

Transitioning Regulatory Frameworks to Support Competency-Based Training and Assessments

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Sophocles said, in *The Trachiniae* in 430 BCE, that “Knowledge must come through action; you can have no test which is not fanciful, save by trial.” Maybe Sophocles understood the principles that underpin competency-based training.

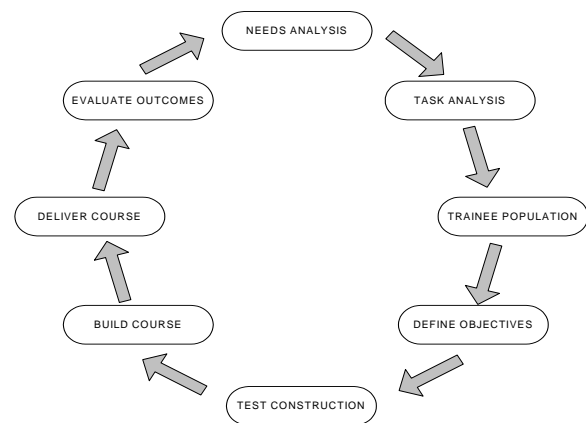
Competency is defined in *Annex 1* of the *Convention on International Civil Aviation* as “A combination of skills, knowledge and attitudes required to perform a task to the prescribed standard.” Competency-based training and assessment is defined in *Procedures for Air Navigation Services (PANS) Training* as “Training and assessment that are characterized by a performance orientation, emphasis on standards of performance and their measurement, and the development of training to the specified performance standards.” This is helpful. It directs us to training that involves clear standards of performance and their measurement.

PANS Training tells us that competency-based training shall include at least the following features:

1. The justification of a training need through a systematic analysis and the identification of indicators for evaluation.
2. The use of a job and task analysis to determine performance standards, the conditions under which the job is carried out, the criticality of tasks, and the inventory of skills, knowledge and attitudes.
3. The identification of the characteristics of the trainee population.
4. The derivation of training objectives from the task analysis and their formulation in an observable and measurable fashion.
5. The development of criterion-referenced, valid, reliable and performance-oriented tests.
6. The development of a curriculum based on adult learning principles and with a view to achieving an optimal path to the attainment of competencies.

7. The development of material-dependent training.
8. The use of a continuous evaluation process to ensure the effectiveness of training and its relevance to line operations.

Now, this is definitely not traditional training we’re talking about. This is the systems approach to training.



Systems Approach to Training

Some people say that the systems approach to training emerged in the 70s when Florida State University developed the ADDIE model of Analysis, Design, Development, Implementation, and Evaluation. But the seeds of a systems approach can be found even in the Training Within Industry (TWI) service that ran in the U.S. Department of War from 1940 to 1945. This disappeared after the war, partly because U.S. industry faced little serious competition at the time. But TWI trainers were brought to Japan by General MacArthur during the occupation and this had an impact on the development and use of *kaizen* and Standard Work at Toyota. The systems approach will be familiar, too, to students of Dr. W. Edwards Deming and the PDCA (plan-do-check-act) problem-solving process typically used in business process improvement.

Traditional vs Competency-Based

Some people think that competency-based training is just like traditional training, only more structured. Not so. Some people think that because, in pilot training, we must pass a flight test, the training must therefore be competency-based. Not so. Traditional training that follows Annex 1 focuses on inputs to training, inputs such as hours of flight time, hours of dual, hours of solo, hours of ground school, the aircraft that must be used, the simulator that must be used, the personnel that must be used, the facilities, etc. All inputs to training. In a prescriptive, traditional training environment, minimums can quickly become maximums. Instead of aiming for excellence, the way we regulate traditional training can tend to drive training toward meeting minimum requirements. This is hardly surprising in a competitive training marketplace.

Our pilot training and licensing regulations in Canada respond to Annex 1 and they are rooted in the Second World War when we trained thousands of pilots in the British Commonwealth Air Training Plan. Following this, in the fifties and sixties, our flight instructor population had a lot of experience. Training was delivered by flying clubs and quality was controlled mainly through our instructor rating requirements. But this was a different era. It was also an era when the knowledge and skills required for the commercial pilot licence were much closer to the knowledge and skills needed by the air transport industry. After all, until the late 60s, the dominant aircraft type in airline service worldwide was the DC3!

