2007

Panel: Advancing the Human Factors Business Case

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In a time characterized by constrained budgets, competing demands for research and operational investments, and pressures to show how projects provide immediate value, human factors is becoming more adept at how we justify our costs and demonstrate the importance of our contributions. We assess practical approaches for advancing the business case for human factors research and engineering using government and industry perspectives.

Introduction

There is an ongoing need to address human factors issues highlighting contributions to safety, capacity, and efficiency in daily operations. Key principles for the human factors business case are integrated as part of panelists' presentations involving cost savings, cost avoidance, and cost justification. The following panelists' summaries highlight key considerations.

Voluntary Safety Program, Douglas Farrow

A major focus of research and development efforts in human factors within the FAA's Flight Standards Service over the last 15 years has been in support of furthering what the FAA refers to as the Voluntary Safety Programs. These are seven programs for which the FAA has never established a mandatory regulatory requirement, but in which the FAA strongly encourages industry participation. Because these programs often represent an additional cost for airlines, and because they all involve the certificate holder sharing additional data with the FAA beyond regulatory requirements, the FAA provides regulatory incentives for participation. The FAA also looks for ways to minimize the financial investments required for these extra programs, both on the part of industry and the FAA. The largest US air carriers participate in most of these programs.

While these programs were originally developed and managed by a variety of different FAA organizations over the years, the FAA has gradually consolidated all of them under a single program office within FAA Headquarters. The Voluntary Safety Programs Branch currently provides oversight for the following programs: Aviation Safety Reporting (Program/System) (ASRS), Aviation Safety Action Program (ASAP), Flight Operations Quality Assurance (FOQA), Advanced Qualification Program (AQP), Voluntary Disclosure Reporting Program (VDRP), and the Internal Evaluation Program (IEP). The seventh program, Line Operational Safety Audits (LOSA), is not an FAA program per se. It is an industry program originally funded by the FAA as a research and development effort, but now a private venture endorsed by the FAA and supported by an FAA Advisory Circular (AC 120-90).

While it is true that financial pressures have increased on both industry and the FAA, safety remains the overriding consideration in deciding which lines of research receive funding. The FAA has a very transparent, standardized and even-handed approach for ranking, and hence funding, proposed research and development projects according to perceived safety need. Consideration for cost-justification is an emerging trend as part of research program assessment.

One long-serving FAA Division R&D Representative lists the following as, historically, the most effective components in cost-justifying R&D expenditures to FAA upper management: Programs that standardize practices, integrate with other programs, leverage FAA resources, automate manual processes, improve the efficiency of the FAA, or any combination thereof.

The FAA Flight Plan goal of accident reduction underlies all of the justifications for all of these programs. The cost avoidance of even a single accident for an air carrier is substantial. In addition to this general and generic cost avoidance justification, individual programs have their own unique financial justifications.

The following is a sampling of recent human factors research efforts sponsored by the Voluntary Safety Programs Branch in order to support safety efforts.

Notice to Airmen (NOTAMS)

NOTAMS is an archaic system used to advise flight crews of primarily tactical information about the National Airspace System (NAS), such as temporarily closed runways. It was developed around ticker-tape technology before the basic human factors of user-friendly text presentation were understood. It is such a confusing mish-mash of upper case letters, abbreviations, and obscure symbols that inconsistencies over its use have been cited in numerous accidents and incidents.

By completing a human factors analysis of the NOTAMS system and collecting survey data from pilots, the FAA was able to recommend modifications to a seriously outdated system that is now recognized as a frequent source of pilot error. The cost consideration was the recognition that the system was vital, but that the effectiveness of the system as currently formatted and structured was becoming increasingly problematic. It was a matter of maintaining the basic safety infrastructure of the NAS. This is a case where the cost justification was based on the generic formula of saving lives by reducing pilot error, rather than by a side-by-side comparison of maintaining versus replacing the system.

Rapidly Reconfigurable Event Set Generator (RRLOE)

By developing a standardized methodology for quickly and effectively developing realistic scenarios for training and checking pilot performance, the FAA was able to slash the cost of evaluating pilot human factors skills, while simultaneously lowering the amount of time required by the FAA to review and approve each such scenario. Because scenarios are routinely developed by the pilot workforce, and because each fleet within the airline needs 3-6 new scenarios each year, the ability to reduce a five person-week task down to less than 30 minutes has saved the air carrier community millions of dollars each year in avoided costs. It has also saved the FAA hundreds of hours of review time in the approval of these scenarios. The majority of air carriers have adopted the methodology pioneered by this toolset.

