The Boeing projections, by contrast, appear to be based on fairly generous expectations of the maintenance savings from new generations of aircraft like the 787, and of the number of such low-maintenance aircraft likely to come into service over this period.

While the regional breakdowns prepared by the ICAO are based on the notional premise that all aircraft registered within a jurisdiction will be maintained within the same jurisdiction, it is unclear how far the remaining forecasts make allowance for offshoring. As further noted below, they do make allowance for labour mobility, suggesting that persistent shortfalls in one nation's training effort could be compensated to some extent by increasing the output of other nations with a greater capacity.

Both the ICAO and the IATA projections were made with declared intent of assessing the adequacy of the current training infrastructure to meet future demand. Both suggest the need for major upgrades of capacity in most parts of the world. Table 2 below contains specific estimates of the average requirement for newly trained personnel over the next 20 years and the likely shortfall in each year, assuming the potential output of each national training system remains at its current level.

Region	Total required by 2030	Annual training need	Annual surplus/ shortfall
Africa	58635	3769	-3169
Asia-Pacific	289510	19010	-14745
Europe	330522	22977	-8352
Latin America	101226	6881	-5566
Middle East	59905	4107	-2062
North America	325171	13586	15824
World	1164969	70331	-18071

Table 2
Estimated average annual training requirement and shortfall by region, 2011-2030
(Source: ICAO, 2009)

It should be noted that these shortfalls in training output do not necessarily translate into shortages of labour. In the Middle East, for example, the ICAO expects that despite an annual demand for new qualifications at roughly twice the level the domestic training system is capable of providing, there are unlikely to be actual labour shortages because of the ability of the Gulf nations to attract labour from large sections of the world by offering generous wages (ICAO, 2009: 46).

The IATA research adds a further dimension to this information by attempting to map the pattern of growth. Its consultations with member airlines indicated that the strongest net growth in demand was expected to occur within the 4-year period from 2009, and remain strong over the full decade, tapering off after that point.

Translating these regional estimates into forecasts for Australia is extremely difficult because Australia represents only an extremely small and atypical segment of the overall Asia/Pacific market, with a relatively stable and mature consumer market and industry structure in a region of the world characterised by massive growth in demand for air travel and a major explosion in both the number and size of competing firms. So generalisations and aggregate predictions which might hold good for the region as a whole cannot necessarily be trusted as indicators of what will occur here.

Perhaps the more sobering implication to be read into these figures is that the biggest shortfalls are expected to arise in precisely those parts of the world to which Australian carriers are increasingly turning to meet their maintenance requirements. Once the full extent of the capacity constraints in these regions becomes apparent, there can be no reason for confidence that Australian customers will receive any priority in the queue (especially over competitors domiciled in the same country); at the very least, simple supply and demand mechanisms will make it possible for suppliers in those regions to increase their prices significantly in a tight market, just as labour shortages will push up the labour component of total costs in many countries whose primary attraction currently lies in their cheap but well qualified labour force. Both factors are likely to reduce the cost differential between performing heavy maintenance in Australia and offshore, just as sovereignty considerations will come increasingly into effect, translating into public demand for Australia to become more self-reliant again as the world supply of MRO becomes more uncertain.

The alternative and perhaps more worrying risk is that many nations (possibly including Australia) will react to their chronic inability to meet the full demands for properly skilled labour by familiar methods such as resorting to the use of unqualified personnel, intensifying the work of those skilled engineers who are available, and skimping on internal quality control. In the worst-case scenario this could lead to a repeat of the kind of thing American carriers experienced with their initial forays into offshore maintenance in the period immediately following deregulation.