Now, competency-based training turns our attention to outcomes, measurable outcomes. It demands a deep understanding of the work in all of its elements. It demands understanding of the full spectrum of the required knowledge and skills and the context in which these will be used, understanding of the conditions under which tasks will be performed and the standard to which they must be performed.

Let's consider a pilot training example. Annex 1 tells us that a pilot can obtain an instrument rating by completing 40 hours of instrument time in an aircraft. A credit is given for simulation. As is normal in the Annex, ground instruction hours are not prescribed (a good thing). Where does this traditional approach take us? Well, we can satisfy Annex 1 without ever entering a cloud, without ever entering the real world to which this rating will give us entry. We don't even have to file an Instrument Flight Rules (IFR) flight plan in our training program, to interact with a real controller, with the air traffic control system. The instructor can give the clearances and do all this training under

Visual Flight Rules (VFR) and Visual Meteorological Conditions (VMC). We traditionally do the flight test under these conditions, too. And once we get this rating, we are given the privilege to pilot our aircraft under IFR in Instrument Meteorological Conditions (IMC).

Now, let's approach this from the direction of competency-based training. We'll start by getting the 40 hours off the table. We'll come to the hours later, after we've done our homework. First, we have to look at the real world. If we look closely, we can see that this world can mean instrument meteorological conditions from departure to destination, where the weather could be at minimums, or even below minimums, forcing a missed approach. This is a world of complexity. This is a world of clouds, fog, rain, snow, ice, high density airspace, uncontrolled airspace, and other challenges, other threats.

In our competency-based training, we have to address these conditions in our design. We want our students to recognize the conditions the real world will present to them and we want them to meet these conditions (or avoid them) with confidence and competence. In designing our training we will ask ourselves whether our training aircraft have the capability to take us into this world. Do our instructors have the competencies they need to take our students into this world? Do we have a flight simulation training device capable of simulating this world? What knowledge, what skills will be needed to enter this world? We'll develop our course of pilot training using the systems approach. The flight training and ground training elements will be interrelated and sequenced to provide for efficient achievement of the learning objectives. We'll set out objectives in the cognitive, psychomotor and affective domains. We will incorporate situation-based or scenario-based learning in our design, a kind of line-oriented or event-set flight training with a series of IFR flights that will present different challenges that will help our students learn and prepare for the IFR world.

You get the idea. How many hours will this take? It will take all the ground and flight and simulation hours needed to ensure that competency is reached. It might take fewer than 40 hours or it might take more. With the growing power of flight simulation, including non-motion devices, we will see more and more IFR training delivered with these tools. (One day, with the growing power of simulation, we may get to zero flight time training for the rating.) Once outcomes are properly defined, judgements can be made about the best way to achieve the outcomes.

The Training Organization

Knowing that the Multi-crew Pilot Licence (MPL) was going to be our first competency-based pilot licence, we understood that the training organization requirements would be critical for success. We wanted the strongest possible system of governance, one that would support the application of a systems approach to pilot training and drive training toward excellence rather than toward minimum requirements. We wanted our rules to encourage innovation and efficiency and we wanted to allow industry to respond quickly to advances in technology and operating and training processes.

We were able to create an entirely new set of rules, performance-based rules, for an Approved Training Organization (ATO) that would be authorized to conduct MPL training. We were able to take the best features of FAR 142 in the U.S. and TRTO rules in Europe and avoid the features that were more appropriate for traditional training. This ATO is required to meet quality management systems obligations as well as our safety management systems (SMS) requirements. All Transport Canada staff involved in MPL oversight have completed a series of training courses on SMS and they have completed further training on quality systems. We have developed extensive guidance information for companies seeking to become an ATO and more guidance information for developers of MPL training programs. As beta testing continues in Canada, we will begin to learn lessons. We will use these lessons to improve our policies, procedures and guidance information and even, if necessary, our rules.

Transport Canada's Approach

Because a strong ATO is the key to successful, competency-based training, let me share with you some of the elements we require in our new Canadian Aviation Regulation (CAR) 407 ATO rules:

Risk Profile

Applicants for ATO certification must provide a risk profile. They have to identify their quality and safety risks and identify the controlling measures. The risk profile focuses on accurately identifying the organization's exposure to all risks that are likely to adversely affect quality and safety. It needs to be constantly updated, easily accessible, and understood by all employees.

