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The European Helicopter Safety Team (EHEST): European Partnership for Improving Helicopter Safety

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Abstract - In 2006 EASA launched the European Strategic Safety Initiative (ESSI), a ten year program to enhance aviation safety in Europe. The ESSI is a partnership between EASA, other European regulators, the industry and the users. More than 150 organisations participate to date. The ESSI has three components: the European Commercial Aviation Safety Team (ECAST), the European General Aviation Safety Team (EGAST) and the European Helicopter Safety Team (EHEST). The EHEST is also the European branch of the International Helicopter Safety Team (IHST). The EHEST is committed to the IHST goal of reducing the helicopter accident rate by 80 percent by 2016 worldwide, with emphasis on European safety. To reach this objective, EHSAT, the European Helicopter Safety Analysis Team, was formed with the purpose of identifying safety issues and intervention recommendations. This paper describes this initiative, its organisation, and methodology and presents early developments.

Acronyms

ADREP – the ICAO Accident / Incident Data Reporting System
CAST - Commercial Aviation Safety Team (U.S.)
EASA - European Aviation Safety Agency
ECCAIRS - European Coordination Centre for Accident and Incident Reporting Systems
EGAST - European General Aviation Safety Team
EHEST - European Helicopter Safety Team
EHSAT - European Helicopter Safety Analysis Team (part of EHEST)
EHSIT - European Helicopter Safety Implementation Team (part of EHEST)
ESSI - European Strategic Safety Initiative
HFACS - Human Factors Analysis and Classification System
ICAO - International Civil Aviation Organisation
IHST- International Helicopter Safety Team
IR - Intervention Recommendation (IHST methodology)
JHSAT - Joint Helicopter Safety Analysis Team (IHST)
JHSIT - Joint Helicopter Safety Implementation Team (IHST)
SMS - Safety Management System
SPS - Standard Problem Statement (IHST methodology)

1. European Strategic Safety Initiative - ESSI

EASA launched in 2006 the European Strategic Safety Initiative (ESSI), a ten year program to enhance aviation safety for European citizens. The ESSI is a partnership between EASA, other European regulators, manufacturers, operators, professional unions, research organisations, military operators and the general aviation community. Participants are drawn from the EASA Member States[1] and the ECAC States[2]. More than 150 organisations participate to date.

[1] EASA Member States are the 27 EU Member States plus Switzerland, Liechtenstein, Norway and Iceland. http://easa.europa.eu/ws_prod/g/g_links.php.

According to the ESSI terms of reference, each ESSI team is co-chaired by a regulatory and an industry member. The basic principle is that industry can complement regulatory action by voluntarily committing to cost-effective safety enhancements. Analysis of data, coordination with other safety initiatives and implementation of cost effective action plans are carried out to achieve fixed safety goals.
The ESSI has three components: the European Commercial Aviation Safety Team (ECAST) - the European equivalent to U.S. CAST, the European General Aviation Safety Team (EGAST), and the European Helicopter Safety Team (EHEST).
EHEST is also the European component of the International Helicopter Safety Team (IHST).
EHEST is committed to the IHST goal of reducing the helicopter accident rate by 80 percent by 2016 worldwide, with emphasis on European safety. To reach this objective, the EHEST has launched a European wide accident analysis study performed by the European Helicopter Safety Team (EHSAT).

2. International Helicopter Safety Team - IHST

Long term helicopter accident rates have remained unacceptably high and trends have not shown significant improvement in the last 20 years on a worldwide basis. The persistence of this issue and the need to improve this record was the central theme of the International Helicopter Safety Symposium (IHSS) in Montreal, Canada in September 2005. IHST was established after this symposium as a major initiative to improve helicopter safety in the United States of America (U.S.) and worldwide.
IHST is a combined government and industry effort to reduce the helicopter accident rate – both civil accidents and noncombat military mishaps - by 80 percent within 10 years. The IHST is led by representatives of the American Helicopter Society International, Helicopter Association International, the Federal Aviation Administration, Transport Canada, the European Aviation Safety Agency (EASA), and several industry partners.
IHST has established regional teams in the U.S., Europe, Canada, India, Brazil, and Australia and is seeking to create new groups in the Middle East, Far East, Commonwealth of Independent States and South Asia.
The IHST Executive Committee organisation is described in Figure 1:

