Modernizing Development, Deployment and Monitoring of Standard Operating Procedures (SOPs)

Bottom-Line-Up-Front:

- The current processes for developing, deploying, and monitoring SOPs is *antiquated*.
- Digitization of the SOPs could change the paradigm from a *document publishing process* to an *engineering process with design, analysis, and testing*.
- Digitization of SOPs will improve quality, decrease costs, reduce liability, and improve safety margins.

Background: What are SOPs and Why are they Important?

Complex, safety-critical systems rely on human operators to monitor and supervise operations to safely and efficiently complete the operational missions.

Standard Operating Procedures (SOPs) define the tasks and actions to be performed by the human operators to complete the mission under normal operating conditions. The SOPs also define the situations and appropriate response to intervene in non-normal or emergency situations.

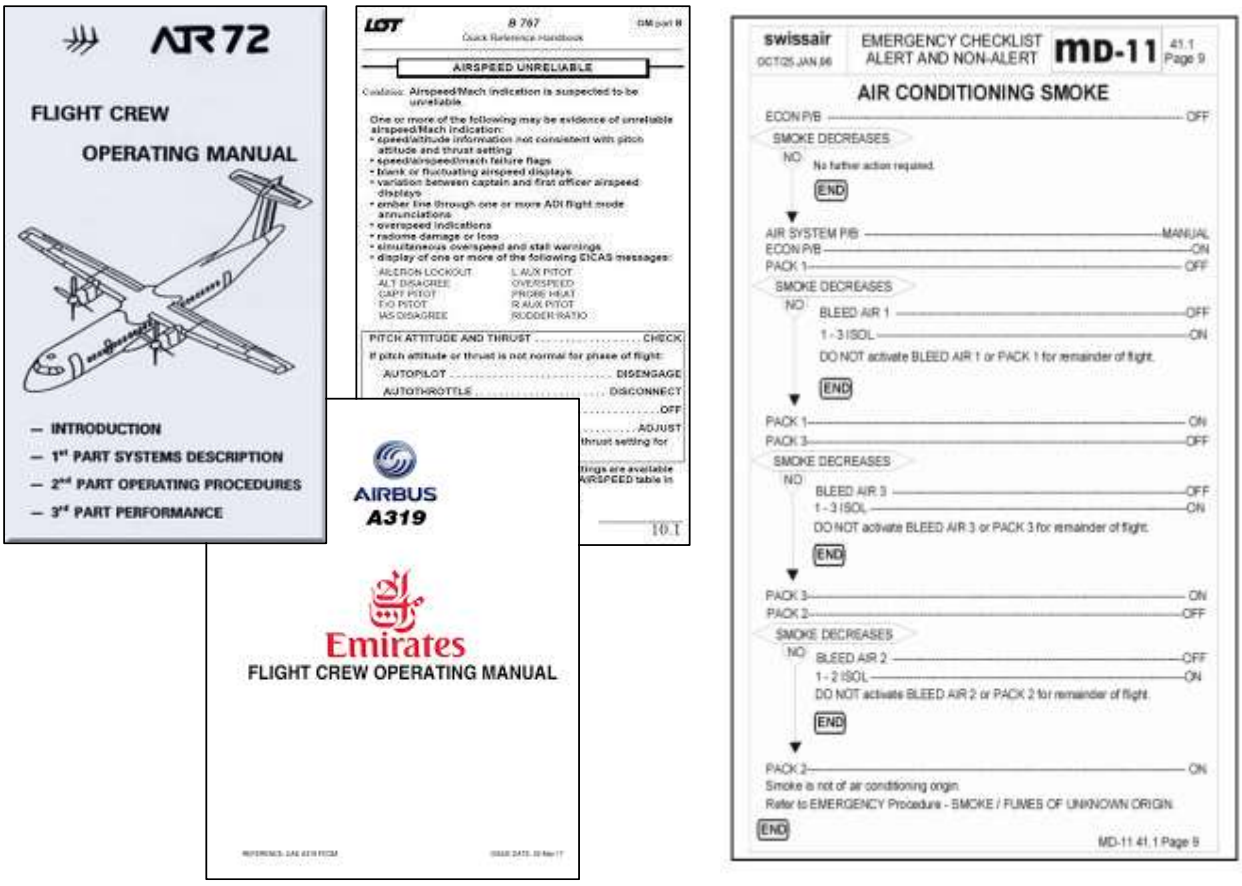

FIGURE 1: Standard Operating Procedures (SOPs) define the tasks and actions to be performed by the human operators to complete the mission under normal, abnormal, and emergency operating conditions

In the airline industry the SOPs are defined in the Flight Crew Operators Manual (FCOM) or Airplane Flight Manual (AFM). There are typically more than 300 SOPs to cover plausible normal, abnormal, and emergency situations.

The SOPs provide the basis for operator training. SOPs also ensure standard performance across a large pool of operators that vary in cultural background and linguistic skills. In this way they facilitate fungible pairing of crews.

SOPs ensure performance standards to meet company efficiency and productivity goals, and maintain desired margins of safety.

SOPs are widely used for liability assignment in the event of an accident.

In this way, SOPs are the "glue" that holds the operator and automation/machine together through all plausible scenarios that might be encountered during operational missions.

Despite their critical nature SOPs are not evaluated with the same rigor applied to "airworthiness certification" of equipment (e.g. aircraft or avionics), or "licensure" of operators. In fact, one could argue that SOPs are treated as an *afterthought*.