Risk Management Plan

A plan for management of risks is a requirement. We want the ATO to be proactive, to find trouble before trouble finds them.

Quality Assurance Policies and Procedures

The risk management plan will define the quality policies and objectives. Properly implemented, it will ensure that procedures are carried out consistently, that problems can be identified and resolved, and that the organization can continuously review and improve its procedures, products and services.

Organizational Training Plan

Employees must be qualified and competent. The organizational training plan will drive excellent training that will tie them to the organizational needs. Some topics that might be included:

- corporate ethos, objectives, relationships
- human factors issues, especially those that can lead to errors
- communication protocol and techniques
- audit principles
- system assessment and corrective action analysis
- hazard identification and risk analysis
- emergency response preparedness

Documentation management

One of the most common findings in audits of training organizations results from systemic weaknesses in documentation control. Weakness in this area is a sure path to poor standardization, frequent deficiencies in student performance, erratic record keeping practices and damage to the company's reputation.

Communication policies and procedures

Communication policies and procedures are needed for both external and internal purposes. These can address such issues as:

- Review and promulgation of organizational objectives and strategic plans
- Publication and distribution of senior management's policy statements regarding commitment to a quality and safety management systems
- Traditional lines of reporting and correspondence protocols
- Processes for initiating and reporting changes to documentation, methodologies, organizational structure, or personnel
- Initiation, production, and dissemination of quality assurance and safety management system activities and reports
- Dissemination of regulatory information
- Distribution of and response to client or regulatory feedback
- Application of a non-punitive reporting culture

Strategic/management reviews policies and procedures

A quality system requires management to regularly review the results of:

- Internal audits
- Corrective and preventive actions
- Performance against objectives
- Changes to the system
- Recommendations for improvement

Instructor competencies

No person can provide flight training on behalf of an ATO unless they meet the prescribed minimum experience levels and qualifications for the position and have demonstrated the necessary competencies to successfully deliver such instruction.

Before appointing a flight instructor, the instructor must complete a period of preparatory training and assessment to ensure that they have the required competencies. This training and assessment must include at least:

- a course of study in instructional theory and techniques (unless the instructor holds or previously held an instructor rating)
- training in the use of all applicable courseware, training aids and devices
- a theoretical knowledge test covering the applicable areas of the assigned curriculum
- training in the theory and practical application of threat and error management
- training in flight deck protocols and disciplines in a multi-crew environment;
- a pilot proficiency check (or equivalent performance check) in accordance with our airline standards, to ascertain competencies in all phases of flight necessary to safely and effectively operate the variant of aircraft being replicated
- an assessment while providing instruction on selected training modules under supervision

Multi-crew Pilot Licence (MPL)

The standards for the first competency-based pilot licence, the MPL, entered Annex 1 in November, 2006. However, because the Flight Crew Licensing and Training Panel wanted to present a unanimous recommendation to the Air Navigation Commission, we were unable to make it fully competency-based, as you can see in the published requirement for a minimum of 240 hours of flight time. The requirement for 240 hours of flight time is prescriptive and traditional. Remember the danger of the minimum becoming the maximum in traditional training? Well, it wasn't long before we saw some of the first 240 hour MPL training programs – the minimum became the maximum. In Canada, if we were ever to receive an

application for a 240 hour MPL training program, we would want to know a lot about how this was derived. In fact, we have seen that MPL training programs that follow a systems methodology will bring flight times in the order of 350 hours or more. Over time, with experience and evidence and improvements in training methods and technology, we might see this figure being reduced.

There is a temptation, in regulating competency-based training, to mix traditional and systems methods together. It is understandable that we are tempted by this but we should do all we can to resist this temptation. The systems approach is far more powerful and prescribing inputs will frustrate efforts to achieve excellence and block avenues to training effectiveness and efficiency. If, however, the regulatory environment does blend the two worlds, then the training has to be designed to meet the prescriptive elements while still aiming for the competencies. The training might be less efficient but effectiveness remains the goal.

MPL training is not just an Airline Transport Pilot – Aeroplane [ATP(A)] integrated course with a new cover. We introduced integrated courses in Canada ten years ago. They have found an important place in our pilot training industry and they will continue to be important. Among other things, the ATP(A) course (which leads to a commercial pilot licence and multi-engine instrument rating) requires a LOT more ground instruction (750 hours), control manuals for training and for operations, multi-crew cooperation training and completion of the ATPL examinations. They are sometimes characterized as a 'frozen ATPL'. But they are designed differently. MPL training requires much more than an ATP(A) integrated course. We don't agree that MPL training is just an ATP(A) course with type rating training bolted on at the end. We don't agree that MPL training is just an "ATPL light". It is much, much more than this. It has to be.