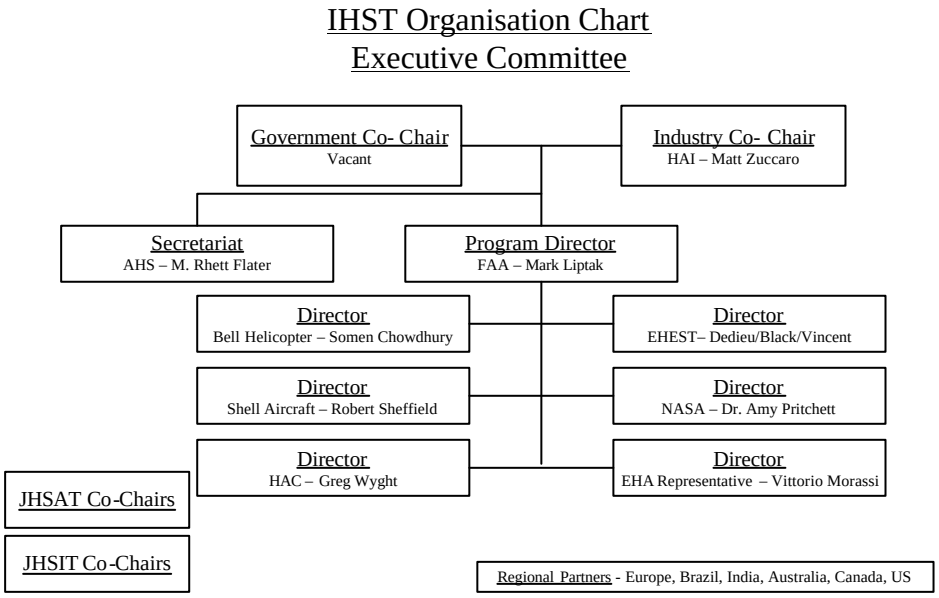

Figure 1 - IHST Organisation Chart - Executive Committee

[2] ECAC covers a wider grouping of Member States of any European organisation dealing with civil aviation: it is currently composed of 44 Member States. http://www.ecac-ceac.org/.

3. European Helicopter Safety Team - EHEST: the European branch of IHST

The European Helicopter Safety Team brings together helicopter manufacturers, operators, EASA, national aviation authorities, helicopter and pilots associations, research organisations, accident investigators, the general aviation community and a few military operators from across Europe.
EHEST counts more than 50 participating organisations, of which around thirty are actively involved in the analysis activities. A listing of participants is provided on the ESSI / EHEST website.
EHEST addresses the broad spectrum of helicopter operations across Europe; from commercial air transport to general aviation.

4. Safety analysis, implementation and monitoring

IHST has two types of working groups: the Joint Helicopter Safety Team (JHSAT) and the Joint Helicopter Safety Implementation Team (JHSIT).
Using a method adopted from the U.S. CAST, JHSAT reanalyses helicopter accidents and produces suggestions for safety improvement called intervention recommendations.
The JHSIT revisits these intervention recommendations, produces safety enhancement action plans, and monitors action plan implementation and progress towards fixed objectives.
Action plans may address both the regulators and the industry.

