Investigate, Communicate and Educate: Are We Doing All Three with the Same Energy?

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ARE WE DOING ALL THREE WITH THE SAME ENERGY?

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An "association" is generally defined in dictionaries as the organizational outcome of the banding together of individual entities having common traits, interests and purposes, and sharing a common objective to support their mutual interests. Thus the traditional roles for an association are advocacy, that is the act of speaking or writing in support of something, and using its group influence in order to attain this common interest, goal or objective. This definition certainly seems to fit ISASI. Now that we have sorted out who we are, what are the goals of ISASI members? I will define for you the mandate of the TSB, and I am confident that this mandate will be fairly close to the goals of ISASI members. It is to advance transportation safety in the marine, pipeline, rail and air modes of transportation by:

- conducting independent investigations, including public inquiries when necessary, into selected transportation occurrences in order to make findings as to their causes and contributing factors;
- identifying safety deficiencies, as evidenced by transportation occurrences;
- making recommendations designed to eliminate or reduce any such safety deficiencies; and,
- reporting publicly on its investigations and related findings.

We are aviation professionals involved in aircraft accident investigation. Whether we may be also employed as pilots, engineers, technicians or other, we like to think of ourselves as experts in our field. And why should we not feel this way? After all, we have received extensive training in basic and advanced investigation procedures, bio-hazards, interview and photography techniques, jet engine and propeller mechanics, crash site survey, team leadership and management, safety deficiency analysis, human factors, and a multitude of other assorted specialty courses. We feel good about our capabilities. We can all recite the SHELL and Reason theories backwards. Anyone who has ever been involved in an accident investigation as investigator-in-charge, team member, Accredited Representative, observer, or in any other capacity, believes that his/her efforts have helped advance safety. We identify safety deficiencies evidenced during the course of our work, and make recommendations to mitigate or eliminate those risks to the travelling air passenger. The question is, or rather, the questions are: How well are we advocating our safety communications? Is the message consistently passed to all of those who need to receive it? Do we consistently target those entities who can learn from our investigations and who are in a position to fix the deficiency which caused the safety communication? Are we fooling ourselves in believing this is so? We can investigate every transportation accident and derive exact conclusions and findings all we want, but if we do not properly pass the safety communication aimed at fixing the problem, we have wasted our money, time and effort, and we also have missed the boat, to use a common expression.

The most important aspect of an investigation is the identification of unsafe acts, unsafe conditions and underlying factors which led to the incident or accident. This methodology will

allow an investigator to validate safety deficiencies which will also have been identified through this process. A validated safety deficiency preamble and its concluding section must:

- Demonstrate that defences were inadequate, missing, or failed.
- Address the possibility of a recurrence.
- Consider and analyse the severity of consequences.
- Provide risk control options (is improvement feasible?).
- Result in safety communications aimed at mitigating or eliminating the identified risk by those responsible.

Naturally, each state investigation agency has to consider a number of factors in determining whether an incident or accident will be investigated. Although ICAO Annex 13, Chapter 5. INVESTIGATION states that accidents **shall** be investigated, and that serious incidents **should** be investigated, it is evident that we cannot do everything, as our resources are limited. Having said that, we should naturally concentrate on those occurrences where the safety payoff appears to be the best. This requires that we have a close initial look at each occurrence to determine the possible level of that safety communication payoff.

The challenge is that if we cannot "communicate" adequately, we will de facto fail to do the "educate" part of the this year's trilogy theme, as both go hand in hand. The result is that the safety message will not be passed, and recurrence under similar circumstances becomes simply a matter of time.

Although we may be excellent at investigating for causes and contributing factors, we have yet to consistently advocate our bread and butter: communication and education. As stated, we are very good at determining the who, what and why of crumpled aluminum and rotating parts. Most major accidents include unsafe acts, conditions or underlying factors where the risk was real and the defences to prevent the mishap were less than adequate or non-existing. Sometimes however, we simply fail to properly communicate a validated safety deficiency to the right party - the one who can fix the problem. At other times, our reports do not explain clearly what the exact nature of the deficiency was, leading the recipient of the safety communication to disagree with our recommendations aimed at reducing this risk; as a result, nothing gets fixed. (How often have you heard the statement: "we disagree with your risk analysis"). On occasion, it becomes too difficult to fully develop a safety deficiency for a number of reasons (lack of factual evidence, difficult analysis, industry pressure or other), and we just give up.