In this context it makes sense to investigate how much could be achieved if Australia were to make the investment in repatriating a larger proportion of its maintenance currently performed offshore, and in particular whether the current training infrastructure and traditional arrangements would be able to ensure an adequate supply of skilled labour to make this transfer feasible.[8]

So far as we have been able to work out, nobody has yet made any publicly accessible forecasts of the future demand AME labour in Australia. The closest we have seen is a rough estimate made in passing in the course of the 2009 White Paper *Flight Path to the Future*, suggesting that the size of the workforce would need to double – a rule-of-thumb estimate commonly applied to growth in the workforce not only in aviation but in many areas of transport, globally as well as in Australia. Without proprietary information to which we had no access (and which would probably not be very reliable in any case, given the current instability in the structure of the domestic industry), we have had no option but to develop our own estimates based on the ICAO benchmarks, Census and Labour Force data, and occasional crumbs of information dropped by industry sources. Perhaps the most useful of these was the passing comment made by a Boeing executive in a newspaper interview last year to the effect that Oceania

[8] It is worth noting that in the American survey referred to earlier, the authors identified a potential for repatriating some 30% of the maintenance currently done offshore, but were told by their respondents that the scope for any expansion beyond that point was limited primarily by the unavailability of skilled labour – this despite the ICAO figures pointing to an apparent problem of oversupply from the training system in North America. (Spafford and Rose, 2013: 11)

would need around 17,000 qualified engineers by 2032, of whom we would expect the largest proportion to be working either in Australia or on Australian aircraft.

One major problem with applying the ICAO model is that their estimates rest on the assumption of an average annual attrition rate for aircraft engineers of 5%. (Boeing put this figure slightly lower at 4%.) The most recent DEEWR occupational bulletin from late 2012[9] estimated the actual attrition rate over the previous five years at more than twice that level. As will be further illustrated below, the level of attrition has a major impact on the supply-demand equation which affects in particular the speed at which training system output could recover if even a very large investment were made in new training resources.

We have nevertheless chosen to apply the ICAO assumptions for the sake of comparability with other forecasts. Based on our own calculations of how many aircraft on the current Australian register fit into each of the ICAO's two categories, we tentatively estimate that the current Australian requirement would run out to 13,128 AME's, of whom just over 4000 would need to be licensed, if all the necessary work were to be carried out on shore in accordance with the ICAO benchmarks. By our own calculations, the employed workforce actually available today to carry out work on the relevant segments of the fleet amounts to slightly over 9000, excluding people employed in Defence installations and those whose workplace is shown in the Census to be in a location not normally accessible to international, domestic or major regional airlines. By these calculations (which inevitably come with a big margin of error), the current level of Australian employment in the occupation is equivalent to around 70% of the ICAO benchmark – a figure which may seem alarming, but actually lies somewhere below the ICAO's estimate of the annual adequacy ratio in most regions of the world over the next 20 years.

Looking to the future, we have developed three representative demand curves representing alternative scenarios for the growth of AME labour requirement in Australia, based on the more reliable of the official world and regional projections. These are mapped out in figure 1 below. While these are essentially notional, we are confident that they fall within the range of realistic projections.

Of the three, the ICAO scenario (scenario 1, shown for the sake of simplicity as a simple exponential curve) indicates the highest level of total demand over the full 20-year period, but shows a slightly less urgent requirement for growth in output of the training system over the first decade, because it starts from the calculated ICAO benchmark requirement for 2013; in other words, an extra allowance would be required for catch-up. Scenario 2, perhaps the most notional, takes as its starting point our estimate of the actual employed workforce as at 2013, but models a convex growth pattern reflecting both the IATA findings on the global demand growth pattern, and a complex set of empirically derived

[9] These occupational demand bulletins were discontinued after the occupation was removed from the official shortage list in the second half of 2013. The estimates were based largely on ABS *Labour Force* data, which are known to be of limited reliability because of the small size of the sample, but were backed up by regular surveys of employers.

assumptions relating to the expected age and maintenance-intensity of the Australian fleet, and the age profile of the workforce, at each point over the two decades. Scenario 3 starts from Boeing's rough estimate of the total demand in Oceania at the end of the period, assumes for the purposes of argument that 15,000 out of the 17,000 will be working in Australia, and uses a lower starting point because Boeing's forecasts cover a smaller segment of the fleet.