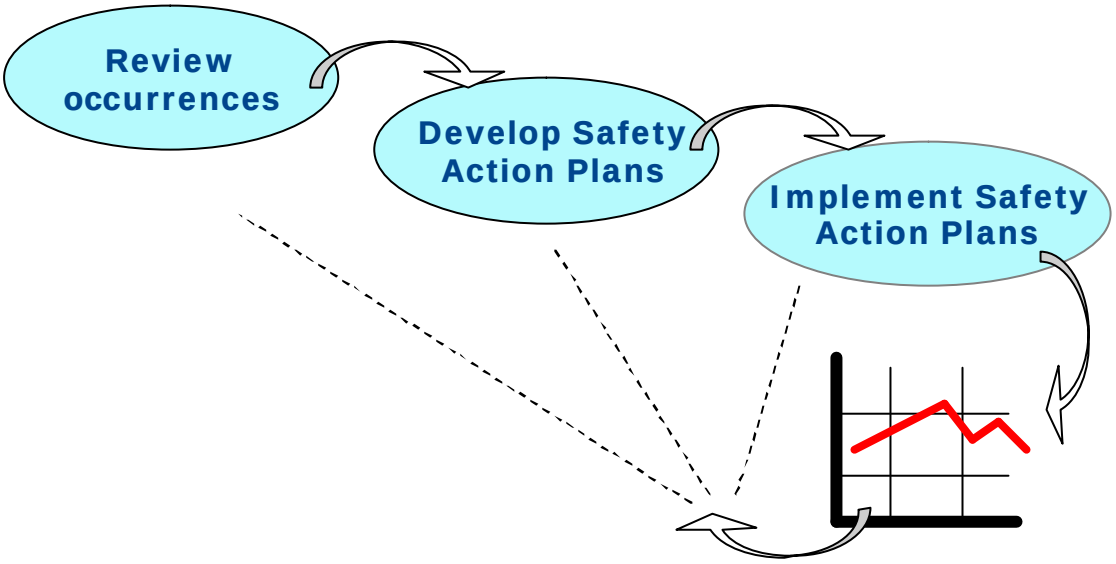

Figure 2 - Safety analysis, implementation, and monitoring

The European Helicopter Safety Analysis Team (EHSAT) is the European JHSAT and the European Helicopter Safety Implementation Team (EHSIT) the European JHSIT. EHSAT has been created late 2007 and EHSIT will be formed probably end of 2008. The work of EHSAT is divided regionally (see Section 6).

Comparison between the IHST and EHEST nomenclature is provided in Table 1 below.

	IHST	**EHEST**
Analysis Team	JHSAT	EHSAT = JHSAT for Europe
Implementation Team	JHSIT	EHSIT = JHSIT for Europe

Table 1 - IHST and EHEST analysis and implementation teams

5. European helicopter safety

This section presents an overview of helicopter accidents and fatal accidents based on data from the EASA Annual Safety Review. This review is published annually by EASA to inform the public of the general safety level in the field of civil aviation. The statistics are grouped according to type of operation and aircraft mass. The sources of the data are accident data obtained from ICAO and additional data from EASA Member States received in response to a specific request.

In the Annual Safety Review statistics the terms 'Europe' and 'EASA Member States' are considered as the 27 EU Member States plus Iceland, Liechtenstein, Norway and Switzerland. The region is assigned based on the State of Registry of the accident aircraft. Within the statistics, special attention is given to fatal accidents. This is because these accidents are internationally well documented. Since no comprehensive operational data (e.g. flying hours) is available for helicopters, only accident numbers are presented here.

Table 2 presents an overview of accident and fatality numbers for helicopters with a maximum certificated take-off mass over 2250 kg. The table shows that the number of fatal accidents in commercial air transport operations in Europe decreased from four in 2006 to one in 2007, and is below the average of the preceding decade. The number of fatal accidents for aerial work and general aviation operations with helicopters remained relatively stable.

Operation Type	Period	Number of accidents	Of which, fatal accidents	Fatalities on board
Commercial Air Transport	1996–2005 (average)	7	3	11
	2006 (total)	15	4	13
	2007 (total)	7	1	7
Aerial Work	1996–2005 (average)	6	2	3
	2006 (total)	7	1	6
	2007 (total)	8	1	0
General Aviation	1996–2005 (average)	4	1	2
	2006 (total)	8	2	7
	2007 (total)	4	3	10

Table 2 - Overview of total number of accidents and fatal accidents for EASA Member State registered helicopters only (maximum certificated take-off mass > 2250 kg).