Finally, we do not advocate or push our product sufficiently. We write our recommendations, and then let others take action as they see fit, hoping they will do the right thing. We consider our work done once the investigation report has gone out the door. If those others do not take appropriate action, we see this as **their** problem, because we told them about it... right? On many occasions, we have not been very good at following up and evaluating government and industry responses to recommendations. Specifically, we have failed to consistently track their proposed actions in response to our recommendations, and we have not verified the timely implementation of those proposed actions. Our reports and proposed safety action often do not reach each of those who need to be appraised of this information. Sometimes they don't get the safety message in time; at other times, they simply do not get it and as a result, we later observe a repeat of an earlier accident.

Our overall past performance in passing the communicate and educate safety message has certainly had its ups and downs. The jury is still out, I believe, whether the ups are winning the

battle. Hopefully, I might be able to conclude my presentation today with measures, ideas and solutions which may help us improve the results of our investigating efforts, that of saving lives, property and environmental damage. In order to set the scene for the remainder of this paper, I will now to use a few examples highlighting difficulties to get safety deficiencies corrected.

On 16 December 1997, an Bombardier RJ100 crashed while conducting an approach to a Canadian airport. The reported aerodrome weather at the time of the accident was: vertical visibility 100 feet obscured, horizontal visibility one-eighth of a mile in fog, and runway visual range 1200 feet. After the autopilot was disengaged at 165 feet above ground, the aircraft deviated from the desired flight path. The aircraft crashed shortly after the captain ordered a go-around because he was not sure that a safe landing could be made on the runway remaining.

Canadian regulations permit Category I approaches to be flown in visibilities lower than would be permitted in most other countries (including the United States), and the regulations are not consistent with what is recommended in ICAO *International Standards and Recommended Practices*. To compensate for the risk associated with landing an aircraft in conditions of low ceiling and visibility, extra aids and defences should be in place. Therefore, to reduce the risk of accidents in poor weather during the approach and landing phases of flight, the Board recommended that:

> The Department of Transport reassess Category I approach and landing criteria (re-aligning weather minima with operating requirements) to ensure a level of safety consistent with Category II criteria.
>
> TSB Recommendation A99-05

On 12 August 1999, a Raytheon Beech 1900 crashed while on approach to a Canadian airport at night. At the time of the approach, the reported ceiling and visibility were well below the minima published on the approach chart. The crew descended the aircraft well below safe minimum altitude while in instrument meteorological conditions. Throughout the approach, even at 100 feet above ground level (agl), the captain asked the pilot flying to continue the descent without having established any visual contact with the runway environment.

The accident report concluded that the issue of additional regulatory restrictions for instrument approaches in poor weather has been discussed in Canada for several years because of the number of accidents that occur during the approach and landing phase. Indeed, from January 1994 to December 2001, the Board investigated 24 such accidents where low visibilities and/or ceilings likely contributed to the accident. Consequently, controlled-flight-into-terrain accidents on approach that result in loss of life and damage to property have continued to occur and will likely continue to occur. The Board therefore recommended that:

> The Department of Transport expedite the approach ban regulations prohibiting pilots from conducting approaches in visibility conditions that are not adequate for the approach to be conducted safely.
>
> TSB Recommendation A02-01

And that:

> The Department of Transport take immediate action to implement regulations restricting pilots from conducting approaches where the ceiling does not provide an adequate safety margin for the approach or landing.
>
> TSB Recommendation A02-02

The Cessna 335 was on an instrument flight with two pilots and two passengers on board. After checking the prevailing weather conditions at destination, the pilot decided to make a back course approach on runway 29. The pilot reported by radio at two miles on final approach. This was the last radio contact with the aircraft. The aircraft was found by a search team travelling along a dirt road bordering the runway. The aircraft was consumed by a very intense fire. All four occupants received fatal injuries. The reported weather at the time of the accident was as follows: visibility one-quarter mile in heavy snow and vertical visibility 300 feet. No aviation regulation in Canada prevents pilots from making instrument flight rules (IFR) approaches where weather conditions are below the approach minima (ceiling and visibility) and no RVR is available at the airport

Wait, there is more. On 25 February 2004, a Boeing 737 aircraft landed beside the runway in the wee hours of the morning. You guessed it. The weather was not very cooperating once again. The reported runway visual range was 1200. The crew lost visual references with the ground after committing to the landing. Fortunately, no one was hurt. Close, but no cigar as they say.