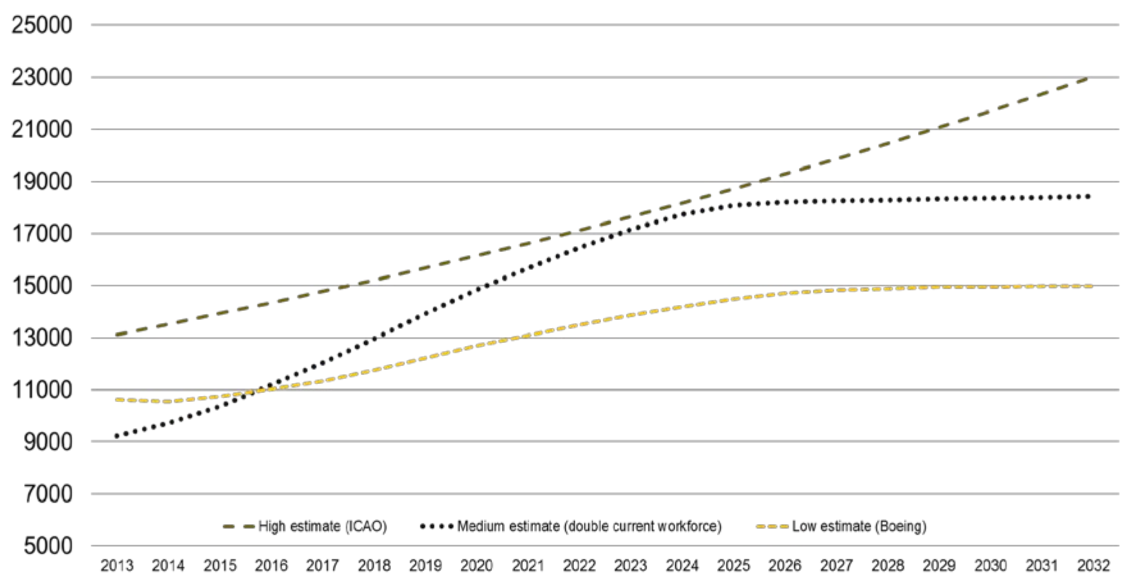

Figure 1: Three demand growth scenarios for Australian AME labour

High estimate: ICAO formula – average annual increase of 3% in labour force (corresponding to 3% increase in fleet size). Applies to commercial jet and turboprop fleet (i.e. excludes much of GA and all helicopters). Shown as simple exponential growth trend for sake of simplicity – pattern in reality would be more complicated. Point of origin (2013) represents estimated current requirement at ICAO benchmarks.

Medium estimate: Many sources refer to a "doubling" of workforce required (along with most other measures of activity) in 20 years. This projection starts from that estimate but models the growth pattern as a notional convex trend, with most growth occurring before 2024 (based partly on 2008 IATA survey findings). Point of origin is full size of estimated employed workforce at end 12-13, excluding GA.

Low estimate: derived from Boeing's estimate of 17,000 maintenance workers required in Oceania in 2032. Covers only jet passenger (>90 seats) and freight planes. Convex curve is also notional.

Of the three, the medium growth scenario (scenario 2) places the greatest demands on the training system, predicting that the number of available skilled workers will need to increase by a total of around 90% after attrition over the next ten years, with demand stabilising after that point. The low (Boeing) scenario appears on the surface to be the least demanding, but it needs to be borne in mind that further allowance would have to be made for the growth and replacement requirements in GA, regional turboprop services and smaller regional jets. None of the scenarios makes provision for the maintenance needs of rotary-wing aircraft.

How realistic is it to expect that the Australian training sector could meet the demands of such an increase in output (leaving aside the obvious considerations of who would pay and where they would be trained)?

A careful look at the performance of the system over the last five years (figure 2) gives little reason for optimism. Admittedly the number of apprenticeship completions at June 2013 shows an increase of some 130% over the output at the beginning of the five years. However, this reflects a large spike in commencements which occurred in 2008 and has since been working its way through the system. Although it will be another eight months before we have official data for the final quarter of 2013, we confidently expect that completions will have fallen off strongly after a peak at around the point where our curve currently stops. If we look at commencements instead, we see a virtually uninterrupted fall over the five years, with the June 2013 figure less than half that for June 2008. At the same time the level of wastage (the combined impact of apprenticeship cancellations, withdrawals, suspensions and expiry) shows a small but steady rise, both in its own right and relative to commencements, with the loss of apprentices before completion increasing by some 10%. This in turn has an impact on the critical statistic of net recruitment, made up of the number of new apprentices adjusted for the number who have failed to complete their apprenticeships within the same time period; by mid-2013 this net figure was less than half the raw statistic for commencements alone.

