

# Developing an Aviation Safety Return-on-Investment System to Help Certificate Holders Assess the Value of Safety Interventions

Prepared for the  
Federal Aviation Administration (FAA)

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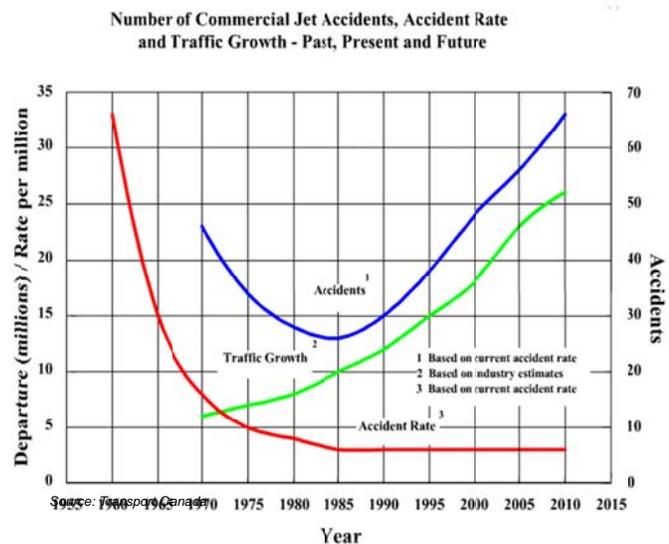
## DEVELOPING AN AVIATION SAFETY RETURN-ON-INVESTMENT SYSTEM TO HELP CERTIFICATE HOLDERS ASSESS THE VALUE OF SAFETY INTERVENTIONS

### CHALLENGE

The Federal Aviation Administration's (FAA) continuing mission is to provide the safest, most efficient airspace system in the world. However, FAA is facing challenges both to its efficiency and to its safety based on an anticipated increase in volume which compound the complexity and congestion of airspace. In 2010, 713 million passengers flew on U.S. airlines. In 2011, it is expected that the number of passengers will increase by 3.5 percent, or 25 million passengers.

FAA Administrator Randy Babbitt addressed the upcoming increases in air traffic in his February 2011 speech at the FAA Aviation Forecast Conference. He pointed out that by 2030, or 20 years from now, the FAA projects that our airspace will carry 1.3 billion passengers—an addition of about 30 times the population of New York City. This rapid increase in utilization has the potential of creating a corresponding increase in safety incidents even if the accident rate were to remain flat, as illustrated in Table 1.

This environment includes complex interfacing human activities such as flight operations, air traffic control airport operations, and aircraft maintenance all operating within potentially adverse organizational and environmental conditions. **Even if today's accident rate is maintained – the number of accidents would be expected to increase unless the industry is able to justify with confidence and implement additional safety management processes that dramatically reduce the rate of precursor events.**



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Broadly, the goal of a Safety Management System (SMS) is to incorporate sustained and systematic use of hazard identification, risk management, and other System Safety methodologies into every aspect of an operating environment. This is done in order to increase safety, as measured by a reduction of accidents and incidents, as well as the precursor events and conditions that lead to them.

To date, some in the industry have expressed concerns and frustrations about the difficulty in measuring the benefits of safety programs, like SMS. Similarly, FAA has confided corollary concerns about the resistance of segments in the industry to adopt the new processes. In the current context of congressional, public, and Office of Inspector General (OIG) / Government Accountability Office (GAO) scrutiny, a standardized and sustainable solution to reinforce the healthy adoption of Safety Management Systems methodologies is a benefit to all parties.

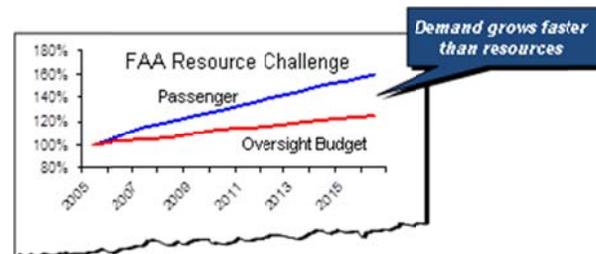
Human Factor interventions play an important role in improving safety within the industry's implementation of SMS. Yet for these interventions to find a place in the strategic objectives of Certificate Holders, they must provide a cost and safety justification. It is therefore necessary to calculate the

financial and safety Return-On-Investment (ROI). However, as outlined by Dr. Bill Johnson<sup>1</sup>, “It is a challenge to place tangible value on many of the specific programs and activities that ensure a safety culture and that intangible concept of safety.” Furthermore, “since accidents are so rare, it is a stretch to use the cost of an accident as the numerator in an ROI calculation.”

