Emerging Technologies and Negative Training

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What is negative training?

- Negative transfer occurs when the process of solving an earlier problem in training makes later problems harder to solve.

- In other words, rather than the training improving performance, the training decreases performance

American Airlines Flight 587 – Nov 2001

- The nature and capabilities of the technology
- The training context in which the technology is used
- Sometimes a less complex device is more appropriate

Traditional training technologies in aviation

- The aircraft
- Full flight simulators
- Part task trainers
- Synthetic trainers
- The comfy chair

New and emerging training technologies

- New platforms
  - More sophisticated synthetic trainers (motion/visual/flight deck recreation)
  - VR/AR
  - More sophisticated desktop based simulators (Microsoft Flight Simulator)
- Supplements to existing platforms
  - Eye-tracking
  - Bio-metric data (heart rate/brain waves/perspiration)
  - AI (learning management software)
  - Use of big data

Huge potential to

- Increase training safety
- Increase training capacity
- Increase training flexibility
- Increase training standards
- Reduce training costs*
  - *Often with a large initial investment

BUT

- To achieve these results will rely on:
  - The appropriateness of the technology to the training task
  - The surrounding training context in which it is used

- Yep it's that easy!

PhD Research

- Historical review of the regulation of flight simulators in Australia
- Long form qualitative interviews with industry
  - Regulators (4)
  - Developers (3)
  - Operators (5)

Challenges in flight training

- For regulators
  - Regulators can't stop people using new technology on their own
  - Guarding against negative training
  - Does the technology match the training tasks?
  - Limited capacity to keep pace with rapidly developing technological development

Challenges in flight training

- For technology developers
  - Lack of clarity in customer requirements
  - Lack of clarity in what is likely to meet with regulatory approval

Challenges in flight training

- For airlines
  - Regulatory approval for integrating new training technologies into their training and checking programs
  - New hires can fly the plane, but there is a lot of variability in non-technical skills
    - Decision making
    - Communication
    - Multi-crew skills

Challenges in flight training

- For flying schools
  - Tight margins – minimal scope for investment
  - Current training model is based on the 1940s – geared towards single pilot CPL using light aircraft and is inflexible
  - Want to use new technology to introduce more flexibility (e.g. greater use of scenario based training)
  - Want the technology to substitute for real aircraft time, not in addition to – which means it must have regulatory approval
  - Lack of size & resources to provide the evidence that regulators require

Eras of Flight Simulator Regulation

Pre-Recognition Era	Recognition Era	Complementary Era	Expansionary Era	Equivariance Era	Primacy Era
1920 – 1945	1946 – 1956	1957 – 1961	1962 – 1986	1987 – 1996	1997 – Present
25 years	10 years	4 years	24 years	9 years	23 years +

Pre-Recognition Era 1920 – 1945 (25 years)

- Basic flight simulators in place to help train pilots almost from the very beginning
- No recognition of simulators in the training system
- But very limited training requirements in general

Recognition Era 1946 – 1956 (10 years)

- Establishment of the ICAO Licencing structure
- Recognition of ground instrument time
- In 1947 Simulators could be used to obtain:
  - 50% of the instrument time to obtain a licence or rating
  - 50% of the instrument rating renewal time
    - Reduced to 25% in 1948
    - Restored to 50% in 1951
  - Partial instrument approach recency
    - Removed in 1948
    - Restored in 1951

5 Principles of Flight Simulation Regulation

The primary concern – what if differences between the simulator and the real aircraft causes a safety problem?

- Instrument flying only
- A portion only, never the whole
- *Training only*
- Experienced pilots only
- A supplement only, the real aircraft takes primacy

Complementary Era 1957 – 1961 (4 years)

- Instrument rating renewal test may now be partially conducted in a simulator
- Instrument Approach recency may now be conducted in a simulator (except for the new ILS approach)
- Class 1 & 2 Airline Transport Pilot Licence (ATPL) renewal tests may be partially done in a simulator
- Simulator training courses must have a regulator approved curriculum, instructors and simulators

Expansionary Era 1962 – 1986 (24 years)

- Recognition of different types (and capabilities) of simulators
- Introduction of approved flight simulator training courses allowing first use of simulation for other types of flying than replacement of instrument flight time
  - Portion of ATPL initial issue hours requirements
  - Replacement of a portion of pilot in command time for 1st class aircraft endorsements
- ATPLs cannot be revoked based solely on the simulator portion of a proficiency check
- Expansion in use of simulators in training and assessment

Equivalence Era 1987 – 1996 (9 years)

- Expansion of simulators outside instrument flight
  - Flight reviews
- Codified levels of simulators and their uses
- Higher level simulators are now treated in many ways as equivalent to the real aircraft
  - Instrument rating renewals
  - Instrument proficiency checks
  - Instrument recency requirements

Primacy Era 1997 – present (24 years)

- Simulators are now required for some training/assessment activities
  - Certain emergency procedures
  - Conversion training in larger aircraft
  - Airline cyclical training to meet instrument proficiency check and approach recency requirements
- Introduction of GPS Endorsements & LAHSO – initial training could be completed in a simulator
- Introduction of the Multi-crew pilot licence (MPL)

Eras of Flight Simulator Regulation

Era	Instrument flying only	Portion only, never the whole	Training only	Experienced pilots only	A supplement only
Recognition 1946 - 1956	Yes	Yes (~50%)	Yes with limited exceptions	Yes	Yes
Complementary 1957 – 1961	Yes	Yes (~50%)	Testing and recency	Yes	Yes
Expansionary 1962 – 1986	Yes with very limited exceptions	Yes, can meet up to 90% of some requirements	No	Yes	Yes
Equivalence 1987 – 1996	Higher level sims treated as the aircraft	Higher level sims can meet 100% of many requirements	No	Yes with some limited exceptions	Yes
Primacy 1997 - present	Higher level sims treated as the aircraft	Higher level sims can meet 100% of many requirements	No	Use of sims for MPL	Sims now required for certain activities

Law and technology – The path of simulation

- The shape of simulation technology helped guide its legally defined role
- The legally defined role influenced its development
  - It matured in that defined role
  - It looked for ways to push the boundaries of the legal role
- Increasing simulator capability lead to pressure on regulators for legal reform to expand its role, and the process starts over

A model for integrating new technology

- Can be a starting point for the regulatory risk assessments around new technology
- Setting a safe zone boundary for the technology – to give the opportunity to build
  - Expertise in using the technology
  - An evidence base for regulators
  - Further develop towards technological maturity

A model for integrating new technology

- Provides a pathway for the expansion of the legally recognised role of the technology over time
  - Can remove/reduce the boundaries as confidence builds and finer risks assessments can be made

Recommendations after the research phase for initial regulatory recognition

- Use the capabilities of the particular technology to build a context with clear boundaries for its use
  - Training tasks
  - Role in the training program (purely training, assessment, recency)
  - Who will use it (ab-initio vs experienced)
  - What other platforms or supplements can act as a risk control
  - What other platforms or supplements can be used as a validation tool
- Use that space to build the expertise and evidence base for the technology
  - Refine the risk analysis through experience
  - Improve the technology within that role and to develop in the boundary area

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