AS-IS Process for Development, Deployment and Monitoring of SOPs

An analysis of the processes for developing, deploying and monitoring of SOP performance across safety critical system operators (e.g. airlines, military systems, …), showed that SOPs are largely an afterthought. The following main issues were identified in this analysis:

1. **SOPS are developed at the tail-end of the development process** prior to production and fielding. SOPs are not developed in conjunction with the design of the automation or taken into consideration of machine performance.
2. **The evaluation and qualification of SOPs is not as rigorous** as the testing and "certification" requirements of automation and machine, or the "licensing" of the operators.
3. **There is no standard measure of the performance of the quality of the SOPs**. The SOP quality is confounded by training, operational differences, operational slack and redundancy, and the ability of human operators to adapt.
4. **The structure of the written, text-based SOPs is ad-hoc**. Natural language text is the preferred form of SOP description and is subject only to rules of grammar allowing flexibility in format.
5. **The process of developing and deploying SOPs is a "documentation publishing" process supported by publishing automation**.
6. **The process of evaluating SOPs relies heavily on Subject Matter Experts (SMEs).** Due to costs and time constraints, human-in-the-loop testing is limited and is not able to cover large portions of the plausible mission operational situations, or ranges of experience and performance of operators.

7. **The largest risk associated with SOPs is liability risk in the event of an accident.** The cost and time of development and deployment is negligible in the budgets for operating these complex, safety critical systems. Liability risks are rare and generally covered by insurance.

Given the importance of SOPs as the "glue" that holds the operator and automation/machine together, and the increasing importance of SOPs in the supervision and intervention of increasingly autonomous systems it might make sense to rethink SOP development, deployment and monitoring of SOPs.