In 2008 EASA requested accident data for light aircraft (mass below 2250 kg) from EASA Member States for the years 2006 and 2007. The number of accidents for helicopters is below the 2006 figures, see Table 3. However, some States did not provide 2007 data. This highlights the need to further improve harmonisation of data collection and data sharing among the European States. The majority of the light helicopter accidents in EASA Member States involve general aviation.

Operation Type	Period	Number of accidents	Of which, fatal accidents	Fatalities on board
Commercial Air Transport, Aerial Work & General Aviation	2006 (total)	90	8	16
	2007 (total)	80	11	21

Table 3 - Overview of total number of accidents and fatal accidents for EASA Member State registered helicopters only (maximum certificated take-off mass below 2250 kg).

6. European Helicopter Safety Team (EHSAT): coordinated regional efforts

EHSAT work is based on analysis of accident reports, and must not be confused with an accident investigation performed by the Accident Investigation Boards. EHSAT accident analysis is based on a standardised method featuring the use of taxonomies and expert judgement. Analysing an accident on all aspects requires a diverse and balanced set of competences. An analysis team should therefore present a balanced range of competences, bringing together representatives from the national aviation authority, accident investigation board, civil operator, helicopter equipment manufacturer or type certificate holder, pilot association, the general aviation community and, optionally, military organisation.
To tackle the variety of languages used in accident reports and optimise the use of resources, EHSAT has established regional teams. The use of local language also facilitates work within national teams, whilst for aggregation purposes all teams are requested to deliver results in English. In a regional team based organisation, relations between team members are often already established and the teams are well aware of local contexts. Regional teams can also facilitate implementation of future safety enhancements at regional level.
EHSAT regional teams have been formed in France, Germany, United Kingdom, Italy, Spain, Switzerland, Norway, Sweden, Denmark and Finland (forming the Nordic team), Ireland and Hungary. In addition, Poland, Romania, Latvia and Slovenia participate in EHEST. So far the countries covered by the regional teams account for more than 90% of the helicopters registered in Europe.

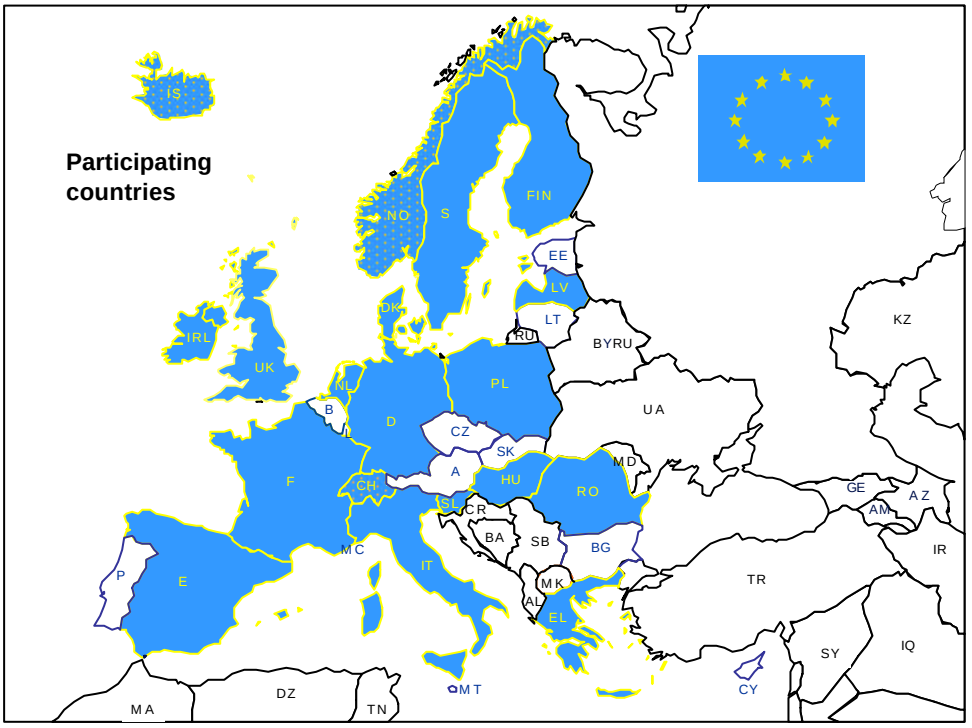

Figure 3 - Regional EHSAT teams (shown in blue)