Here are some of the features of the Canadian MPL:

Objective

The Canadian MPL will signify that the bearer has successfully undergone a Transport Canada authorized MPL flight-training program and has demonstrated the skill, knowledge and attitudinal competencies required to perform the duties of a co-pilot of a multi-engine, turbine-powered, pressurized aeroplane, which is certified to be operated by two or more pilots, flown under either VFR or IFR conditions.

Sponsoring air carrier

Transport Canada will not authorize MPL training for which there is not a sponsoring air carrier. We are already seeing partnerships form between training providers, including colleges, and the aviation industry to deliver MPL training phases for sponsoring air carriers.

Screening and selection

Strong candidate screening and selection is essential for success. The sponsoring air carrier clearly has an interest in this and will want to seek out candidates who will make excellent employees. But we caution ATOs about the risks to them if they are not engaged in this process. If they take anyone the air carrier sends to them, they may receive candidates that do not have the abilities needed for success in the training program.

Language

ICAO Level 4 is needed to hold the licence but a high level of language competency is needed to begin training. Since the effective delivery of second language training is likely beyond the capability of most ATOs, we expect to see our ATOs engaging the services of an external agency specializing in aviation English language training.

Phases

Very few training organizations have the resources to deliver all four phases of MPL training. We recognize this and, in our rulemaking, we built the structures for one MPL program to be delivered in phases by more than one ATO. One ATO might have authority to deliver Phase 1 and Phase 2. Another ATO might have authority to deliver Phase 3 and another Phase 4. Each ATO must have a quality system but there must also be a single quality system that controls the entire program.

Beta Testing

Once we have determined that the ATO has everything in place to deliver successful MPL training, we give provisional authority to run a beta-test. Beta-testing is not complete until successful outcomes are achieved and proven to be sustainable. Only when the evidence is in do we give final authority and this evidence must include the proof of successful performance of graduates when they begin flying the line with the sponsoring air carrier.

Even if the beta-test is successful, if the training program is then delivered at another ATO, a new beta-test would be required. The test would not have to be as comprehensive as a first beta-test but we would need proof that the new ATO can deliver the required training successfully.

Evaluation

Some of you will be familiar with Kirkpatrick's Four Level Evaluation Model. The four levels consist of:

1. Reaction – How well did the learners like the training?
2. Learning – What knowledge and skills were gained? What attitudes were changed?
3. Behaviour – What changes in job behaviour resulted from the training?
4. Results – What were the tangible results of the training in terms of reduced cost, improved quality, efficiency, etc?

At best, licensing authorities, in their testing, will reach the second level. With the Canadian MPL, we will get to the third level and likely the fourth. How can we do this? We won't authorize MPL training unless the sponsoring air carrier agrees with the ATO, by contract or some other legal means, to provide required data on the performance of the MPL graduates. We want to know how the MPL graduate performs on the job. The fourth level asks what difference the training has made to the air carrier. We will be interested to learn from the sponsoring air carriers what difference the MPL will have made to them.

Takeoffs and Landings

Another prescriptive, traditional requirement for the MPL is set out in PANS Training. This is the requirement for at least 12 take-offs and landings in the advanced phase of training. Authorities are given a mechanism for reducing this to six. We want to see more than just numbers, we want to see, before commencing line indoctrination, proof of competency, demonstrated in airborne training on the aeroplane type for which the licence is endorsed, in performing at least the following manoeuvres:

- take-offs and landings
- simulated engine failure after takeoff
- approach with a simulated engine failure to a full stop landing
- instrument approach resulting in a go-around

Examinations

Annex 1 requires ATPL knowledge for the MPL. We recognize that most regulators will simply use their ATPL examinations but we wanted to design more powerful examinations for the MPL, examinations that would be much more global in their reach than our ATPL examinations. One of our MPL examinations will be a 'phase-of-flight' examination that will present scenarios that must be recognized, assessed and managed, scenarios that will draw from the real world of air carrier operations. We

will work closely with industry as we develop our MPL examinations. As well, in developing these examinations we will want to know whether there is a correlation between performance on the examination and performance on the flight test. More than that, we will want to know whether the examination will predict performance on the job!