On 25 April 2004, another Beechcraft C-100 overran the end of a runway and crashed when it landed near the departure end in poor visibility. I could mention many more commercial operations approach and landing accidents related to low ceilings and visibility investigated by the TSB in the last ten years.

What happened to the above recommendations? In September 1999, TC had initiated action to implement new approach ban regulations aimed at reducing the likelihood of accidents during instrument approaches in low visibility conditions. **Good idea!** This process is still ongoing. Until these regulations are promulgated, there will continue to be inadequate defences against the risks associated with pilots descending below the decision height or minimum descent altitude in an attempt to land in visibility conditions that are unsafe. We will continue to investigate this type of accident until some day, large amounts of blood are spilled under these conditions. The deficiency will then be vigorously addressed, but it will of course have been too late. Why is the message not getting through?

Let's look at two cases involving maintenance issues. The Beech A-100 aircraft crashed near the airport shortly after takeoff. After getting airborne, the aircraft was observed to immediately pitch up to approximately a 70 degree angle. It then appeared to stall at an altitude estimated to be between 500-700 feet agl. The nose then fell through the horizon to a pronounced nose down attitude. As the airspeed built up, the aircraft began to recover from the excessive nose down attitude. The aircraft contacted the ground and crashed as it was beginning to enter into a second roller-coaster sequence. The wreckage trail, consisting of the underbelly baggage pod and its contents, all landing gear and the left propeller assembly, covered a distance of 491 feet. The remainder of the aircraft came to rest essentially in one piece after it had crossed over a railroad bed and track. A small fuel fed fire from the punctured left wing ensued a few minutes after the

occupants exited the aircraft but was rapidly extinguished by the airport fire fighting services. Miraculously, no one aboard was seriously injured.

The investigation quickly determined that the primary and alternate trim "H" bracket attaching the aircraft's stabilizer to the airframe had been improperly reconnected during weekend maintenance performed prior to the flight. After the occurrence, investigators found that the top of the actuators was not attached to the airframe. The two bolts did not pass through the actuator holes when reinstalled, but only through the attachment holes in the airframe. When the bolts were tightened during installation, they squeezed the ends of the actuators to the attachment points on the airframe. The inspection was carried out superficially without close inspection from inside the tail cone or using the tools, such as a mirror, which would be standard for this type of inspection. The accident report mentioned the difficulty in visually verifying that the bolts were inserted properly in the airframe channel, and suggested that the aircraft maintenance manual directives concerning this task could be enhanced.

Then, it happened again! On 23 April 2003, a Beech 99A was on a scheduled flight from Saskatoon to Prince Albert, Saskatchewan, with a crew of two and four passengers on board. This was the 12th flight following major inspection and repair activity and the aircraft had flown approximately 7 hours since completion of the work. Shortly after the flaps were selected for approach, a loud bang emanated from somewhere in the tail and the aircraft immediately started to pitch up. The crew applied full forward elevator and reduced power. The airspeed slowed and from a near-vertical attitude, the aircraft rolled left then pitched steeply nose-down. The crew applied full-up elevator and full engine power to recover from the dive. The nose of the aircraft came up and the crew extended the landing gear just prior to a high-speed touchdown on rolling agricultural fields. On contact with the ground, all three landing gear and the belly baggage pod were torn from the aircraft. The aircraft slid to rest approximately one-half mile from the initial ground contact point. The crew and passengers exited the aircraft through the main cabin door. Injuries incurred were not life-threatening.