Analyses performed at regional level are aggregated by a central EHSAT team composed of representatives from all regional EHSATs. The central EHSAT collects regional results and experiences, checks and aggregates results (quality control), revises the taxonomies, tool and process manual (standardisation), trains new regional teams, reports to the EHEST, and coordinates with the IHST / JHSAT.

7. Scope of analysis and methodology

The EHSAT analysis scope has been initially limited to accidents (definition ICAO Annex 13) reported by the accident investigation boards, with date of occurrence starting from the year 2000 onwards and State of occurrence located in Europe. In order not to interfere with

ongoing accident investigation board investigations, only those accidents are analysed where a final investigation report is available.
EHSAT is committed to ensuring that the analysis carried out in Europe is compatible with the work perform in the U.S. and by other analysis teams worldwide, so that the analyses can be aggregated at worldwide level. The methodology therefore was basically inherited from IHST / JHSAT, which itself adapted to helicopters the methodology originally developed in the late nineties by CAST for the analysis of fixed wing commercial air transport accidents.
The analysis is accomplished by a team of subject matter experts analysing what happened and why (the chain of events), and what might have been done differently (interventions) to prevent similar events in the future.

The analysis methodology features five steps:

1. Collect General Information
Several accident identification elements are collected for classification and analysis purposes such as Occurrence Date, State of Occurrence, Aircraft Registration, Aircraft Type, Type of Operation, Aircraft Damage, Injury Level, Phase of Flight, Meteorological Conditions, and Pilot and co-pilot flight experience.

2. Describe and Analyse the Accident
The analysis aims at identifying all factors that played a role in the accident. The underlying assumption is that accidents are the result of a chain of events that could have been prevented by altering or eliminating one or more of the "links" in the chain. Instead of focusing on an accident's "primary cause", the process focuses on identifying and removing one or more links in the accident causal chain, which can initiate hours, days or even weeks before the accident.
An event is defined as a decision, action or failure that contributed to or led to an occurrence. Events and conditions are presented in chronological order, and analysed one by one.
The method requires analysing what happened and why. Both are described in free text. 'What happened' provides factual description, using or summarising statements from the accident report, whilst identification of 'why' certain things happened is based on the analysis provided in the accident report or on aspects identified by the analysis team based on expert judgement.

3. Assign standardised codes to the factors
Standardised codes support accident aggregation and statistical analysis. Two models are used to assign codes: Standard Problem Statements and HFACS codes.

The Standard Problem Statements (SPS) taxonomy inherited from IHST/JHSAT has over 400 codes in 14 different areas. The structure consists of three levels: the first level identifies the main area of the SPS, and the second and third levels go into more detail. Level 1 categories are: Ground duties; Safety Management; Maintenance; Infrastructure; Pilot Judgement and actions; Communications; Pilot situation awareness; Part/system failure; Mission Risk; Post-crash survival; Data issues; Ground personnel; Regulatory; and Aircraft Design.
A single factor can be coded using more than one SPS.

Analysis /Why/Contributing factors	SPS nr.	level 1	level 2	level 3
The commander inadvertently entered IMC and probably became spatially disoriented	701005	Pilot situation awareness	Visibility/Weather	Inadvertent entry into IMC

Figure 4 - Example of Standard Problem Statement

The Human Factors Analysis and Classification System (HFACS, by D.A. Wiegmann and S.A. Shappell) contains over 170 codes in 4 main areas to code human factors and organisational aspects in detail. More information on the HFACS model is provided in the Appendix.