If the leadership of a Certificate Holder has difficulty placing value on safety interventions and the prospect of an accident is such a remote probability to assign a credible cost, then how can the industry make the investment required to be more proactive in reducing the precursor events that are known to contribute to serious events, such as accidents?

Furthermore, in the face of such limited momentum on the part of Certificate Holders and an oversight budget that cannot keep pace with Passenger volumes, how can FAA encourage or Promote improvements to safety?

The Civil Aerospace Medical Institute (CAMI) of the FAA is charged with enhancing Human Factor interventions throughout the industry. In conjunction with the Human Factors in Aviation Maintenance section, there is a desire to address these two concerns through an innovative solution. This solution would provide no-cost automation that would give Certificate Holders a justifiable means to evaluate the ROI of potential Safety interventions.



By providing such a solution, several benefits are apparent. First, industry will have confidence that the methods used to measure investment and return are industry standard. Second, FAA oversight activities would benefit from increased adoption of SMS and the supporting risk management decision making processes with industry standard methods and tools. Finally, this will create anonymous insight to help the industry and FAA understand the effectiveness of Risk Management practices within industry’s SMS implementation.

The following pages explore possible options to implementation of an Aviation Safety Return-on-Investment System.

## APPROACH

As the average age of the U.S. commercial aviation fleet increases, maintenance costs increase accordingly. This dynamic presents a challenge to those interested in improving safety. Not only does the amount of direct and indirect labor, materials, contract services costs increase, but there is also the increasing financial impact of reliability driven events like delays and cancellations. The cumulative effect of these large scale age-driven costs, along with the relatively low rate of serious safety incidents, is to displace available funding for safety interventions.

In considering where to apply a tool for evaluation the ROI of potential safety interventions, the Maintenance function seems appropriate. While safety of Flight Operations benefits from appropriately high levels of scrutiny due to its inherently high criticality, Maintenance, or Technical Operations, often fall into a state of neglect. These effects can often be seen in such evidence as the age of supporting IT systems, amount of training, or dynamic Human Factor evaluations. And while Maintenance has not been the most significant contributor to the majority of serious aviation safety events, this function has been a

<sup>1</sup> William B. Johnson, Ph. D (2010). *Measuring the Impact of Safety Programs Operations*. Presented at the Royal Aeronautical Society Airworthiness & Maintenance Conference, Cranfield University.

legitimate area of concern. Given the financial squeeze that occurs in this operating function, providing management improved decision support in evaluating the ROI of potential safety interventions seems to serve the industry well.

Any automation must be seen in the business context for which it is developed. This is a business decision support tool, where the results obtained are simply a range of options with which to inform management's decisions on implementation of mitigation strategies. A decision support tool such as the Aviation Safety Return-on-Investment System presents some interesting challenges. First, as indicated above, since there is often difficulty in finding how to determine the cost of safety, industry will likely place a high value on a solution with a high degree of confidence in the financial model. Along this same line, because of the safety nature of the information, there is a clear need for information anonymity, security, and as well as the integrity of the administrator of such a system. The second clear set of challenges is that the technical solution must be accessible to the wide range of Certificate Holders that will likely be participating in such a system. Even if the software itself is provided at no-cost, they will be sensitive to secondary burdens like infrastructure, compatibility testing, and version control.

### **Business Context**

The first challenge can best be addressed along two lines of reasoning. The first is the information that is collected, the second being the algorithm used to actually calculate the output ROI. Considering the wide range of Certificate Holders that will likely use this system, it makes sense to allow selectable cost fields with variable values. Since a Certificate Holder may implement an intervention within shop floor procedures or as a training implementation, we see the investment inputs to these solutions being potentially very different. Labor may be the only cost factor in some interventions, whereas labor, material and contracted services may be used as part of another intervention. The solution would require flexibility in selecting the right "Investment" drivers. Similarly, it is likely that Certificate Holders will find the model more credible if they were allowed to input their own average labor rates for the model to calculate.