Post-accident inspection revealed that the stabilizer trim actuator had detached from the fuselage structure allowing the stabilizer to move freely under the influence of air loads. During installation, the two bolts had been installed behind the actuator mounting lugs, trapping the lugs between the shanks of the bolts and rivets in the airframe structure. Sounds very much like the other one? You bet! The findings of this report as to cause and contributing factors were generally the same as those of the first one. An interesting finding as to risk read as follows: "The nature of the installation presents a risk that qualified persons may inadvertently install Beech 99 and Beech 100 horizontal stabilizer trim actuators incorrectly. There are no published warnings to advise installers that there is a potential to install the actuator incorrectly."

On 02 May 2003, ten days after the accident, the TSB issued an occurrence bulletin detailing the factual information relative to this occurrence and the Beech King Air 100 occurrence of June 1999. On 20 June 2003, the TSB forwarded a Safety Advisory regarding the facts of this occurrence to Transport Canada for potential safety action. Transport Canada produced a Service Difficulty Alert (AL-2003-07, dated 2003-07-17) based on the TSB occurrence bulletin, advising of the occurrence and indicating that the installation procedures in the maintenance manual are being reassessed. Transport Canada contacted the U.S. Federal Aviation Administration, requesting their assistance and that of the aircraft manufacturer, suggesting issuance of a service letter and incorporation of warnings in the appropriate aircraft maintenance manuals. Raytheon

Aircraft issued King Air Communiqué No. 2003-03 to alert appropriate operators and maintenance personnel of the possibility of incorrect installation of the actuators.

Has the message now been passed to all those who need to receive it? I sincerely hope so. Will all maintenance personnel working on those types of aircraft heed the message? I simply don't know. One thing is evident: if AMEs do not look at their maintenance manual when performing this function, my guess is that it will happen again.

How come the first lesson was not learned? Was it because our safety message was not strong enough in the first report? Was it ignored? Was it not received by all operators who have this type of trim bracket arrangement? Was it simply forgotten after a year? What could we/should we have done to ensure this did not happen again? We sometimes say that there are seldom new accidents, just old accidents re-visited. For your sake and my sake, I hope we don't really mean this.

Lets now look at the communications aspect. There are various methods by which each State investigation agencies communicate safety deficiencies. These can range from the very informal verbal communications between the Investigator-in-Charge (IIC) of an incident or accident and the parties involved, all the way to the formal recommendations issued with a final report. Between these two extremes, we find initial reports, interim reports, factual reports, 60-day reports, occurrence bulletins, information and advisory letters, Board Concerns, et j'en passe. All of those can and often convey a safety message that the intended recipient(s) should catch, understand and act upon.

In Canada, the only safety action which requires a formal response is that expressed in the form of a Board Recommendation to the Minister or Transport. All other interested parties, such as operators, NAV CANADA and other organizations need not respond or comment on any TSB Safety Communications. Finally, each state investigation agency has its own standards and processes as to how a safety action message should be drafted. Sometimes, states put the emphasis on defining the safety deficiency in the text of their recommendations and leave the nuts and bolts aspect of fixing the problem to those in the best position to do so. At other times, they are much more specific in the wording of their recommendations concerning the actions that need to be undertaken. It would be nice to have a recognized method or standard of accomplishing this, but are we dreaming in colour?

Practices differ between state investigation agencies concerning safety action which requires to be directed at another state. The TSB has no set policy in this regard, and I suspect that other states may be in a similar situation. In some cases, safety action communications are sent directly to the foreign state' s regulatory authorities. In other cases, recommendations are sent through the state's accident investigation authority, such as the NTSB, ATSB and AAIB. Because the TSB has no set policy, our Board uses a mix of the two methods. I should point out that foreign regulatory authorities are not required to respond to safety communications issued by another state, but that they usually do. A state accident investigation authority can also put pressure on its own regulatory agency, manufactures and operators to respond, but the state issuing the safety communication may not get adequate feedback, due to this lack of an internationally recognized policy in this respect.

When it comes to operators, a formal response on their part to a state recommendation or other safety action proposal is of course not mandatory. Operators can take action to reduce the risk

based on the safety communication, or they can simply ignore it. An operator can also agree to take action to mitigate a validated risk or deficiency and subsequently do nothing about it. Some of the factors are: company set up, finances, attitude, and the importance attached to maintaining a healthy safety culture at all levels of the company. Furthermore, communications passed to an operator do not always simultaneously get transmitted to all other operators who need to receive the communication, especially when the deficiency has ramifications over more than one continent. Finally, states are not well equipped to monitor or track safety action taken by their own operators in response to a recommendation issued by another state. For these reasons, monitoring safety action taken by operators can be, and regularly is, a hit and miss affair.