Simulator Fidelity

By demonstrating the unpredicted efficacy of non-motion simulation devices to compete effectively with full motion devices in both initial and recurrent training regimes, the FAA begins to lay the groundwork for a possible unprecedented expansion of lower order and lower cost devices, sharply cutting industry training budgets while simultaneously easing the FAA's oversight workload, which is lighter for fixed devices than for motion devices. A previous study estimated the potential industry-wide cost savings of moving training from full motion simulators down to fixed based training devices to be in the neighborhood of $67M per year for recurrent airline pilot training alone. Because of the substantial body of scientific evidence these studies appear to refute, and because of significant political and economic interests in extremely high fidelity devices, no action should be anticipated on this issue in the near future

Aviation Causal Contributors for Event Report Systems (ACCERS) Taxonomy

By examining over half a dozen taxonomies used for safety event reporting, the FAA was able to come up with an all-inclusive methodology for categorizing safety event reports that met the accepted scientific best practices for taxonomy development and was at the same time sufficiently user-friendly to be reliably employed by the pilot workforce. This project was cost justified as laying the groundwork for the future of FAA oversight. The future vision of FAA oversight includes a downsizing of the inspection function and an increasing reliance on auditing and data analysis, hence the need for better taxonomies. The future workforce required to support this new oversight model is anticipated to be less expensive, as it will include fewer former pilots, dispatchers and maintenance technicians and more data analysts and automated functions.

Line Operations Safety Audit, David Bair

This presentation discusses the investment in the use of LOSA methodology and will highlight how LOSA results, when implemented proactively will improve the flight operation. Line Operations Safety Audit (LOSA) is an industry best practice for measuring normal crew behaviors and performance during regular scheduled line flights over a specified time period of data collection using trained observers in the cockpit jump seat. Developed by the University of Texas in Austin and the LOSA Collaborative, LOSA mandates 10 operating characteristics that serve to define and direct the activities during and after the audit and serves to protect the true intent of this voluntary, non-jeopardy data driven safety program. Recently AC 120-90 has been adopted and serves as the latest guide to operators for implementing LOSA. Ultimately the best use of LOSA is to enfold the audit into the safety change process by conducting additional audits every 3 to 5 years. In this manner, the organization can analyze the data collected, make appropriate changes to policy and procedures, adopt and train these new procedures over a normal recurrent training rotation and then re-measure during the next audit. This process can take three years but does not require the completion of that time period to take advantage of the audit results. Indeed, once true hazards are recognized during the audit de-briefing, intervention can take place almost immediately through procedural changes for specific issues.

Qualitative vs. Quantitative

In the decision to spend money in an organization, the question always arises as to ROI, return on investment. LOSA is no different. But any proactive safety program will not always prove immediate or even short range returns from a quantitative perspective; meaning if you invest a certain amount of money you can not always realize a return with interest, so to speak. Rather a qualitative result is the goal and needs to be accepted early on.

Why should the safety margin surrounding the flight operation be any less important than the company's financial margins?

I would suggest that it could be even more important because of the immediate, intermediate and longer range consequences of an accident. But how does the organization know if a healthy safety margin exists unless it is measured somehow? What is the quality of the safety margin? Should the organization believe an operation is safe because incidents and accidents are not happening on a regular basis? How close is the organization to having a serious accident or incident? If the organization does not measure the effectiveness of the safety margin, they are left with responding to incidents and/or accidents as they occur.

LOSA will not give the kinds of quantitative results like the outside financial auditing firm provides for the accounting department. As mentioned before, a quantitative approach is the wrong measuring philosophy. LOSA provides the *qualitative* data that can be used to more than reasonably extrapolate a picture of the operation into the future with accuracy.

More About Qualitative Results

Critical to this consideration is the report on how the crews actually handled the off normal events that came up during the flights. If threats lead to errors that lead to more errors, the operation [safety margin] suffers. Ultimately, if the crew experiences a resulting undesired aircraft state, like a long landing from an unstable approach or an off course or off altitude condition, the safety margin is in serious danger of breaching. But what happens more often is that the crew eventually salvages the event and there are no serious consequences or outcomes at all.

Crew Resource Management (CRM)

In addition to suggested areas needing improvement the LOSA captures all the areas that crews are doing well in. And believe me, there are going to be a lot to them. The vast majorities of flight crews are very professional and are very committed to safety. CRM practices and skills are measured. The effective management of errors and threats are captured and in fact lend very well to new curriculum development.

LOSA data is critical data in exploring the human factors associated in the normal line operation as well. When drilling down into actual events as seen in LOSA we see unintentional non-compliance issues, meaning the crews just made mistakes. Those errors may or may not be linked to an outside threat. So when spontaneous errors are occurring, there are usually underlying associated contributing human factors such as crew fatigue or cockpit automation design issues. We also find that crews that *intentionally* violate certain regulations or company policy and procedures seem to be making a larger number of *unintentional* errors as compared to crews that do not intentionally break the rules. This may suggest some cultural and/or crew leadership issues resident within the organization.