As with the "Investment" drivers, "Return" values associated with the negative impact of undesired outcomes should be allowed to be tailored to meet a standardized profile of potential Certificate Holders and the most likely circumstances that these interventions are likely to impact. Furthermore, the full range of undesired outcomes should be presented for finding "Return" values, from damage to the aircraft or equipment to operational delays or rework. These undesired outcomes, or organizational errors, are large enough in volume to be credibly monitored and are often given impact values by the Certificate Holder. Validation efforts with industry groups like the ATA safety Committee would be essential to getting these profiles to accurately reflect the operating environment of the industry. When considering the logic or algorithm used to calculate ROI, several approaches can be considered. While standard off the shelf spreadsheet software provides a basic calculation that can be used in a system like this, as reviewed above, it is the factoring of the input values that must be considered above all. In his paper on Measuring the Impact of Safety Programs, Dr. Johnson offers a formula which could well serve as the basis of the algorithm, assuming industry has the opportunity to comment and refine the inputs.

In terms of information anonymity, security, and as well as the integrity of the administrator of such a system, it is our perspective that the industry will want to have very tailored data that reflects their unique situation, but it must be held in complete anonymity, and at no cost. While apparently contradictory constraints, these objectives can be met, while at the same time offering the FAA the ability to generate reports on industry activity in generic terms. How can this be accomplished?

There are existing operating models that can inform the approach to handling sensitive information like what is proposed here and providing a standardized framework for generating comparisons between certificate holders of similar operations. For NASA's Aviation Safety Reporting System (ASRS), Booz Allen Hamilton has introduced a variety of solutions over the years that absorb a huge volume of safety reports that can be processed in a way that meets NASA and the FAA's most stringent information security concerns. ASRS receives very detailed reports that contains personal contact information in the initial submittal, yet produces reports that have all sensitive attribution information removed and is then used to generate reports fit for public use. By evaluating these solutions, we believe the Aviation Safety

Return-on-Investment System can address the anonymity, security, and integrity concerns of industry in a cost effective manner. Within the proposed AFS Safety Assurance System (SAS), Booz Allen supported the FAA System Approach for Safety Oversight Program Office (AFS-30) in the development of a System Model that considers all functions of any Certificate Holder under Parts 121, 135, and 145, the associated Regulatory Controls, and applicable configuration data. Additionally, FAA has begun development of a Master Hazard List, which will allow the Aviation Safety Return-on-Investment System to expand beyond the Human Factor contributions to organizational error and accidents, which are the initial focus of this tool, to include the full range of contributing factors, including Organizational, Physical, and Environmental Factors. This would allow the audience for the tool to be expanded to the full range of Safety activities.

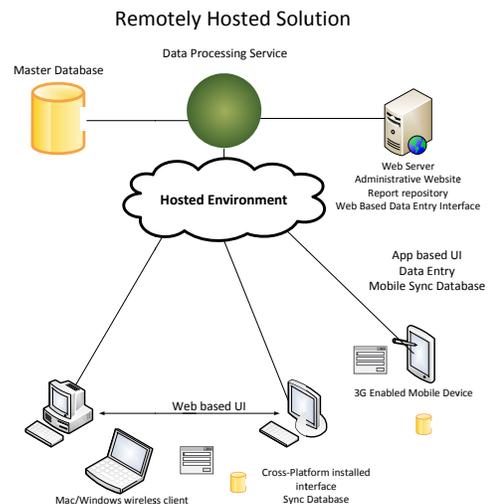
Both of these tools could be used to help industry and the FAA identify, in common terms and scope, the area of functional hazard the Certificate Holder is addressing their intervention. These tools allow standardized comparison of Certificate Holder functions, Hazards, Contributing Factors, and controls. Furthermore, use of these tools facilitates data standardization and sharing between services and divisions of FAA which is mandated under FAA Safety Management System Guidance Order 8000.369, pp. 14, 15. Tools and lessons developed under these two systems can have a profound effect of the utility and acceptance of the Aviation Safety Return-on-Investment System with the FAA and across industry.

## Technology

Successful adoption of an ROI solution will depend greatly on how it is presented to the aviation community, with an eye on the large airlines, but also be readily accessible to the many smaller general aviation and Repair Station Certificate Holders throughout the country. Two solutions come immediately to mind, the locally hosted solution, and the remotely hosted solution. In both cases the data entry interface could be similar, a browser based interface for input devices that are always connected to the network, and an out of browser, cross-platform interface for input devices that may not always be connected to the network.