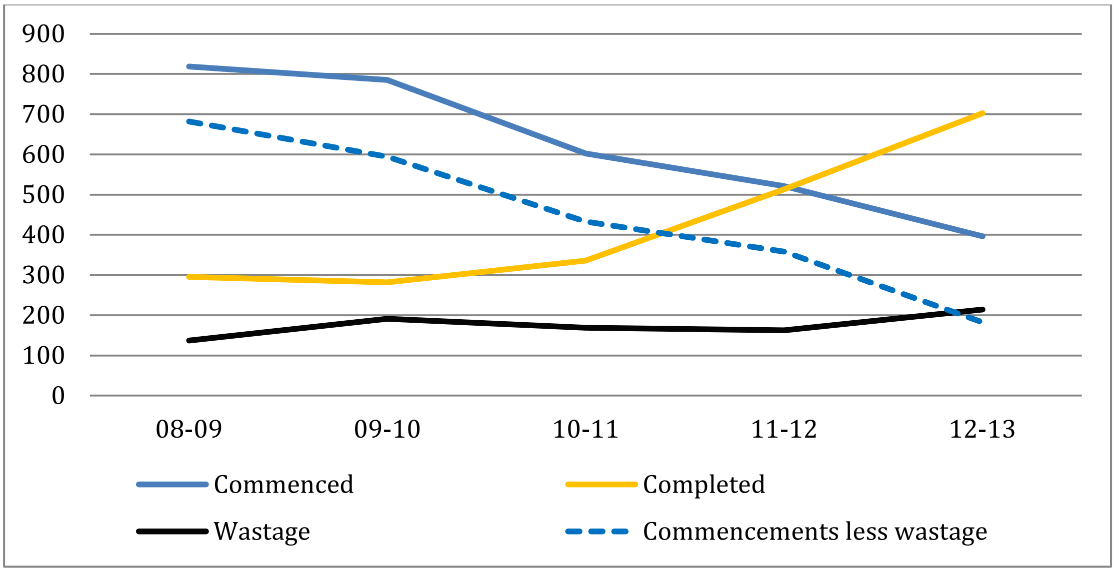

Figure 2: All AME apprenticeships by status and fiscal year, 2008-13
(Source: NCVER Apprentices and Trainees)

The collapse of activity becomes even more conspicuous when we take into account the relative contributions of the civilian and Defence sectors. Figure 3 below makes it graphically clear how quickly the contribution of Defence establishments to the total training effort has risen, relative to civilian employers, over this period, with the relative share of Defence rising from 28% to 77%.

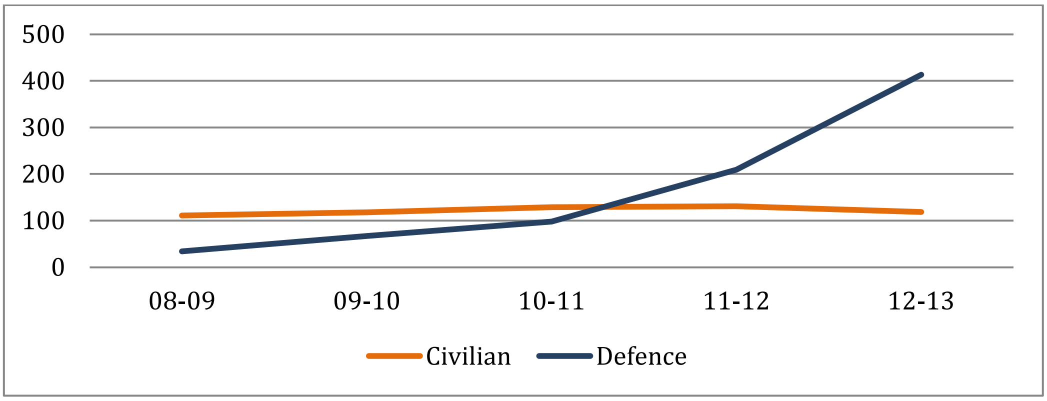

Figure 3: Commencements by sector

Figure 4, which tracks the average number in training over each full fiscal year, not only illustrates the magnitude and importance of the spike in commencements in 2008, and how its impact has tailed off in the last year, but makes it clear that this one-off surge in investment occurred purely within the Defence sector. Civilian activity shows a steady decline over the five years, with the total number engaged at all points of the apprenticeship cycle falling by around 17%.

