Nationaal Lucht- en Ruimtevaartlaboratorium
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Executive summary

European HElicopter Safety Team (EHEST): Mapping Safety Issues with Technological Solutions

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The European Helicopter Safety Team (EHEST) took off in 2006 as the helicopter component of the European Strategic Safety Initiative (ESSI) and the European branch of the International Helicopter Safety Team (IHST). EHEST is committed to the IHST objective: reduce the worldwide helicopter accident rate by 80 percent by 2016. Accidents are analysed to derive intervention recommendations, which are then transferred to the European Helicopter Safety Implementation Team (EHSIT). The EHSIT has formed various Specialist Teams (ST's) to develop tools and other safety enhancing products and material in the form of safety leaflets, videos, guides, Standard Operating Procedures and toolkits.

Technology is not high on the list of intervention recommendations, but can provide a variety of solutions to address safety issues, prevent different types of accidents or increase survivability.

Description of work
To assess the benefit of technologies on mitigating safety issues, the Specialist Team Technology has developed a dedicated tool (technology - safety issues matrix). The tool mutually links the results of the accident analysis (accident causes and their contributing factors) to R&D and technological developments.

Results and conclusions
The work done so far is just the start of the process. The lay-out of the matrix has been finalised and a description of work and process manual have been drafted. So far only a rather limited number of technologies have been listed and scored.

Applicability
Based on the preliminary results it can already be concluded that the concept of the technology-safety issues matrix itself is a powerful tool to prioritise technologies on the basis of their safety merit.

This report is based on a presentation held at the 37th European Rotorcraft Forum, Gallarate (Italy), September 13-15, 2011.

European HElicopter Safety Team (EHEST):
Mapping Safety Issues with Technological Solutions

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Summary

The European Helicopter Safety Team (EHEST) took off in 2006 as the helicopter component of the European Strategic Safety Initiative (ESSI) and the European branch of the International Helicopter Safety Team (IHST). EHEST is committed to the IHST objective to reduce the worldwide helicopter accident rate by 80 percent by 2016, with emphasis on improving European safety. Accidents are analysed to derive intervention recommendations, which are transferred for implementation to the European Helicopter Safety Implementation Team (EHSIT). The EHSIT has formed various Specialist Teams (ST's) to develop tools and other safety enhancing products and material in the form of safety leaflets, videos, guides, Standard Operating Procedures and toolkits.

Of the accidents analysed: 140 accidents (45%) involve General Aviation operations; 103 accidents (33%) involve Aerial Work operations; 59 (19%) were Commercial Air Transport operations; and 9 (3%) involved State Flights. Most accidents analysed occurred during the en route phase of flight.

Technology is not high on the list of intervention recommendations but can provide a variety of solutions to address safety issues, prevent different types of accidents or increase survivability.

To assess the benefit of technologies on mitigating safety issues, the Specialist Team Technology has developed a dedicated tool (technology - safety issues matrix). The tool mutually links the results of the accident analysis (accident causes and their contributing factors) to R&D and technological developments. The work done so far is just the start of the process. The lay-out of the matrix has been finalised and a description of work and process manual have been drafted. Only a rather limited number of technologies have been listed and scored so far. Based on the preliminary results it can already be concluded that the concept of the technology-safety issues matrix itself is a powerful tool to prioritise technologies on the basis of their safety merit.

Contents

Abbreviations

AAIB	Air Accident Investigation Branch
AHS	American Helicopter Society
AIB	Accident Investigation Board
APYTHEL	Asociación de Pilotos y Técnicos de Helicópteros de España
BEA	Bureau d'Enquêtes et d'Analyses
BFU	Bundesstelle für Flugunfalluntersuchung
CAA	Civil Aviation Authority
CAST	Commercial Aviation Safety Team
CHC	Canadian Helicopter Corporation
CICT	CAST/ICAO Common Taxonomy
CICTT	CAST/ICAO Common Taxonomy Team
DGAC	Direction Générale de l'Aviation Civile
DLR	Deutsches Zentrum für Luft- und Raumfahrt
DVE	Degraded Visual Environment
EASA	European Aviation Safety Agency
EGAST	European General Aviation Safety Team
EHA	European Helicopter Association
EHAC	European HEMS & Air Ambulance Committee
EHEST	European Helicopter Safety Team
EHOC	European Helicopter Operators Committee
EHSAT	European Helicopter Safety Analysis Team
EHSIT	European Helicopter Safety Implementation Team
ENAC	Ente Nazionale per l'Aviazione Civile
ERF	European Rotorcraft Forum
ESSI	European Strategic Safety Initiative
FOCA	Federal Office of Civil Aviation
GAPAN	Guild of Air Pilots & Air Navigators
HEMS	Helicopter Emergency Medical Service
HFACS	Human Factors
HFDM	Helicopter Flight Data Monitoring
HOMP	Helicopter Operations Monitoring Program
HUMS	Health and Usage Monitoring System
ICAO	International Civil Aviation Organisation
IHST	International Helicopter Safety Team
IR	Intervention Recommendation