### Remotely Hosted Solution

A remotely hosted solution has the master database and processing services residing in a secure site located away from the end user, in this case, the operators or repair stations that would use the tool. Virtually all data entry, individual analysis, and reporting duties would be performed by these certificate holders that have a secure and reliable connection to the network; therefore the interface for these services would be best served through an internet browser. This ensures that the application can be developed using IT industry standard techniques, and maintains cross-platform support. In essence, this approach places the development, hosting, version control, and maintenance burden on the FAA, or a trusted third party administrator, like NASA. From the perspective of the certificate holder, this approach is ideal. Not only is there no up-front costs, but there is no liability for compatibility testing or version control. This approach appears to meet the needs of the user community and important FAA objectives.



### Downloadable interface

One enhancement of systems design often requires a downloadable interface. In exploring the use case for a project like this we believe the disadvantages of such a requirement appears to outweigh the advantages. Delivering a cross-platform downloadable interface for data entry presents several challenges that must be overcome including data synchronization, compatibility, and development costs.

As the downloadable interface must also support disconnected clients, a technology must be utilized that will support asynchronous processing. While several of these technologies exist, as this is a common problem in the software development world, the cost and complexity appears on first view not be worth the investment.

#### Pros

- This solution provides a single data collection point for those seeking industry wide reports, or industry wide ROI data.
- Product updates need only be installed on a single site, with clients being alerted to download new interfaces.

#### Cons

- This solution provides a solution that may not be quickly and easily adopted by all areas of the aviation industry. Although the software is hosted off site, and small Certificate Holders need not purchase infrastructure to maintain the software, compatibility concerns may exist for those Certificate Holders that maintain a controlled IT environment. Downloadable software required to run the solution may be seen as an unacceptable testing and versioning burden.
- This solution will take an experienced team of developers and database engineers to create and support
- This solution must be hosted somewhere, and the funding of this hosting site, and connectivity bandwidth must be procured.
- Anonymity would be difficult to maintain with this system, especially if it is intended to allow reports for individual companies be available. A service that scrubs data for any identifiable content would need to be implemented for industry wide reports; however that identifiable data would still be stored at the hosted site.

Given the high level of system complexity and cost for both developer and user, it is our recommendation that this enhancement be left to future releases, once the core system show inherent value and the additional capability is still desired.

#### Locally Hosted Solution

The locally hosted solution has many databases and instances of the product installed across many different sites. Outside of that defining characteristic, the two solutions, Locally or Remotely Hosted, are virtually identical in terms of interface and reports. If generic, industry-wide ROI values are to be created, a service would need to be implemented to synchronize each individual instance with a remotely hosted master database. This would require that the individual databases be connected with a public facing network so that data synchronization can occur. Generic reporting could still be available through an industry portal, while reports for the individual Certificate Holder that initiated each ROI case could request reports from their locally installed instance.

It is expected that such an approach would be seen as an unacceptable infrastructure burden on the Certificate Holders, making this alternative potentially unviable.

#### Pros

- This system provides for complete anonymity. The client need not participate in the industry wide synchronization if they choose not to.

#### Cons

- Each site must provide software licenses for each supporting piece of the solution, i.e. database software, web server, etc. This could make the solution excessively cumbersome for small Certificate Holders with limited resources.
- Connecting databases to public facing networks is prohibited by many company IT policies. This also opens potentially sensitive data up to possible security concerns.

Given the success of other hosted systems, such as NASA's Aviation Safety Reporting System (ASRS), the best approach appears to be the remotely hosted solution. This solution also provides the most easily adoptable platform for both airlines and small Certificate Holders, offering the widest no-cost distribution. No additional software would need to be purchased, or Information Technology staff contracted to support unwanted hardware and software. If only a browser is required to run the solution, as in the case of ASRS, the likelihood of adoption by small and large certificate holders is substantially increased. The remotely hosted solution also provides an easy path to support hand held devices.

## RESULTS

From a financial perspective, the Aviation Safety Return-on-Investment System is a fascinating solution to an intransigent problem. What is the benefit of improving safety, when accident rates are so low? As indicated earlier, and in full concurrence with Dr. Johnson, the attention of this approach should be on the precursor events that may contribute to the accident and certainly contribute to economic waste. Large airlines have been implementing Lean manufacturing techniques for nearly a decade now with significant results. Through the use of Value Stream Mapping, Kaizen events, Heijunka or Load Leveling, and especially Poke Yoka or Error Proofing, these organizations have seen the dollar value of implementing error PREVENTION measures. In fact, there is so much interest in applying Lean thinking within airlines, there is an entire conference on the topic<sup>2</sup>. Through the use of a system such as this, industry best practices can be observed in generic fashion across the industry. Individual Certificate Holders could compare their areas of interest and cost effectiveness to others in similar peer groups. Similarly, an Individual Certificate Holder could demonstrate to their Certificate Management Team that they actively manage safety in a manner consistent with industry best practice with little or no additional investment. This is ready to use software that will allow aviation managers to calculate ROI for safety errors and interventions based on monetary costs and safety risk vs. monetary and/or safety returns.

