2015 HAI HELI-EXPO
BY HELICOPTER ASSOCIATION INTERNATIONAL

USHST United States Helicopter Safety Team

EMBRY-RIDDLE Aeronautical University WORLDWIDE

HAI ROTOR SAFETY CHALLENGE

THE REALITY OF AERONAUTICAL KNOWLEDGE: THE ANALYSIS OF ACCIDENT REPORTS AGAINST WHAT AIRCREWS ARE SUPPOSED TO KNOW

INTRODUCTION

- Faculty with Embry-Riddle Aeronautical University
- Program Chair, Bachelor of Science in Aeronautics
- IHST Affiliations
  - USHST, Joint Helicopter Implementation Data Analysis Team (JHIMDAT)
  - USHST, Joint Helicopter Safety Implementation Team (JHSIT)
  - USHST, Training Working Group

COURSE DESCRIPTION

- Discussion of practical knowledge beyond the Helicopter Flying Handbook combined with research of the IHST's Analysis Team.
- In-depth look at aeronautical knowledge, decision-making, and understanding limitations
- Ideal for all experience levels; Best where training occurs initial/recurrent

OBJECTIVES

Perspective

- Gain a higher level of operational/safety awareness as related to their functions within a company.
- Review accident information through the eyes of aeronautical knowledge
- Develop an acute awareness of perspective and how to use it

REFERENCES

Compendiums I & II

International Helicopter Safety Team, (2011). *IHST reports: US JHSAT compendium report – Volume I*. Retrieved from http:// www.ihst.org

International Helicopter Safety Team, (2011). *IHST reports: US JHSAT compendium report – Volume II*. Retrieved from http://www.ihst.org

USJHIMDAT (2014). *Comparative report. U.S.JHIMDAT data to U.S.JHSAT data.*

Burgess, S. (2012). *The reality of aeronautical knowledge: The analysis of accident reports against what aircrews are supposed to know*. Joint Helicopter Measurement and Data Analysis Team, International Helicopter Safety Team. Retrieved from http://www.ihst.org

AGENDA

Perspective of Aeronautical Knowledge

Beyond the Helicopter Flying Handbook

Discussion of Accidents by Occurrence Category

Conclusion

Discussion and Collaboration

Where do we come from?

What is our cultural background?

per·spec·tive

/pərˈspektiv/

noun

- a particular attitude toward or way of regarding something.
- the relationship of aspects of a subject to each other and to a whole.
- subjective evaluation of relative significance.
- the ability to perceive things in their actual interrelations or comparative importance.
- the state of one's ideas, the facts known to one, etc., in having a meaningful interrelationship.
- Other elements of perspective

FAA SAFETY VIDEO

WHAT PROVIDES PERSPECTIVE?

- Training usually follows a set standard
- We learn the minimums or just beyond
  - We discuss an Auto
  - We are demonstrated an Auto
  - Then we practice an Auto
- Do we add value to the training?
  - (Not thru abrupt maneuvers though)
- Do we take perspective far enough?

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PERSPECTIVE

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PERSPECTIVE

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PERSPECTIVE

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Safety Videos

Safety Moments *Videos*

Volume 3

Each video clip features **Martin Lesperance**, a popular safety speaker and expert with 26 years' experience as a firefighter and paramedic, speaking about a particular safety tip or issue.

Tragedies Make Us Safer - 3:15

Unfortunately, it often takes the deaths of others to make us safer. In this tragedy, over 300 people died, most of which were children. Shortly after this incident, the law was changed so an odour was added to natural gas to prevent horrible events like this one from happening again.

Watch Preview

WHY SHOULD WE DO EXPLORE REALITY OF KNOWLEDGE?

- Accidents happening in our industry seem to be occurring more in specific areas
  - Small companies (<3 ships)
  - Single Owner Operators
- Young/new Instructors in schools may end up in this population
- The population is hard to communicate with
- Research is needed and just now starting to happen

TOOLS FOR PERSPECTIVE

Critical Thinking.

- Apply knowledge at the synthesis level to define and solve problems within professional and personal environments.
- As an integral component of problem solving and decision-making, this combination of skills allows one to form contentions, conclusions and recommendations.
- This skill combines all of the following tasks; analysis, evaluation, conceptualizing, application, solutions, recommendation, synthesis, researching, observation, experience, reflection, reasoning, communication.