Oversight

A number of factors will affect the degree and frequency of oversight during the MPL beta test. Primary among these is the confidence of Transport Canada in the ATO's quality system. The applicant's risk profile, completed during the pre-certification phase as part of the ATO application, will serve to establish risk indicators or oversight trigger points. These trigger points involve events or circumstances where regulatory oversight would be prudent and may vary from one ATO to another.

Another influencing factor is the type of learning management system (LMS) used. While there are different methods available, an LMS that allows remote internet access would let inspectors observe, remotely, student progress relative to the syllabus in real time.

Our oversight of the delivery of MPL training is going to do much more than evaluate processes. We will determine whether the processes are effective, whether the outcomes are being achieved and whether the results are sustainable.

Flight Test

Our MPL flight test will require two simulator sessions because of the need to measure candidate competencies as both the pilot flying (PF) and pilot not flying (PNF) in real world operational scenarios. And through system degradation scenarios and other means, our flight test will assess manual flight competency.

Learning Management System

We expect MPL training to use an electronic learning management system (LMS) that continuously tracks checking and testing (and training) activities designed to ensure that a student is consistently meeting the training objectives. An alternative is available but we are already seeing the power of a good LMS to support course management, student record-keeping, instructor performance, scheduling and even flight following. Our beta tests might prove that this is an essential requirement.

Bridging

Recognizing that some MPL holders will one day want to fly single-pilot aeroplanes we built the necessary bridges into our rules, bridges to the private pilot licence and the commercial pilot

licence. We also built the bridge to the airline transport pilot licence but their ATPL will not give privileges on single-pilot aeroplanes unless further bridging requirements are met.

MPL Advisory Board

Now that MPL training is under way in Canada, we will soon convene the MPL Advisory Board of Canada in order to remain engaged with principal stakeholders in the on-going development of our MPL regulatory environment.

What the Authority Needs

Licensing authorities that have experience only with traditional training will need new competencies in order to meet their responsibilities for authorization and oversight of competency-based training. We can start by looking at PANS Training because it lists the inspector competencies that are needed.

PANS Training – Inspector Competencies

1. Assess ATOs application to conduct a competency-based training programme
 - Validate background data on ATO
 - Review application
 - Evaluate quality assurance system implementation
 - Document findings
2. Evaluate competency-base training programme
 - Assess training needs analysis
 - Assess curriculum design
 - Assess courseware
 - Assess evaluation procedures
 - Confirm required qualifications and competencies of instructors and designated/delegated examiners
 - Document evaluation findings
3. Inspect competency-based training programme
 - Inspect ground school facilities
 - Inspect FSTD facilities
 - Inspect flight training facilities
 - Inspect record-keeping system
 - Evaluate conduct of training
 - Document inspection findings
4. Conduct surveillance
 - Carry out a risk assessment
 - Establish initial surveillance plan
 - Conduct operational review of training programme
 - Instigate follow-up rectification/enforcement action
 - Document surveillance findings
 - Establish ongoing surveillance plan

5. Conduct trend analysis of approvals/surveillance activity

This is a good list but it really describes the kind of competencies needed to approve traditional training with quality assurance added. We do this with our integrated courses in Canada, which were developed following the European model. Our experience with implementing competency-based training tells us that we will need more than this. We were able to form a team to drive the implementation of the MPL. We wanted a team that had more knowledge and more skill than what is set out in PANS Training.

In Transport Canada, as we prepared ourselves to authorize competency-based training for the MPL, we had some strengths and we had some areas in which we needed to build strength. Regarding our strengths, we had, in our headquarters in Ottawa and in our regional offices, specialist inspectors with strong flight training backgrounds. They hold our highest level of flight instructor rating and have years of experience in the flight training industry, including many who were chief flight instructors. They also have years of flight testing experience. Second, all flight schools in Canada that operate aeroplanes or helicopters require an operator certificate and all of these operators were already moving toward safety management systems (SMS). Our industry was already becoming more systems oriented in its thinking. Third, all of our inspectors had completed a series of courses in SMS to prepare them for the introduction of this regulatory requirement for our operators. So, our inspectors were becoming more systems oriented in their thinking. Fourth, we had some inspectors with strong backgrounds in military pilot training, people who understood that strong competencies can be built with well-designed and structured training that is focused on outcomes. They brought added competencies to our team. Fifth, we had knowledge of outcomes-based education, that student-centred learning philosophy that focuses on empirically measured student performance. In Canada, as in the United States and other countries during the 1980s and 90s, outcomes-based methods were adopted by our educational systems. We had also seen the Aviation Accreditation Board International, the body that accredits university aviation programs, shifting from traditional standards to standards criteria based on learning outcomes. Sixth, we had the support of senior management, who understood the importance of this initiative and were prepared to give the resources needed. Finally, we were lucky to find people who had managed a training organization with both U.S. FAR 142 and European TRTO