In terms of the impact to fostering improved safety throughout the NAS, this system could allow comparison of the cause and effect in macro terms of the types and locations of interventions being implemented by Certificate Holders to real time results as seen through the cleansed ASRS/ASAP reporting volumes. In the March 2011 issue of Aviation Week Magazine<sup>3</sup>, Linda Connell, ASRS program director, indicated that "three months [after an ATC tower had improved procedures], the reports started flowing in again — because the tower had reverted to the old procedure due to capacity issues. It showed me that we had our finger on the pulse of what was going on there." This observation by Ms. Connell shows how aggregated trend data from ASRS could help identify the effectiveness of the ROI choices made by airlines.

Here we see the real value of the results that could be attributed to a "double-blind" system. The patterns of anonymous ASRS/ASAP/ATSAP reports would show increases or reductions in events seen on the ground. This could be compared to the generic patterns of processes and hazards that are being assessed for mitigation by Certificate Holders. This approach could further serve to help justify investments for those Certificate Holders who may be slow to adopt.

Each of these benefits serves the highest interests of safety by providing standardized tools at no-cost, and help to promote the mission of the FAA and the industry.

## CONCLUSION

The Aviation Safety Return-on-Investment System will assist in marketing the strategic benefits of human factor interventions to managers and executives and serve as a management decision aid. A concept like

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<sup>2</sup> [http://www.leanflightinitiative.com/files/docs/LFI\\_Conference2011.pdf](http://www.leanflightinitiative.com/files/docs/LFI_Conference2011.pdf)

<sup>3</sup> David Esler, (March, 2011). Invaluable Confessions Collection. *The Aviation Week Magazine*

this continues to serve the industry with no-cost safety services that began with ASRS over 36 years ago. Such a tool will also assist FAA in marketing the strategic benefits of human factor interventions to managers and executives in the process of promoting SMS.

By developing a decision support tool that allows Certificate Holders create a confidential business case for their safety investments, FAA will encourage the promotion of SMS protocols at the heart of Risk Management. Additionally, by making this service available at no-cost continues to serve the highest interest of aviation safety by eliminating barriers for industry leaders to explore and manage their own risk. By encouraging managers to discuss and understand the cost and benefit of safety within their organization, the concepts of Acceptable Levels of Risk (ALoS) and Risk Acceptance Criteria become practical activities within their organization. System safety requires industry to look beyond compliance to anticipate where hazards are present, the level of risk they pose, and what mitigations or interventions are the most cost effective to implement. The Aviation Return on Investment System helps aviation managers fulfill this objective.

Booz Allen has extensive experience in modeling financial solutions for a large range of Federal agencies. At Booz Allen Hamilton, a strategy and technology consulting firm, our economic and business analysts assess market structure, firm interaction, technology maturity, and other variables that influence how regulations affect businesses and consumers. We complement our functional analysis with our industry expertise in transportation, energy, environment, healthcare, and defense. Our multi-disciplinary professionals apply robust analytical tools and methodologies to assess regulatory impacts. We also help determine actual versus intended impacts, how to construct regulations that meet mission goals and objectives, and the changes firms must make to their operations to comply with regulations.

Booz Allen's consultants apply best practices developed from years of experience providing clients with cost-benefit analysis, economic impact analysis, and traditional cost estimating. We augment these capabilities with risk/uncertainty and sensitivity analysis to identify key financial drivers, employing tools such as IMPLAN, Crystal Ball, and SAS. For a rigorous assessment of qualitative impacts, we apply tools such as the Value Measurement Methodology (VMM), now a best practice of the federal government's CIO Council for cost-benefit analysis. We also implement performance measurement using techniques such as Balanced Scorecard to track how well an implemented regulation meets its objectives in a continually evolving market environment.

By relying on such extensive experience, we are able to adapt standard solutions to meet the individual need in each business case. In our estimation, the Aviation Safety Return-on-Investment System is a small, yet sensitive solution that would benefit from the in-depth experience on the Aviation Safety Reporting System (ASRS) and financial models Booz Allen has successfully built for the Federal Government.

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### For Further Information Please Contact