Philosophy of Safety and Making Changes

The data collection phase is the easiest part of the LOSA. The most difficult part is deciding what to do with the data. LOSA affords managers a measured approach to making proactive change to avoid changes forced upon them resulting from unpleasant accidents or incidents. After the areas of enhancements are identified, a good way to start is to choose which ones, if left unattended, could result in serious events in the near future, and then prioritize the rest.

I am aware of an airline that identified unstable approaches as one such area that needed serious attention. As it turned out, they were experiencing an unacceptable rate as compared to the LOSA archive airlines. It was actually somewhat alarming. They formed teams to look into every area of enhancement identified in the LOSA and when researching the unstable approach issue it was discovered that the flight manual definition for stable approach was very vague. This resulted in a wide variety of interpretations by the crews and check airman alike. The standards group agreed and went to work on crafting a better definition. After the manual was revised, the training group had a better defined policy that could be both taught and measured in the simulator and during line checks. Three years later, the next LOSA measured the rate of unstable approaches as almost non-existent! The success of the change was due to simply defining what the company expected for parameters during both instrument and visual approaches, and implementing a policy that was reasonable in terms of requiring a missed approach or go around. Critical to this point is that the policy or procedure was well crafted and was reasonable to expect from the crews. In other words the crews accepted the policy as reasonable. This is important since if new policy and procedures resulting from LOSA are not well written and impose unrealistic performance requirements from the crews, there may be resistance to comply and the next time a LOSA is conducted, the crews may not think too highly about having someone on their jumpseat and may resist the audit.

Another suggestion in making changes after an audit is to now *actively* involve the check airman. Typically, check airman do not make the best LOSA observers for two reasons. One is that they are used to observing crews under very different circumstances, meaning that if the crew member performs badly during a line check, the pilot's job could be at stake. So changing the role to be a non-jeopardy LOSA observer may be difficult for the check airman to remain non-judgmental as an impartial observer just collecting data. The second reason is that the crews may not behave normally with a check airman on the jump seat. This has the result of producing bad data because of the crew's inhibitions and possible discomfort having a check airman on the jump seat and feeling like this could be a line check even though it's explained otherwise.

I recommend that the check airman be assigned to lead "Target Teams" to work the issues during the corrective action phase. All recommendations have to be approved by the manager over standard. But if you want the check airman to calibrate and train crews in the new procedures resulting from the LOSA it helps if they sense some ownership in the development of the improvements.

More on the Safety Change Process

The investment in LOSA as a means to measure the effectiveness of the safety margin around the flight operation is as essential as measuring every financial margin within the airline, if not more so. Decisions regarding the strategy of the airline business model are closely tied to accurate financial data and the auditing of that data. The same philosophy in managing the safety margin is equally appropriate and given the possible serious outcomes of not auditing for possible latent hazardous conditions the ultimate future of the airline may be at stake.

Aircraft Maintenance, William Johnson

Justification of expense, or **return on investment (ROI),** for maintenance human factors is not new (FAA, 2005; Hastings, et al, 2000; Johnson, et al, 2000; and Johnson, 2006). The premise is that ROI is most credible and effective when small examples are used then scaled up to a larger program-level to justify cost.

This section provides easy-to-calculate, easy-to-explain cost justification for human factors interventions. The calculation of ROI is straight forward. Merely determine the cost of the investment compared to the return. The return can be measured in money made or money saved.

While this approach seems simple, measuring cost in the real world is not. For example, maintenance organizations seldom consider the cost of delay or cancellation that resulted from a maintenance error. Recent manufacturer data shows that the cost per hour delay of a flight ranges from $16,000 each hour on wide bodies to $2,000 each hour for older narrow body jet airliners. This averages out to $7,500, per hour for the airline fleet. If you consider that it costs $100,000 every day that a wide body airliner is grounded for maintenance, it's easy to justify the cost of human factors intervention programs.

The return on investment approach is best understood if viewed from the perspective of:

- Cost vs. lost production
- R&D costs vs. return
- Cost vs. productivity increase
- "Trust me" approach

While the first three approaches seem intuitive the last one, the "trust me" approach can be a hard to sell. Here are examples.

Cost vs. lost production is a common approach. For example, if we deliver 4 hours of communication training to all employees we estimate that it will reduce gate delays by 10%. That reduction can eliminate 20 hours of delays per week for a savings of $140,000/week in one major hub. While this appears to be straight forward it presents challenges in proving that the reduction in delays resulted from improved communication.