JHSAT	Joint Helicopter Safety Analysis Team
NASA	National Aeronautics and Space Administration
NLR	Nationaal Lucht- en Ruimtevaartlaboratorium (National Aerospace Laboratory)
OPS	Operations
RAeS	Royal Aeronautical Society
R&D	Research & Development
RFID	Radio Frequency Identification
RPM	Revolutions Per Minute
SMS	Safety Management System
SOP	Standard Operating Procedure
SPS	Standard Problem Statement
ST	Specialist Team
TRL	Technology Readiness Level

1 Introduction

The historic and current helicopter accident rate is (too) high. The International Helicopter Safety Team (IHST) (Ref. 1) was launched in 2005 with the objective to reduce the helicopter accident rate by 80% worldwide by 2016. The European Helicopter Safety Team (EHEST) contributes to this effort. Within the EHEST initiative accidents are analysed to derive intervention recommendations, which are transferred to the European Helicopter Safety Implementation Team (EHSIT). The EHSIT has formed various Specialist Teams (ST) to develop tools and other safety enhancing material to address the top safety issues.

An interesting question was asked at the 2009 edition of the European Rotorcraft Forum (ERF): *"What kind of safety benefits can we expect from (existing and new) technologies and how can the EHEST results be used to assess the safety importance of technologies and contribute to orienting their development?"* This question sparked the creation of a ST on Technology. This team recently developed a Technology – Safety Issues Matrix to map safety issues with technological solutions.

This paper describes in the EHEST organisation the main analysis results, the safety products under development and in more detail the Technology – Safety Issues Matrix as developed by the ST Technology, and the way forward. This paper is finalised with some concluding remarks.

2 EHEST Organisation

The European Helicopter Safety Team (EHEST) took off in 2006 as the helicopter component of the European Strategic Safety Initiative (ESSI) (Ref. 2) and the European branch of the International Helicopter Safety Team (IHST) (Ref. 1). EHEST is committed to the IHST objective to reduce the worldwide helicopter accident rate by 80 percent by 2016, with emphasis on improving European safety.

EHEST brings together helicopter manufacturers, operators, authorities, helicopter and pilots associations, research institutes, accident investigation boards and a few military operators from across Europe. EHEST has members from organisations including Eurocopter, AgustaWestland, new EHA, EHOC, EHAC, CHC Helicopter, Shell Aircraft Ltd, British Petroleum, EASA, UK CAA, DGAC France, BEA France, ENAC Italy, CAA Norway, FOCA Switzerland, RAeS/GAPAN, Irish CAA and AAIB, AIB Hungary, UK AAIB, BFU Germany, QinetiQ, NLR, DLR, AIB and CAA Spain, APYTHEL, Swiss Helicopter Association, and European

Cockpit Association (the complete list is available on the EHEST website). In total the initiative counts around 50 organisations and 130 participants, of which around 70 are actively involved in the analysis and implementation work. EHEST addresses the broad spectrum of helicopter operations across Europe, from Commercial Air Transport to General Aviation, and flight training activities.

The initiative is organised as follows:

- a strategic and decision making body: the EHEST, co-chaired by EASA, Eurocopter, and EHOC;
- an analysis team: the European Helicopter Safety Analysis Team (EHSAT), co-chaired by EASA and AgustaWestland;
- an implementation team: the European Helicopter Safety Implementation Team (EHSIT), co-chaired by Eurocopter, new EHA/INAER, and the Irish CAA. The EHSIT is sub-divided in five Specialist Teams (STs): ST Training, ST Operations and SMS, ST Regulation, ST Maintenance and ST Technology.;
- a communication team: the EHEST Communication Working Group. Led by CHC Helicopters this team has defined a strategy to address General Aviation and the small operators, addressing the global helicopter community through publication in professional journals (Ref. 3) and linking to international forums such as AHS (Ref. 4), ERF (Ref. 5), and the EASA Rotorcraft Symposiums (Ref. 6).