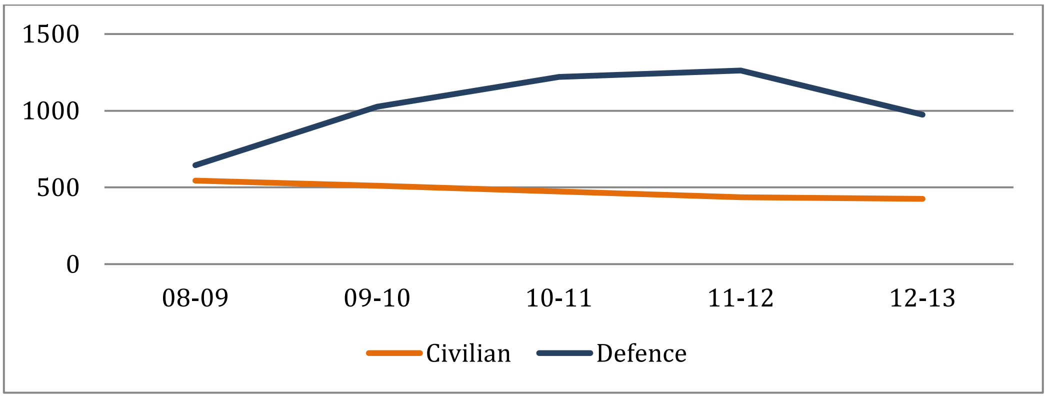

Figure 4: Apprentices in training (four-quarter average) by sector

The decline is perhaps clearest when we return to the crucial figure of net recruitment (figure 5). While the trend for civilian commencements was essentially flat (punctuated by a small increase in 2011-12, apparently the result of a one-off apprentice intake by Qantas), the trend of Defence commencements has plunged from its peak in 2008, effectively rejoining the civilian curve by 2011. We expect a further decline in the civilian figures once data for the next three quarters become available, as the net recruitment figure for the March quarter last year was the lowest since records have been kept.

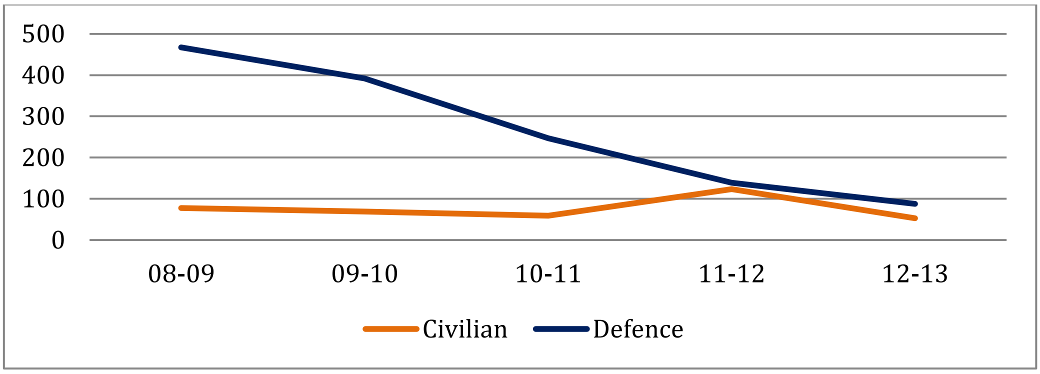

Figure 5: Net recruitment to occupation (commencements less wastage), by sector *(source: NCVER Apprentices and Trainees)*

How important is this growing dependence on Defence establishments to build up Australia's AME workforce? Admittedly many of those trained by Defence will move on into civilian employment (assuming it is available), albeit with a minimum two-year lag after qualification while they work out their compulsory minimum period of service. There are indications that the technology gap between Defence and civilian MRO is narrowing over time as the Services come to use more common platforms with civilian aircraft; indeed, leading-edge training in the Air Force could be seen as providing graduates with a head start when it comes to mastering the more advanced technologies (particularly composite airframes) which are now starting to come into service in the latest generation of commercial airliners. It is also relevant that the main sources of potential growth in Australia's independent third-party MRO industry consist of businesses which handle a combination of civilian and defence work, in most instances probably drawing on offsets for a significant proportion of their capital investment.