training authority and had experience giving line indoctrination training to airline pilots around the world.

So, we had some strengths. But we also had areas in which we needed to build more strength, more competence. First, in order to embrace competency-based training, we needed more knowledge of instructional systems design (ISD). We had some of this, but we needed more. Second, we needed more knowledge of quality management systems (QMS). We were able to obtain excellent training that was designed using our own certification tools and our own ATO rules. In other words, it was designed to respond to our NEEDS. Third, we needed to build a team that included not just expertise in training for a licence but also expertise in airline training. This required a cross-functional, multi-disciplinary team, one that transcended our organization chart. Fourth, we wanted to know more about learning management systems. We knew that a strong learning management system would be essential for success in MPL training. Fifth, we also wanted people who understood the BUSINESS of training at the airline level. We already had people who understood the flying school business. Sixth, we needed to develop a strategy not just for training our staff but we needed to build a structured on-the-job training pathway for them to follow to expertise. Finally, we needed to learn more about performance-based regulations because we had to develop an entire subpart of our rules for competency-based pilot training organizations and to do this we couldn't use the old model of prescriptive rules.

Conclusion

So, how do we transition regulatory frameworks to support competency-based training and assessments? Well, we can start by reading PANS Training and notice that we need regulatory structures that unlock the power of a systems approach to training. Chapter 2 – General Provisions for Competency-based Training and Assessments is already done so start there.

Traditional training is typically governed through licence requirements. Competency-based training can probably be most effectively governed through the ATO requirements. So, if you want to know whether training is traditional or competency-based, just look at how the regulator controls it. Transport Canada licence requirements for the MPL are simple. We require that the MPL applicant have completed an MPL course that we have authorized. Our ATO requirements take up an entire subpart in the Canadian Aviation Regulations.

As we give attention to competency-based training, we have to remember the success we have had with traditional training. We're not talking about replacing one form of training with another. We're just talking about providing another option, another pathway. If you are having success with traditional training (and don't mind working in a prescriptive regulatory environment) then continue with this. If you think that you have a better way to train, one that could bring better results and greater efficiency, then competency-based training will give you a way to innovate.

We will continue to need, in our development of aviation professionals, a strong relationship between our colleges and universities and the aviation industry. Colleges and universities will do more than train for a licence. They will pursue further learning objectives, as required by their educational standards, and develop professionals with, among other things, strong analytical skills, understanding of professional and ethical responsibility, ability to analyze and interpret data, ability to function on multi-disciplinary and diverse teams, ability to communicate effectively and ability to engage in life-long learning. For university aviation programs, we can have the greatest confidence in those programs that have met an accreditation standard based on learning outcomes.

We will need new guidance information to help us with competency-based training.

PANS Training can help. So can the *Manual on the Approval of Flight Crew Training Organizations* and it wouldn't take much to make this a *Manual on the Approval of Aviation Training Organizations*. Some of our aviation disciplines are already applying a systems approach. For air traffic controllers, a profession in which the training is commonly provided by the employer, Nav Canada in my country is already using a systems approach in the design and delivery of their training. In fact, in any training paid for by the employer, there is a powerful economic self-interest in making sure the training works. For aircraft maintenance, the Annex 1 requirements for "technician, engineer, mechanic" are traditional. Four years of experience is required, or two years if the applicant has completed an approved training course. This reliance on experience might give some interesting lessons for other professions. We might call it "on-the-job training" or "internship" or "operating experience" but it all means the same thing – our pathway from novice to expert is going to involve a significant component of continued learning in the workplace. We need to better understand the importance of this in the formation of expertise and ask whether we can use it better to consolidate and build greater competency in the next generation of aviation professionals.