3 Analysis Main Results

The EHSAT analyses accident investigation reports and, from this analysis, identifies suggestions for safety enhancement called intervention recommendations.

To tackle the variety of languages in the accident reports and account regional characteristics, EHSAT regional teams have been formed in France, Germany, United Kingdom, Italy, Spain, Switzerland, Norway, Sweden, Finland, Ireland Hungary and the Netherlands. So far the countries covered by the regional teams account for more than 90% of the helicopters registered in Europe. The analysis of the different regional teams is consolidated at European level by the EHSAT Core Team composed of all regional team leaders and EASA. This initiative is unique in its efforts to prepare a Europe-wide analysis of helicopter accidents.

The EHSAT will ultimately also be involved in the measuring of results and effectiveness of safety improvements developed within the initiative.

Results were published in October 2010 in the Final Report - EHEST Analysis of 2000-2005 European Helicopter Accidents (Ref. 7) available on the EHEST website.

Results are based on the analysis of 311 helicopter accidents in this timeframe 2000-2005. The scope of the data set is accidents that occurred within an EASA Members State where a final investigation report from the Accident Investigation Board (AIB) has been issued.

Of the accidents analysed: 140 accidents (45%) involve General Aviation operations; 103 accidents (33%) involve Aerial Work operations; 59 (19%) were Commercial Air Transport operations; and 9 (3%) involved State Flights. Most accidents analysed by the EHSAT occurred during the en route phase of flight.

The accident analysis aims at identifying all factors, causal or contributory, that played a role in the accident. Factors are coded using the Standard Problem Statements (SPS's) taxonomy adopted from the US Joint Helicopter Analysis Team (JHSAT). The top three SPS categories are 'Pilot judgement and actions', 'Safety Culture and Management' and 'Ground duties' (Figure 1).

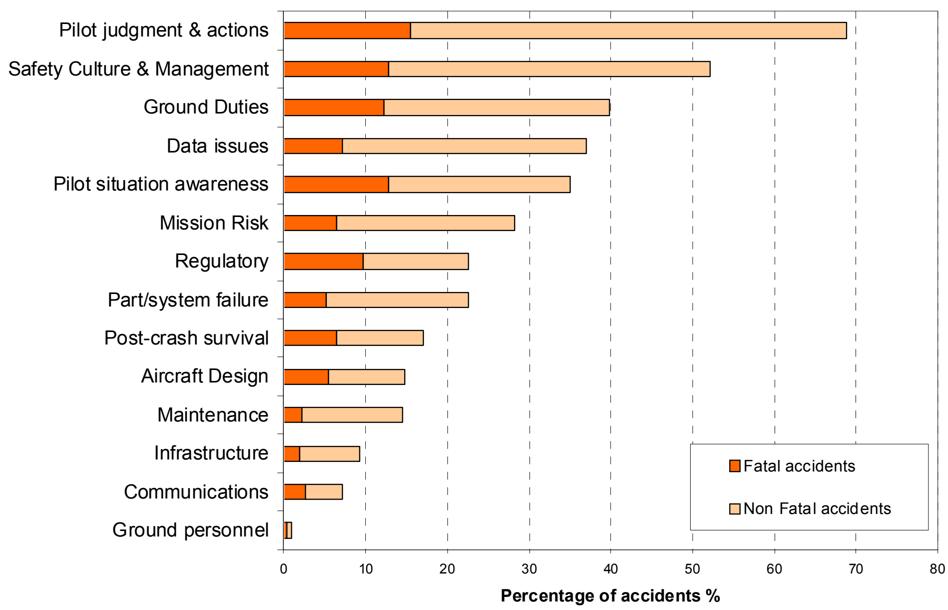

Figure 1 Standard Problem Statement (SPS) Analysis Results: % of accidents where SPS has been identified at least once in the accident dataset 2000-2005

Technology is not high on this list. But technology provides a variety of solutions that address these safety issues and contribute to prevent different types of accidents or to increase survivability.

Different SPS patterns were observed for Commercial Air Transport, Aerial Work and General Aviation and several presentations in international Conferences provide typical accident scenarios for illustration purposes.