TOOLS FOR PERSPECTIVE

- Use of Exemplars
- The Reality of Aeronautical Knowledge: The Analysis of Accident Reports Against What Aircrews are Supposed to Know
- Supplements to the HFH are necessary
- Doctrine, techniques and procedures need perspective
- Inclusion of actual NTSB accident reports offer a realistic viewpoint and association to the environment in which we operate the helicopter. These are real events, which happened to real people.

TOOLS FOR PERSPECTIVE

(Answer these Questions Strictly from your Perspective
And not your Companies perspective)

- Do you associate a flight operation with safety?
- How integral is safety TO your operational environment?
- How do you see the industry promoting safety?
- How overt is safety in your environment?
- Was safety perspective always present in your career?

TOOLS FOR PERSPECTIVE

- Statistics
- IHST data can be used to lend perspective
- Associate the data to your setting
- Take the information to the next level
- Associate accident data into your training

STATISTICS AS PERSPECTIVE

- Accident Occurrences like Loss of Control was identified with 41% of the accidents.
- Loss of Control can occur at various times during a flight, so it was important to further express a category 'Phases of Flight' with sub-categories such as;
  - Landing (108 accidents/ 4 fatal accidents)
  - Enroute (102 accidents/34 fatal accidents).

STATISTICS AS PERSPECTIVE

- Highest % of accidents came from the (personal/private) industry category
  - 97 out of the 523 total accidents (18.5%).
- Instructional/Training (Dual) incurred the highest percentage of accidents (14%, or 73 accidents) for “Activity” classification.
- Positioning/Return to Base had 69 accidents (13%).

STATISTICS AS PERSPECTIVE

- FAR Part 91 incurred 70% of the total accidents.
- FAR Part 91 accounts for just over half of the rotorcraft hours each year (amount of exposure).
- FAR Part 91 accounts for a higher percentage of accidents compared to amount of exposure partly because
  - Personal/Private and Instructional/Training industries have such a high percentage of accidents and both operate Part 91.

STATISTICS AS PERSPECTIVE

Most of the accidents occurred in good weather during the day

Over half of the pilots (246 of 523) totaled over 2,000 flight hours

PIC time was less than 500 hours (for almost the same population).

DO THESE STATS TELL US ANYTHING?

WHAT HAS THE INDUSTRY/IHST/HAI RECENTLY DONE WITH PERSPECTIVE?

- Flyers, Fact Sheets, Essays, Presentations
- Posting research
- Training worksheets
- IHST and HAI working groups and committees
- Training and education
- Publications
- etc

APPLIED PERSPECTIVE

- Reality text takes knowledge and compares to real accidents.
- Accidents were reviewed to determine best examples of cause and effect
- Extension of HFH discussion concurrent with IHST accident occurrence categories

EXTENDING THE DISCUSSION

- Intent to extend discussion on specific areas of the HFH to IHST accident data analysis
- 18 topics are expanded
  - Standard issues like mast bumping or SWP/VRS
  - Multifaceted issues like Situational Awareness and ADM
  - Complex issues like Low Level Flight dealing with WX/PWR/Visibility/Obstacles/Distractions

SYNTHESIS

- Snapshots of high volume accidents by occurrence category
  - Explain
  - Introduce
  - Define
  - Identify problem
- Accident Narratives

Lets have a look .....

Chapter 2
Loss of Control

1. Short explanation and introduction. [HFH Ch. 9, 10, 11; AOM]

Loss of control accidents account for the largest group of accidents from the studies. Additionally, as the chart below depicts, there are sub-occurrence categories within loss of control accidents. In this document, we will review the top group which include performance management, dynamic rollover, exceeding operating limits, emergency procedures, and loss of tail rotor effectiveness.

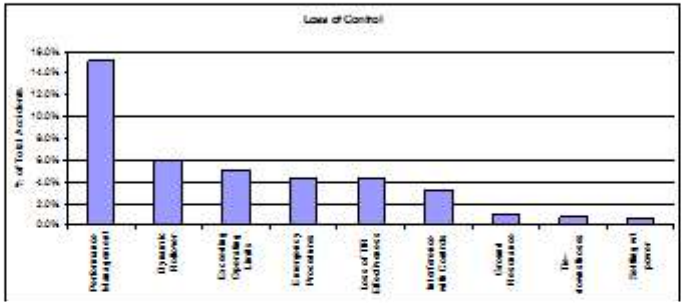

Figure 2. Loss of Control. Adapted from U.S. JHSAT Comparison Volume I Figure 9. The sum of the percentages exceed 100% as each of the 523 accidents analyzed could be assigned to multiple occurrence categories. For example, if the aircraft ran out of fuel, an autorotation ensued, followed by a loss of control, the accident is counted against three separate occurrence categories: Fuel, Autorotation, and Loss of Control