Manufacturers of aeronautic products are also not required to respond formally to safety action emitted directly to them by a foreign state either, but they generally do. It is important for manufacturers to substantiate on paper the reason or reasons they may disagree with a given safety communication. If they agree with it, they must indicate the actions they will take or intend to take to mitigate or eliminate the safety risk. When the risk and its consequences are judged unacceptable, state regulatory authorities will normally issue an Airworthiness Directive directly to manufacturers and operators.

On issues where it can be argued (truthfully or not) that the risk is lesser than presented, manufacturers may choose to issue a service bulletin to operators and owners of the concerned aircraft, equipment, or part. To do nothing might be foolish, but at the same time, the manufacturer has to be concerned about the legal implications of admitting a deficiency in his product, especially if said product was found to have been at cause in previous occurrence(s). For that reason, manufacturers sometimes object to the issuing a particular service bulletin as this action may imply some degree of responsibility for previously recorded or investigated events. Finally, the difficulty that investigation authorities have with service bulletins is of course the fact that they have no mandatory compliance, even when the manufacturer-recommended action has a "mandatory"status or a required completion deadline based on a given date or time in service of the part. Operators may choose to disregard a service bulletin, and some do.

Let’s now look at how we actually monitor those responses we do receive, and what we do with these. Most investigation authorities such as the TSB have no power to mandate or require action to mitigate or eliminate the risk specified in its safety communications issued following investigation. The implementation of air regulations is the responsibility of the state regulatory authority and there is an excellent reason for that. This method allows investigation authorities to maintain a complete independence from the regulatory arm of a government. On the other hand, that same reason distresses us as investigators when we see recurring accidents like those described earlier year after year because the risk control options evidenced in our safety action recommendations are not being implemented.

At the TSB, one of my responsibilities is to track all formal responses to safety action, including those responses emitted by foreign states, operators and manufacturers. Each response to a recommendation is initially sent to the IIC who then provides my office with his assessment in one of the following categories: fully satisfactory, satisfactory intent, satisfactory in part, or unsatisfactory. The assessment is then reviewed at Head Office against the standard and then forwarded to the Board. The assessments are reviewed on an annual basis to ascertain progress on mitigating risk evidenced in safety communication. Currently, in Canada, the assessment category given is not passed back to those who provided the response and, therefore the feedback

stops at that point. As a result, there is no impetus for the action addressee to show due haste in addressing the problem. The risk may therefore remain unchanged.

The last issue I would like to address at this time with the tracking and assessment of responses to safety communications is the type of response we all too often receive. Life would be great if each response began with a statement of agreement with the recommendation, the actions which will be taken to reduce or eliminate the risk, and the milestones to accomplish the task clearly shown. Unfortunately, that is not what we get. How can we properly address and assess a response which contains mostly explanations rather than actions, and where no implementation time frame is given? I wish I knew how to answer this question, because if there ever was a million-dollar question, that is it. This should not, however, stop us from searching for the answer.

I would now like to offer some concluding thoughts on the communication theme. Sadly, our safety communications do not always convincingly demonstrate the residual risk, the probability of recurrence, and the severity of consequence (weak evidence or wording) to the interested party. This results in a weak impact of the safety message we are trying to convey and, accordingly, it receives an inappropriate level of attention and response. As an example, parties to an investigation are not always involved in the full analysis process that allows for better understanding of the safety issues involved. Some states may feel that they are losing a degree of independence in doing so. However, I believe we can retain our independence while ensuring involved parties understand the thought process behind each safety issue being analysed. This method makes it easier to reach a consensus on a deficiency which needs to be addressed.

Furthermore, our recommendations are sometimes directed at the wrong addressee, that is, they are not communicated to those requiring the information. Because we do not have international standards related to safety communications to a foreign state, we sometimes miss the mark. As stated earlier, action taken is often not adequately tracked and the response assessments are not made public by all investigating authorities. Those entities responsible for effecting change are often not challenged when their response is judged inadequate. Finally, the response often does not provide mitigating action milestones. These are important issues that organisations such as this esteemed body or ICAO may wish to pursue further in order to advance safety.