The contrary argument is that concentrating workforce preparation in Defence establishments shifts the entire cost on to the public purse, probably with no material positive impact on Australia’s defence capability once a certain point is passed. Conversely, if any Commonwealth government wanted to kickstart training activity on a large scale, there is no doubt that using Defence as the host would be the most readily available and least interventionist expedient.

We have nevertheless focused our modelling on the civilian sector alone, if only because this sector will need to provide the employment, and with it the essential continuous work-based learning which will be needed if the passenger safety concerns which are central to the brief of this review are to be adequately provided for. It is only realistic to expect that ex-Defence personnel will continue, as they have right from the beginnings of commercial aviation, to provide an important source of recruitment over and above the output of the formal training system, skilled workers displaced from Qantas and other large employers, and recruitment from overseas or migrants already in Australia. But once they are in the employ of the main passenger carriers, it will be up to the latter to ensure that their skills are kept up to date and developed progressively to ensure that the growth of the licensed workforce keeps pace with that of the AME workforce in general.

Having examined the current and recent performance of the training system, we return to examining how feasible it would be to restore its activity to the point where it is capable of keeping pace with the growth of the work that remains within Australia (whether from choice, or because it is either impracticable or uneconomic to send it overseas), and preferably sufficient to open the way to the repatriation of at least some work which is currently sent offshore.

First we revisit the notional demand curves introduced earlier, and compare them against two possible supply curves representing the historical performance of the system – not just its present levels of output and activity, but its best performance on record over the whole 14 years for which separate statistics have been kept for the civilian training sector. The first of these (the darker solid line in figure 6) takes the growth trend for completions over the 10 years up to June 2013, and projects it forward in a simple exponential curve for the next 20 years. The second (lighter line) starts with the largest recorded civilian completions in any single year (370) and assumes that this number can be maintained every year through to 2032[10].

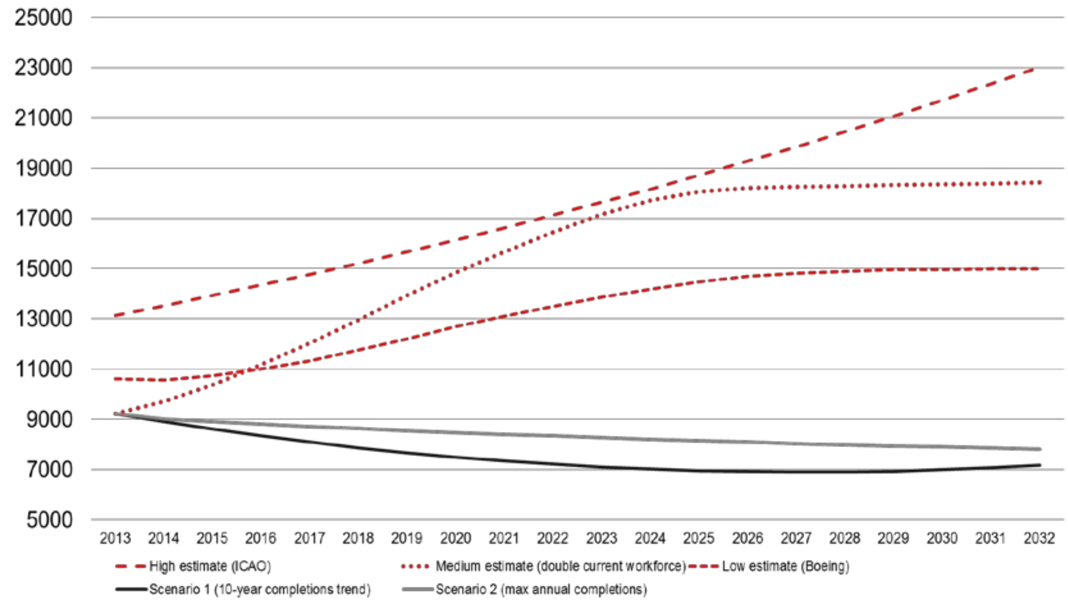

Figure 6: Two supply growth scenarios based on historic trends

Scenario 1: 10-year completions trend for year to June 30, 2004-2013, exponential growth projection
Scenario 2: Highest recorded annual civilian completions (370) projected for each forward year