2. Accident Occurrence. Loss of Control (LOC) occurred in 41% of the 523 accidents studied by the U.S. JHSAT. LOC is defined as the pilot losing control of the aircraft for any of these reasons:
   - Performance Management - pilot maintaining insufficient power or rotor RPM for conditions.
   - Dynamic Rollover – the tendency of the helicopter to continue rolling when the critical angle is exceeded, if one gear is on the ground, and the helicopter is pivoting around that point.
   - Exceeding Operating Limits - helicopter is operated near the established limitations of the model/type.
   - Emergency Procedures - improperly responding to an onboard emergency.
   - Interference with Controls - interference by pilots, passengers, loose baggage, or factors related to maintenance.
   - Ground Resonance
   - Loss of Tail Rotor Effectiveness (LTE) or Unanticipated Yaw is an occurrence of an uncommanded yaw, which, if not corrected, can result in loss of control
   - Tie-downs/Hoses
   - Settling with Power

3. **Standard Problem Statement**. The most common Loss of Control problem came from Performance management. Within this occurrence it is clear that the pilot decision-making was a problem. Additionally, there appears to be a significant amount of information missing to pinpoint specific performance management issues. Accident reporting vs. engine monitoring equipment contributed to this lack of solid causal factors and the industry is engaged in improving this situation. What the reader can take away from the following charts is how at each level, loss of control predominantly occurs from a human factors point of view. In most cases the underlying cause was the failure to perform specific procedures, execute a proper decision, communicate, or adequately plan.

Performance Management (Loss of Control) (present in in 79 out of 523 accidents)

SPS Level 1	SPS Level 2	SPS Level 3
Pilot Judgment & Actions	Procedure Implementation	Inappropriate Energy/power management
Pilot Judgment & Actions	Procedure Implementation	Pilot control/handling deficiencies
Pilot Judgment & Actions	Landing Procedures	Autorotation – Practice
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Disregarded cues that should have led to termination of current course of action or maneuver
Pilot Judgment & Actions	Crew Resource Management	Inadequate and untimely CFI action to correct student action

Dynamic Rollover (Loss of Control) (present in in 31 out of 523 accidents)

SPS Level 1	SPS Level 2	SPS Level 3
Pilot Judgment & Actions	Procedure Implementation	Improper recognition and response to dynamic rollover
Pilot Judgment & Actions	Procedure Implementation	Pilot control/handling deficiencies
Pilot Judgment & Actions	Crew Resource Management	Inadequate and untimely CFI action to correct student action
Pilot Judgment & Actions	Landing Procedures	Selection of inappropriate landing site

Exceeding Operating Limits (Loss of Control) (present in 27 out of 523 accidents)

SPS Level 1	SPS Level 2	SPS Level 3
Pilot Judgment & Actions	Human Factors - Pilot's Decision	Disregarded cues that should have led to termination of current course of action or maneuver
Ground Duties	Mission/Flight Planning	Inadequate consideration of aircraft performance
Ground Duties	Mission/Flight Planning	Inadequate consideration of aircraft operational limits
Pilot Judgment & Actions	Procedure Implementation	Pilot control/handling deficiencies
Pilot Situational Awareness	External Environment Awareness	Lack of knowledge of aircraft's aerodynamic state (envelope)

Emergency Procedures (Loss of Control) (present in 23 out of 523 accidents)

SPS Level 1	SPS Level 2	SPS Level 3
Maintenance	Performance of MX Duties	Failure to perform proper maintenance procedure
Pilot judgment & actions	Procedure Implementation	Pilot control/handling deficiencies
Ground Duties	Aircraft Preflight	Performance of Aircraft Preflight procedures inadequate

Loss Of Tail Rotor Effectiveness (Loss of Control) (present in 23 out of 523 accidents)

SPS Level 1	SPS Level 2	SPS Level 3
Pilot judgment & actions	Procedure Implementation	Inadequate response to Loss of tail rotor effectiveness
Pilot judgment & actions	Human Factors - Pilot's Decision	Disregarded cues that should have led to termination of current course of action or maneuver
Safety Management	Flight Procedure Training	Inadequate avoidance, recognition and recovery training: Loss of Tail Rotor Effectiveness (LTE)

4. **Intervention Recommendation**. Training and Safety Management were the two primary recommendations for intervention for loss of control accidents. This is followed by specifically suggesting training it by topic of aeronautical knowledge relating to piloting skills, airframe knowledge, and specific information regarding typical flight operations and missions. All recommendations center on the integration of safety and operations management.