Analysis /Why/Contributing factors	HFACS nr.	level 1	level 2	level 3
The commander inadvertently entered IMC and probably became spatially disoriented	5305100	Preconditions - Condition of Individuals	Perceptual Factors	Spactial Disorientation 3 Incapacitating
	5001040	Unsafe Acts - Errors	Skill-based Errors	Overcontrol/Under control
	5501030	Supervision	Inadequate Supervision	Local Training Issue / Programs
	5603020	Organizational Influences	Organizational Process	Program and Policy Risk Assessment

Figure 5 - Example of application of HFACS code

4. Produce Intervention Recommendations

The next analysis step consists of identifying Intervention Recommendations (IRs). IRs are aimed at preventing factors, directly or more remotely involved, from reoccurring. One or several Intervention Recommendations (IRs) can be formulated for each SPS. IRs are freely generated and formatted in free text, using the diverse expertises in the analysis team. Using free text supports creativity.

Intervention recommendation (free text)	Intervention recommendation (coded on Category level)
All periodic base check flying tests carried out by the Operator should include the pilot's capability to fly by sole reference to flight instruments.	Training/Instructional
Regulations should address the hazards of flight in a Degraded Visual Environment (DVE).	Regulatory

Figure 6 - Example of Intervention Recommendations

5. Score Standard Problem Statements and Intervention Recommendations

To assist the implementation team, and ultimately the industry and authorities, to determine best action course, SPSs are scored on Validity and Importance and IRs on Ability and Usage. Validity is dependent on the level, quality and credibility of data and information available in the event report: SPSs associated with hypothetical events not supported by documented evidence in the accident reports are scored low on validity. Importance is the measure of the identified SPS importance in the event's chain of causal factors. Ability is the measure of how well an IR can mitigate an event's problem or contributing factor, assuming it performed exactly as intended. Usage is the measure of how confident we are that this intervention will be utilised and will perform as expected given this particular accident scenario.

Accident analyses provided by all regional teams are then analysed at aggregated level to present a European picture. Analysis results are then passed on to the implementation team, the EHSIT. Economic and other considerations are introduced in the EHSIT process to decide on best course of action and develop suitable safety enhancement action plans.

Several improvements to the original IHST / JHSAT methodology have been introduced by the EHSAT:

- Accident general information is coded using the ICAO ADREP 2000 taxonomy with the purpose of standardisation and of allowing exchange of information with the ECCAIRS[3] system.
- Reducing by 80% the helicopter accident rate in the next 10 years put emphasis on General Aviation operations and human factors. Therefore, in addition to the standard SPS taxonomy by JHSAT, pilot or flight crew human factors and operator organisational factors are coded using the Human Factors Analysis and Classification System (HFACS) developed by Wiegmann and Shappell.
- Alternatively, HFACS ME is used to code maintenance related human factors. HFACS ME is the coding system for maintenance personnel and organisation developed by the U.S. Naval Safety Center. The system features the following main categories (from local to remote): Maintainer Acts, Maintainer Conditions, Working Conditions, and Management Conditions.
- Support to IR generation: analysts are invited to go through all flight phases and to target various aspects such as regulations, design and other technical factors (e.g., weight and balance), certification, operations; procedures, staffing, qualification, licensing and training, weather, winds, turbulences and other environment factors, working environment factors, workload, fatigue, attitudes, national, regional, company and professional culture and other human factors, production, commercial and market factors, management, Safety Management Systems (SMS) and safety culture, and accident investigation aspects.
- Support to IR classification and analysis: IR free text descriptions are coded using a standard IR taxonomy.