Not only do the resulting curves come nowhere near any of the assumed demand curves, they fail even to generate a net increase in the existing workforce

[10] Strictly speaking, this would not be a practical possibility at least in the short term, because the entire number in training as of mid-2013, at all points in the apprenticeship cycle, was only 460; but we maintain the fiction for the sake of illustration.

numbers once attrition has been accounted for. Note once again, we are talking about the ICAO standard figure of 5% a year – the result would look even more deflating if we were to use the figure of more than 10% identified by DEEWR (assuming that rate could be sustained for two decades). The projected curve continues downwards until 2027, when it levels out and starts to show a very slight rise; the fixed-increment curve dips steadily downward over the full two decades. Clearly if Australia is to keep pace with the net growth in demand, let alone catch up on the current shortfall, a considerably more ambitious strategy will be required.

To identify the level of investment that would be needed, Figure 7 models two strategies which lie, at least in theory, just within the bounds of feasibility, though each would require very deep pockets and we have conveniently ignored the question of where the graduates would find work, at least in the early years.

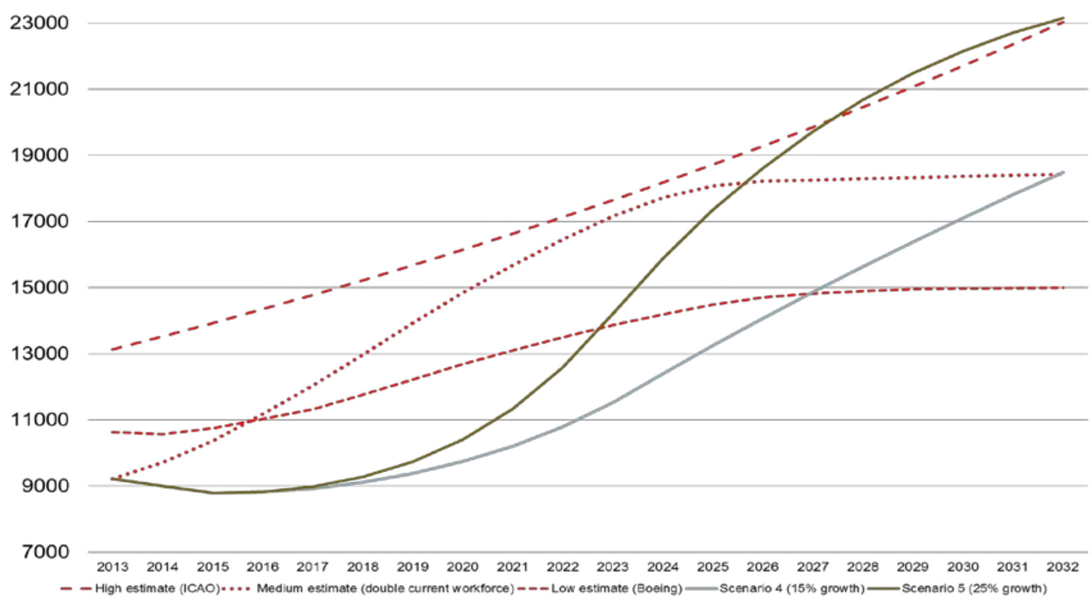

Figure 7: Two highly optimistic supply scenarios

Scenario 3: 500 new commencements in 2014, growing at 15% annually from 2015, tapering back to 1% after 2023
Scenario 4: as above but increasing by 25% p.a. to level out at 2500 in 2023, reducing by 5% p.a. from 2024 to avoid overshoot.