Having said that, have our investigative efforts produced results? Let’s take a look at our past performance, and take a shot at the future. It is a fact that deadly mistakes by commercial and airline pilots have decreased dramatically over the last decade. In other words, the old "pilot error" findings have been on a steady downward slide. That is a good thing, as Martha Stewart would say. Year 2003 was in fact one of the best in commercial air transport history. Was that a fluke? I don’t think so. We will never know how many accidents we have prevented due to our concerted efforts, but the numbers do not lie. We are indeed making progress with the "beast", but we must not rest. CFIT continues to be one of the main causes of accidents. The enhanced ground proximity warning system (EGPWS) is reported to be a major player in helping to reduce CFIT accidents. Indeed, no aircraft equipped with this updated system has been involved in a CFIT accident to date. These are good news. I wish everything else was this rosy, but it is not. Fatal accidents caused by maintenance errors are seen to be on the increase. There are claims that there will be one major accident per week in ten years due to air traffic increase unless the accident rate is reduced. The risk of mid-air accidents is also real, as evidenced by the recent mid-air collision in Germany. RVSM rules will make navigation and altitude bust errors yet more critical. ETOPs and over-the-pole flights will increase, with the associated risk of someday

having to investigate an accident around the polar cap. We can also expect there will continue to be major accidents over water or at sea, like the TWA 800, SWR 111 and the more recent Alaska Airline and Flash Air flights.

So, what are we doing to make things better? Flight operational Quality Assurance (FOQA) is coming on line in some states. FOQA is seen as a great tool for tracking and investigating incidents before they become accidents. Quick access recorders (QARs) offer the possibility of increased FDR data gathering capabilities. The technology is already there. Manufacturers and their engineers need only invest a little more time, money and effort into developing a hardened QAR, and the capability to extricate the facts of an accident will increase exponentially. Any accident investigator can see the advantages of having additional data. An accident sequence sometimes begins well over the half-hour that older CVRs capture. Two-hour CVRs are being installed in new aircraft, and some older ones are being retrofitted with the improved boxes. There are still some hurdles to clear, but the possibility of having video recorders in aircraft cockpits in the future is beginning to take hold, as the advantages of this technology are real and are being recognized. A large number of aircraft systems now capture information into non-volatile memory chips that can reveal important information to help determine the cause of an accident. Finally, many investigation authorities have, or are developing, a list of safety issues that they are interested in. It would be a good idea for us to exchange notes on those safety issues we each are interested in pursuing.

The challenge to educate is real. Aviation safety does not improve by quantum leaps over short periods. Rather, it goes through a series of up and down curves, as we fix old deficiencies while new one pop up. Accident investigators will have to make every effort to ensure that safety communications reach all those affected by the risk. We must learn to think globally instead of locally. We must therefore standardize our approach to safety communications; that is develop coherent related internationally recognized policies and standards. FOQA data will be of limited use if gathered threshold information is not investigated properly, or if the results are not passed to others who can learn from other's mistakes. Investigating authorities must become more active in advocating safety action, and those responsible for effecting changes to improve safety must show diligence in mandating those changes.

Ladies and gentlemen, our challenge is clear: for each safety deficiency that we conclude must be addressed, we must write clear, convincing safety communications and it is imperative that these be targeted at the appropriate audience. If we fail to do this, our message will not get the attention it deserves and others will not learn about these identified risks. Finally, unless we as investigators make vigorous efforts to track responses to communications and critically assess action taken as a result of these communications, those risks will remain. The tragedy will be that we will know that we could have done more to prevent a catastrophic recurrence of a serious accident, but did not. We will have to live with that knowledge. The alternative, advocating safety at all levels, requires more work and dedication on our part, but is much more rewarding in the end. As I said at the beginning of this paper, the traditional role of organisations is advocacy. So let’s do some hard thinking amongst ourselves as to how we can best advocate out there! Surely, we can improve our track record, but it will require constant effort, innovation and dedication towards the aim. Any bright ideas out there?