For Loss of Control in general, the Top 3 IRs for training were: Training emphasis for maintaining awareness of cues critical to safe flight, Enhanced Aircraft Performance & Limitations Training, and Inflight Power/Energy Management Training.

For Loss of Control in general, the Top 3 IRs for Safety Management were: Personal Risk Management Program (IMSAFE), Use Operational Risk Management Program (Preflight), Establish/Improve Company Risk Management Program.

Often times young pilots are attuned to what their aircraft control requirements are in the cockpit and what directly relates to those tasks such as CRM. This mentality is sometimes carried forward as the pilot graduates to instructor, and perhaps more so in these small companies. It is important to integrate pilot training and education with environment that includes a comprehensive management system for both operations and safety. This should occur early in a pilot training program.

5. **Accident Narratives**. Since we are reviewing several Loss of Control (LOC) areas, there will be several narratives for each of the loss of control discussions above.

National Transportation Safety Board **FACTUAL REPORT AVIATION**	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	LOC - Performance Management
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
A helicopter was destroyed following a loss of tailrotor effectiveness landing. The flight was conducted under the provisions of 14 CFR Part 135 and was on a visual flight rules flight plan. Visual meteorological conditions prevailed at the time of the accident. The pilot reported minor injuries to himself and one passenger. There were a total of four occupants including the pilot.
After losing tail rotor effectiveness, the pilot was able to land the helicopter in a field amongst pine trees. The main rotor stuck the trees and the helicopter rolled over on its right side. A fire erupted and the helicopter was consumed. The occupants had exited the aircraft prior to the fire.
In a written statement, the pilot said that, as he approached the landing area, the helicopter was, "...about 250 pounds below maximum gross weight of 3,200 pounds." The pilot stated that, while on approach to land, he noticed a tree that he had not seen before and decided to abort the landing. He said he, "...began a power pull to 100 percent torque and a transition to forward flight. The helicopter immediately began a rapidly accelerating yaw to the right. I applied maximum left pedal to halt the yaw, which was ineffectual." The pilot stated that, when he was clear of obstacles, he attempted to regain control. He said that, at that point, he, "...believed [he] still had a functioning tail rotor, but that it may have entered a 'loss of tail rotor effectiveness' state and need only be regained." The pilot also stated that, "the 'low rotor RPM' warning light and horn began to come on with each pull of the collective..."

The National Transportation Safety Board determines the probable cause(s) of this accident as follows.
The pilot's failure to attain translational lift following an aborted landing and the loss of tail rotor effectiveness encountered by the pilot. Factors to the accident were the low rotor rpm and the trees.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	LOC - Dynamic Rollover
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The pilot of the med-vac helicopter reported that, during liftoff at the remote site, he encountered a loss of visual reference due to a "brown out" condition created by blowing dust at 3 feet AGL. He then attempted to land the helicopter without any visual reference; however, the right skid contacted the ground first. A rolling motion to the left was created and, after the left skid contacted the ground, a dynamic rollover ensued. The helicopter came to rest on its left side.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's selection of an unsuitable landing site, which caused "brown-out" conditions during departure liftoff and resulted in loss of control of the helicopter.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: FATAL
	Occurrence Type: Accident	LOC - Exceeding Operating Limits
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
The pilot was assigned to fly for a geophysical seismic team in rugged high desert conditions (elevation 5,366 feet). On his second day of flying, he was requested, by one of the team members, to "fly a little easier; less aggressively." On his third day of flying, he was assigned to pick up five team members and their equipment. Once airborne (density altitude was 8,908 feet), he had been briefed that he would receive GPS team distribution coordinates; instead, he was instructed to land and hold for a period of time. A witness observed the helicopter fly eastbound, and then make a 45 to 60 degree bank turn [180 degrees] back to the west. The witness then saw the helicopter turn southbound, lower its nose down almost vertically, and then reduce its nose low pitch to approximately 45 degrees as it disappeared from sight. Post accident examination of the engine revealed that the manual throttle pointer on the fuel control was in the emergency position. The first and second stage turbine wheels were found with their blades 50 to 70 percent melted, indicating an engine that functioned for a time at a temperature level well above its limits.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's loss of aircraft control due to abrupt flight maneuvering. Contributing factors were the high density altitude weather condition, the total loss of engine power due to the pilot manually introducing excessive fuel into the engine and over temping the turbine section, and the lack of suitable terrain for the ensuing autorotation.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	LOC - Emergency Procedures
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
Two commercial helicopter pilots, both certificated helicopter instructors, were in a turbine-powered helicopter practicing autorotations with a power recovery prior to touchdown. The flying pilot inadvertently activated the flight stop augmented fuel flow switch during a power recovery, and overspeed the engine and main rotor. The other pilot joined him on the controls, and increased collective to reduce rotor rpm. The helicopter climbed abruptly to about 60 feet above the ground, where the tail rotor drive shaft separated. The engine subsequently lost power, and an autorotation was accomplished. Investigation disclosed that the engine and main rotor system had been exposed to significant overspeed conditions, resulting in a catastrophic failure of the turbine engine, and the tail rotor drive shaft coupling. The flight stop switch on the collective has no protective guard, and can be readily engaged, allowing the engine to enter the augmented fuel flow regime and, under certain conditions, causing the engine to overspeed. The switch has a history of inadvertent activation, and resultant engine overspeed events.