Scenario 3 sets an arbitrary departure point of 500 net commencements in calendar 2014, with that number increasing by 15% every year up to the point in the mid-20s where the growth in numbers of qualified personnel becomes self-sustaining. Leaving aside the questions of funding and facilities, such a growth rate does lie within the bounds of normal expansion in activity which VET institutions can regularly sustain for programs experiencing a sudden increase in student demand. The second and more ambitious scenario (scenario 4) looks at what would happen if that annual growth were to be pushed out to 25%. Both of these scenarios are also based on the reasonably heroic assumptions that wastage can be reduced to zero, and that the time to initial qualification (equivalent to the current Certificate IV) could be reduced to two years – something which countries like Malaysia are currently working on, but which would be very difficult to combine with the traditional basis of the apprenticeship system.

The first thing to note about these two scenarios is that despite the enormous spike in investment they represent, the number of qualified people in the workforce would actually continue dropping for two years after the initial investment was made, and would take four years to return to the 2013 level, postponing net growth until a point in the demand cycle where the curve was reaching its steepest slope. This is a compelling illustration of the impact of attrition (even by the ICAO's modest estimate) and the amount of effort that would be needed to get back to replacement level.

Once this initial lag is overcome, the different scenarios eventually do lead to supply catching up with at least two of the demand curves within the 20-year period – in the case of the 15% scenario, cutting the Boeing curve by 2027 and achieving the loosely predicted doubling in the workforce right on schedule in 2032, while the 25% scenario crosses the lowest demand curve in 2023, the medium one in 2026, and the highest one a year later. Despite this, each would leave a very significant shortfall below even the lowest projected growth of demand for a minimum of nine years.

Once again we must stress that we are offering these projections purely for the sake of illustration, and not in the expectation that anyone will seriously want to adopt these strategies. In the first instance they serve to illustrate the problems of *lock-in* and *irreversibility*, which are so often overlooked in public policy analysis, showing how an apparently small and incremental underinvestment can take only a few years to reach the point where its impact becomes extremely expensive, if not actually impracticable, to undo. Equally, they illustrate that most of the currently foreseeable initiatives are likely to fall well below the level of effectiveness at which they make any practical positive difference – always assuming, of course, that the actual growth in demand comes anywhere near the kind of patterns we assume.

The logical conclusion is that Australia has forfeited its chance to maintain a qualified labour force sufficient to look after its full maintenance requirements for the immediately foreseeable future, even supposing the will was there to do so. For the rest of this decade or maybe longer, Australia will unavoidably remain locked into a certain level of offshoring, under-resourcing, or some combination of the two – not because it is desirable, safe or efficient, but because it can no longer be avoided.

Given that unhappy conclusion, it would be tempting for Australia to throw in the towel and fall back on the expectation that somebody else will be prepared to look after the maintenance of our main-route passenger fleet, provided we are prepared to pay them enough. But that expectation too is unrealistic in the light of the ICAO predictions that virtually every other part of the world can expect to experience a similar problem, of much the same dimensions, over the period of the strongest growth in labour requirement. If we rely on that approach, Australian carriers are likely to find themselves relegated to the back of the maintenance queue by other players with considerably greater political and/or market power.

Nor must we overlook the fact that there are some areas of maintenance which cannot practically be outsourced, or will need to remain within Australia because of their nature (e.g. overnight line maintenance on domestic routes). In particular we have an escalating problem with servicing the needs of GA. Not only is it most unlikely that offshoring will provide an easy answer to this problem; even the apparent windfall of large numbers of highly qualified engineers displaced by Qantas and other major employers does not appear to be translating into a larger labour force for GA, partly because many of the skills learnt in a major airline's workshop do not translate easily to the more antiquated GA fleet, but equally because the low wages and inferior working conditions present in much of GA maintenance are simply not attractive to people who have made their career in a modern, clean metropolitan workshop handling moderately advanced technology.

To conclude: as so often in public policy, there is no first-best solution. There are problems which will not go away, none of them can be resolved neatly or satisfactorily, but some remedy will need to be found, if only by muddling through, to keep our fleet in the air. The safety of the travelling public demands that sooner or later Australia will need to rebuild its MRO capacity, and the workforce to support it. But this is likely to require extensive structural reform, well beyond what the present market is likely to bring about.

For that reason we are not recommending any specific remedy to the problem in the context of this review; we simply wish to make you fully aware of the problem, to be taken into account along with all the more intrinsically resolvable challenges on which it may be within your remit to recommend.

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