9. Recent developments and preliminary results

In 2007 efforts have been directed at the work of the EHSAT. The main topics were the continued development of the EHSAT regional analysis teams and the development of the analysis tool and process manual supporting accident analysis.
The first operational version of the analysis tool and process manual were issued and circulated to the regional teams in October 2007. Since, the regional teams have started and proceeded with the accident analysis phase, and results are being aggregated.
Around 200 accident analyses are expected to be completed by the time this RAeS European Rotorcraft Forum will take place. The analysis of these results is underway.
Preliminary results will be presented at the one-day EHEST Conference of 13 October in Estoril, one day before HELITECH (http://www.helitecheurope.com/) opens its doors to visitors. The EHEST Conference will address areas such as the European-specific accident analysis method adapted from IHST, analysis results and intervention suggestions and how to prioritise these and recommend measures to reduce the accident rate.
Delegates from European regulatory bodies and across operator communities are warmly invited to attend[4].
Meanwhile, U.S. analysis results can be consulted on the IHST website. The U.S. team indeed has started analysing U.S. accidents process one year and a half before the European team. The link to JHSAT report "U.S. Joint Helicopter Safety Team: Year 2000 Report to the International Helicopter Safety Team" published is September 2007 is provided in the References section below.
The U.S. JHSIT has also been launched and has started reviewing and working on the U.S. JHSAT results. The U.S. JHSAT analysed 197 reported helicopter accidents for the year 2000 as recorded in the NTSB's U.S. database. The U.S. JHSAT found that a major contributing

[3] ECCAIRS stands for European Coordination Centre for Accident and Incident Reporting Systems. The mission of ECCAIRS is to assist National and European transport entities in collecting, sharing and analysing their safety information in order to improve public transport safety. The ECCAIRS Reporting System is composed of various applications forming together a suite of products allowing organisations to create, maintain and deploy e repository of accident and incident reports.

[4] Online registration is provided on http://www.ihst.org/.

factor in most accidents was the *failure to adequately manage known risks:* due to the lack of a systematic process, including leadership and accountability, operators did not adequately prioritise and address the risks that lead to most accidents. Consequently a Safety Management Toolkit for helicopter operators was developed and is available on the IHST website. The toolkit targets mainly small operators, who most need support. In line with ICAO and FAA guidance and requirements, the IHST SMS toolkit supports an all risks control and management strategy.

10. Conclusion

The IHST has set a goal of reducing helicopter accidents worldwide by 80% by 2016.
As part of the ESSI, the EHEST has been formed to play its part in achieving this goal in Europe. This team combines stakeholders from across the European helicopter community. To provide the basis for data-driven safety intervention planning, the first major activity was to then launch the EHSAT which has successfully created a network of regional safety analysis teams across Europe. These regional teams have already been able to analyse over 200 helicopter accident reports issued by a wide range of national Accident Investigation Boards from across the continent. The data from this first batch of analyses is currently being aggregated by a central EHSAT team and will be reported at a specially organised conference on 13 October 2008 at the HELITECH site.
While this work is compatible with the methodology adopted by the equivalent team analysing accidents in the U.S., the European initiative has demonstrated some major improvements in methodology. The main changes were the introduction of the Human Factors Analysis & Classification Scheme and coding that introduces compatibility with ICAO ADREP 2000 and ECCAIRS.
The implementation team EHSIT will then review the EHSAT analysis and develop suitable safety enhancement action plans. Action plans may address both the regulators and the industry. Economic and other considerations are introduced in the EHSIT process to decide on the best course of action.

Acknowledgements
The contribution of all organisations participating in the EHEST initiative and the support from the U.S. IHST team is greatly acknowledged.

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IHST: http://www.ihst.org/
JHSAT Year 2000 analysis report: http://ihst.org/images/stories//usJHSAT2000Report.pdf
IHST SMS Toolkit: http://ihst.org/images/stories/SMStoolKit/ihst-sms%20tool.pdf
HFACS: http://hfacs.com/
Department of Defense HFACS by U.S. Naval Safety:
http://safecen.navy.mil/hfacs/downloads/hfacs.pdf
Human Factors Anlaysis by U.S. Naval Safety Center:
http://www.safetycenter.navy.mil/aviation/aeromedical/downloads/human_factor_analysis_flip-book.pdf

Appendix: HFACS by Wiegmann and Shappell
HFACS, the Human Factors Analysis and Classification System (HFACS) developed by Wiegmann and Shappell, is a multi layer taxonomy system aimed at analysing human factors. HFACS can be used in various activity domains: aviation, medicine, process industry, etc. Based on the 'Swiss cheese model' by J. Reason, it provides the following categories (from local to distant):