The National Transportation Safety Board determines the probable cause(s) of this accident as follows. The pilot's inadvertent activation of the collective flight stop/emergency fuel augmentation switch, which resulted in engine and main rotor overspeeds, thereby precipitating failures of the tail rotor drive shaft coupling and power turbine blades. A factor associated with the accident was the manufacturer's inadequate design of the flight stop switch, which has insufficient safeguards to preclude inadvertent activation.

National Transportation Safety Board FACTUAL REPORT AVIATION	NTSB ID:	Aircraft Registration Number:
	Occurrence Date:	Most Critical Injury: None
	Occurrence Type: Accident	LOC - Emergency Procedures
Airport Proximity: Off Airport/Airstrip	Distance From Landing Facility:	

Accident Information Summary-
After the patient was placed aboard the helicopter, the pilot started the engines and performed a hover check. He then moved the helicopter forward to gain airspeed and initiated a climb to cruise altitude. After reaching an altitude of about 100 feet, the main rotor rpm light and audio warning system activated, and the number 2 engine N1 rpm and torque began to decay. The pilot attempted to regain normal engine parameters, but was unable to regain engine rpm. The pilot maneuvered to avoid several light poles as he attempted to land in a parking lot. By this time, main rotor rpm had bled off sufficiently to prevent the hydraulic pumps from pressurizing the hydraulic system, and all flight controls locked is a slight right-banked attitude. This prevented the helicopter from reaching the parking lot. The helicopter impacted a construction area in a right bank, nose down attitude. An on-site and later follow-up investigation by FAA and Rolls-Royce investigators revealed a B-nut on the Pc line connecting the power turbine governor (PTGOV) to the fuel control unit (FCU) had become loose at the T-fitting end. It was partially torqued and could be moved with the fingers. The female end was threaded onto the male end three-quarters of a turn. There was no cross-threading. The torque stripe was broken. According to Rolls-Royce Allison, "This line serves a critical function to the engine control system and when leakage occurs will cause the engine to roll back to an idle or near idle condition."

The NTSB determines the probable cause(s) of this accident as follows. A loose B-nut on the PC line connecting the power turbine governor (PTGOV) to the fuel control unit (FCU) that created a leak and caused the engine to roll back to an idle condition, causing a low hydraulic system pressure and subsequent control lock. A contributing factor was the unsuitable terrain (construction area) on which to make a forced landing.

APPLICATION

Is there validity to lending perspective between safety and aeronautical knowledge?

Could such perspective help reduce accident rates?

Cooper's Essay on Principles

- Alertness
- Decisiveness
- Speed
- Coolness
- Ruthlessness
- Surprise

APPLICATION

- Is there validity to lending perspective between safety and aeronautical knowledge?
- Could perspective help reduce accident rates?
- Cooper's Essay on Principles
  - Alertness
  - Decisiveness
  - Speed
  - Coolness
  - ~~Ruthlessness~~
  - ~~Surprise~~

Questions?

What's next?

10:00 am – 11:00 am	**Aviation Human Factors: Protecting Us from Ourselves** Jason Quisling, Air Methods & USHST	**Introduction to Just Culture** Dudley Smith, CAMTS	**iPad Takes Flight! EFB Challenge Edition** Charles Schneider, MyGoFlight
	Max Impact: A Story of Survival Jonathan Godfrey, Children's National Health System	**Safety Data Analysis: Make It Actionable** Jeff Currin, Air Methods	**What the FRAT?** Bryan Smith, ALEA & USHST; USHST SMS Committee Members

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