R&D Costs vs. return process as demonstrated by Dr. Paul Krois and the team at the FAA Human Factors Research Office has shown that R&D programs can provide a significant return on the investment**.** A recent example is the FAA Human Factors Certification Job Aid that delivered an estimated time savings of 85% in locating pre-certification information. The FAA Human Factors Office has valuable tools and interesting discussion about ROI on their Human Factors Workbench website: http://www.hf.faa.gov/Portal/ToolsList.aspx?CategoryID=46).

Cost vs. productivity increase was shown in another FAA project, the Online Aviation Safety Inspection System (Hastings, et al, 2000). Using a "utility analysis" based on data from 400 users of a new computer-based job aid, the cost verses productivity analysis showed a 19% annual reduction in the amount of time searching for data ($16M/year). The numbers did not include such intangibles as quality of work life, ability to access current information, quality of data produced and potential safety impact. However, this ROI analysis helped justify the investment and the long-term use of the OASIS job aid.

"Trust Me" is the final method discussed here. The origin is a British consultant who insisted that managers should "Trust him" when he said that human factors interventions like training, improved work environment, better documentation, and so forth will improve performance and are worth the money. He may be correct. In fact, the "Trust me" method is quite representative of traditional airline decision making. However, the premise of this paper is that maintenance organizations must defend spending on human factors and strive to go beyond the "Trust Me" method of justifying ROI. Establish the trust with many small examples as shown below.

The FAA Operator's Manual for Human Factors in Maintenance

In 2005 the FAA and a panel of industry, government, and academic professionals created the Operator's Manual for Human Factors in Maintenance (FAA, 2005). The web-based document explains why each topic is critical, how to address the topic, how to measure success, and key sources for more information. Chapters cover Event Investigation, Documentation, Training, Shift Turnover, and Fatigue/Alertness. The final chapter addresses the issue of program sustainment and cost justification shown below.

Calculating ROI in a Maintenance Environment

This section shows an example ROI and makes the case that many small interventions can add up to big savings and easily justify cost. Today's Safety Management Systems report events and identify the risks that must be mitigated. These events are ideal targets for ROI calculations. Usually the cost of reported events can be estimated. At the same time, the organization can estimate the cost to fix the cause of the event. The fix may include rewriting procedures, buying new computers or other hardware, developing and delivering training, and other such interventions. The difficult next step is to estimate the probability the intervention will reduce future events. We suggest you base the probability estimate on historical data or on your organization's financial targets/safety goals. The probability multiplied by the annual cost of the events, minus the cost to fix, is the return on the investment. Divide return by the cost of the intervention to get the ROI ratio. A ratio greater than zero means the ROI can be achieved in less than a year. It is reasonable to continue even when the time for payback is more than a year. Calculations are described in FAA (2005).

Ground Damage ROI Example

A carrier was experiencing many ground damage events, mostly associated with moving the aircraft during scheduled maintenance activity. They recorded that, in one year, a specific hangar recorded sixteen ground damage events totaling $260K. Further investigation showed that this was an average year for ground damage events in that hangar.

The company applied Boeing's Maintenance Error Decision Aid (MEDA) to investigate the events and made recommendations including:

- Paint aircraft specific markings on the floor
- Set up and identify clear zones around the entire aircraft
- Adapt work platforms matched to aircraft type
- Clarify operating procedures and tell all personnel
- Continue to audit damage on weekly basis

The annual COST of events was $260K. The estimated cost to paint floor markings, change the work stands and procedures, and training the personnel was $52K. Using the terms described above, the COST TO FIX is $52K.

The company estimated the PROBABILITY OF SUCCESS was about 75%, meaning they expected the interventions would cut out 75% of the ground damage. The (PROBABILITY OF SUCCESS X COST) - COST TO FIX = RETURN. (.75 X $260K) - $52K = $143K RETURN.

To get the RETURN ON INVESTMENT RATIO divide RETURN by COST TO FIX ($143K / $52K = 2.75 ROI). With that kind of ROI the company receives an ROI in slightly over 4 months (12 months/2.75=4.3). In fact, that is exactly what happened at this carrier. This became a showcase example for justifying other human factors investments. This success gave the Human Factors Manager credibility and enabled him to use a few "Trust Me" justifications with other interventions.

This section has presented four types of ROI and demonstrated that costs are best justified by conducting the ROI analyses in small bits. Positive small examples will build trust and demonstrate that human factors interventions have great value.

Discussion

A theme common to these perspectives shows there are a range of strategies and techniques for how human factors can address the investment case. One example highlights the benefit of facilitating increased standardization in operational practices.

It should be noted that by its nature, research on human factors issues is not guaranteed to provide a return from the project's costs. This includes research outputs that support regulatory or operational decisions.

Disclaimer

The views expressed are those of the authors and do not represent the FAA.

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