- *Unsafe acts of operators (e.g. pilot/flight crew):* Acts are those factors that are most closely tied to the mishap, and can be described as active failures or actions committed by the operator that result in human error or unsafe situation (errors and violations);

- *Preconditions for unsafe acts*: Preconditions are factors in a mishap if active and/or latent preconditions such as conditions of the operators, environmental or personnel factors affect practices, conditions or actions of individuals and result in human error or an unsafe situation (such as adverse mental states (fatigue, overconfidence,…), physical/mental limitations, crew resource mismanagement, personal readiness);
- *Unsafe supervision*: factors that can be traced back to supervision;
- *Organisational influences*: These latent conditions generally involve issues related to Resource/Acquisition Management, Organisational Climate, and Organisational Processes. Organisational Influences are factors in a mishap if the communications, actions, omissions or policies of upper-level management directly or indirectly affect supervision practices, conditions or actions of the operator(s) and result in system failure, human error or an unsafe situation.

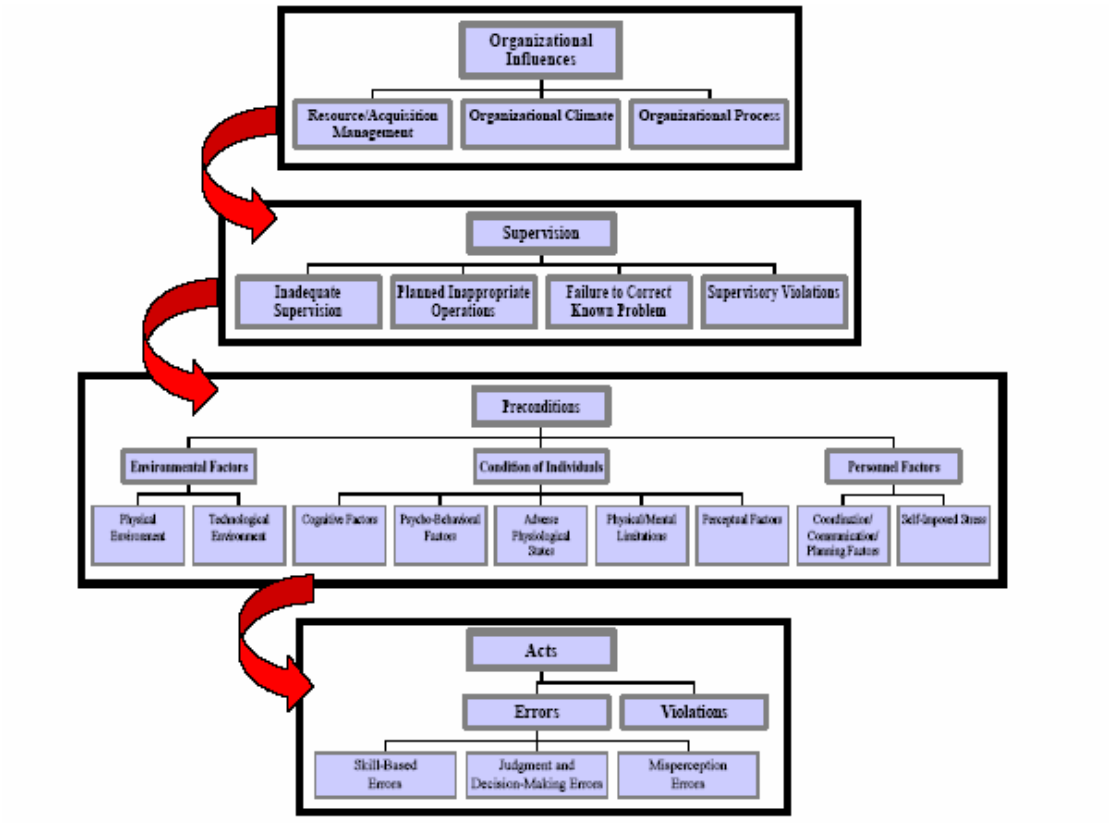

Figure 7 - HFACS model by Wiegman and Shappell