TO-BE Process for Development, Deployment and Monitoring of SOPs

Advances in technology facilitate modernizing the life-cycle management of SOPS (see Figure 1)

1. SOPs are **digitized** (not text documents)
2. SOPs are **defined using a canonical structure** that enables necessary flexibility (but avoids an ad-hoc structure)
3. SOPs design is measured by a **quantitative performance standard**. The quantitative measure takes into account variability in operational conditions and variability in human performance.
4. The digitized SOPs in a canonical structure **enable analysis and simulation** for approval. This enables assessment of SOP design performance in the presence of operational variability and human factor variability. This can inform the assessment by SMEs
5. The quantitative performance standard enable the **monitoring of the SOPs in training and operations** decoupled from operational variances, slack, redundancy, and human adaptation.
6. The digitized SOPs provides the opportunity to **integrate SOP design into the development phase** and be part of the automation and machine design process
7. The digitized SOPs provide for **configuration management and revision control** across the life-cycle. Changes in one SOP can be automatically updated across all SOPs and throughout training and operational documentation.
8. The digitized SOPs provide opportunities **for cost and time reduction in developing and deploying** the SOPs.
9. The digitized, quantified performance of the SOPs provide a measure of **mitigation against liability claims.**

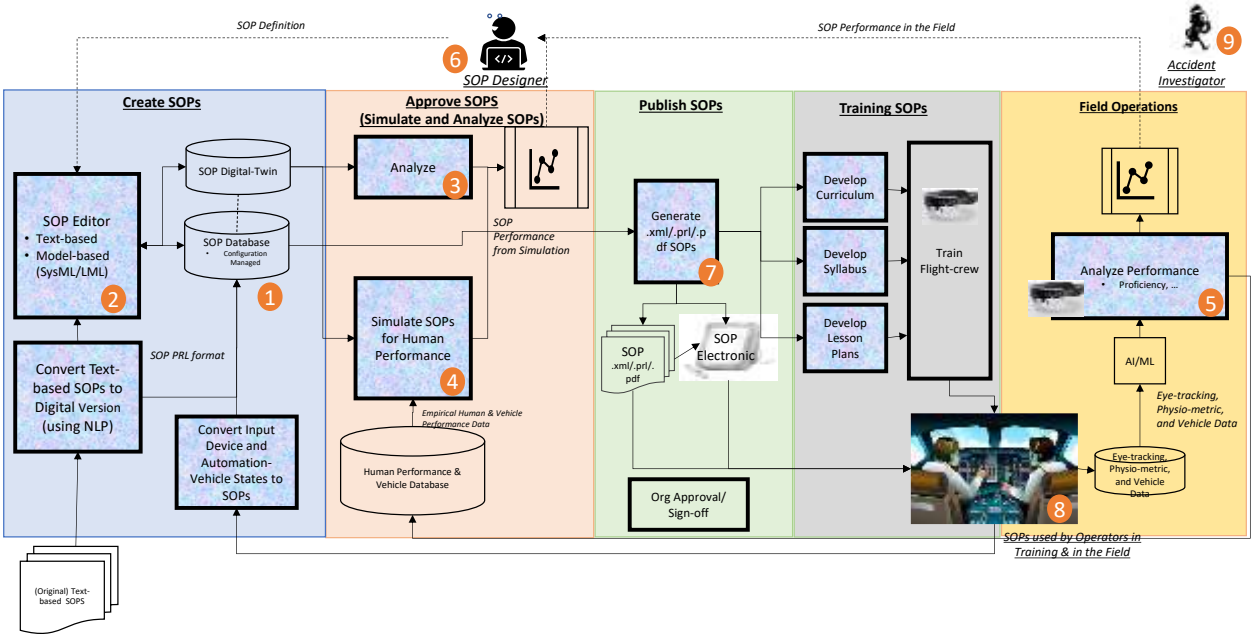

FIGURE 2: Life-cycle management of SOPs for SOP: (a) Creation, (b) Approval, (c) Publication, (d) Training, and (e) Operational Performance Monitoring. The numbers refer to the modernization opportunities listed above.

Bottom-Line

Digitization of the SOPs could change the paradigm from a *document publishing process* to an *engineering process with design, analysis, and testing*. Digitization of SOPs will improve quality, decrease costs, reduce liability, and improve safety margins.

For more information on the technologies for modernizing the processes for developing, deploying, and monitoring please contact Dr. Lance Sherry (lsherry@gmu.edu)