To address Human Factors in a more structured manner, EHSAT also used a second taxonomy and classification system, namely HFACS by Wiegmann and Shappell (Ref. 8). HFACS features four layers: unsafe acts, preconditions of unsafe acts, unsafe supervision, and organisational influences. Focusing on unsafe acts only would be like focusing on symptoms without looking at the disease that caused them. The report provided interesting information on why ‘Pilot judgement and actions’ and ‘Pilot situation awareness’ figures were amongst the top three accident factors. E.g. using a helicopter for aerial work can result in pushing the helicopter and pilot towards the limits of their capabilities, and operating close to terrain or obstacles. Therefore aerial work is highly prone to accidents related to the two mentioned categories

EHSAT also derived intervention recommendations from the analysis. The top categories are ‘Safety Management’, Safety Culture and Operations’, ‘Training and Instruction’, ‘Regulatory Matters’, ‘Data and Information System’, ‘Maintenance’ and ‘Aircraft System and Equipment Design’. Each of these subjects led to the creation of a dedicated team: five in the form of an EHSIT Specialist Team (ST) and one ‘Data and Information System’ in the form of an international Helicopter Flight Data Monitoring (HFDM) initiative, whose presentation falls outside the scope of this paper.

4 Safety Products under Development

The EHSIT Specialist Teams develop various safety products. All products are selected because of their potential to resolve the top safety issues identified. Within the different teams the following products are developed or under development. All finalised products are published on the EHEST website (available via Ref. 2).

- Safety leaflets: a leaflet entitled Safety Considerations was published in 2010. This leaflet addresses important subjects such as Vortex Ring State, Loss of Tail Rotor Effectiveness, dynamic and static rollover, and loss of visual references. Additional leaflets addressing Helicopter Airmanship, Risk Assessment in Training, Off-Airfields Landing Site, Rotor RPM Management and Autorotation, and Planning and Decision Making are under development.

- Videos: a video on Flying in the Degraded Visual Environment (DVE) has been published. Videos on Helicopter Passengers Management and Helicopter Mission Preparation Including Off-Airfield Landing are under development.
- Guides: development of a Helicopter Flight Instructor Guide that addresses Threat and Error Management is planned.
- Standard Operating Procedures (SOP's): are under development for Helicopter Emergency Medical Service (HEMS) operations and more are considered for Aerial Work operations.
- Tools and toolkits: a Maintenance Toolkit has been published on the IHST and EHEST websites. This Toolkit enables operators to assess their existing maintenance activities against guidelines for maintenance procedures, quality assurance, training and competence assurance, record keeping, HUMS, maintenance support equipment and fuel systems. The toolkit shows best practice used by many operators throughout the world. A tool for pre-flight Risk Assessment is under development as well as a European Safety Management System (SMS) toolkit. The latter is in the form of a European Helicopter SMS Manual and is based on the EASA Opinion OPS recently published on the EASA website. A tool to assess the benefit of technologies on mitigating safety issues is also under development (more information on this tool in the remainder of this paper).

5 Technology – Safety Issues Matrix

One of the previously mentioned EHSIT Specialist Teams is the ST Technology, which has been created to assess the benefit of technologies on mitigating safety issues.

5.1 Background

Rotorcraft technological developments have not been as fast as, for instance, fixed wing jet fighter developments. Current technologies are focussing on 3rd generation rotorcraft versus 5th generation fighter aircraft. Lack of investments has hampered technological breakthroughs. Technologies that may have been in use on fixed wing aircraft for many years are transferred to rotorcraft at a (much) later date. Only few technologies have been developed specifically for rotorcraft.

An interesting question was asked at the 2009 edition of ERF (Ref. 5): *"What kind of safety benefits can be expected from (existing and new) technologies and how can the EHEST results* *be used to assess the safety importance of technologies and contribute to orientating their development?"*

Technologies provide a variety of solutions that directly or indirectly address the safety issues identified in the EHSAT analysis and that can contribute to prevent accidents or to increase survivability. Such technologies include for example predictive ground collision avoidance using digital terrain referenced navigation, light Helicopter HOMP system, deployable system for crash–load attenuation, and integration of RFID technologies in the helicopter maintenance process.

It was decided that the ST Technology would develop a tool that links the results of the EHSAT analysis (incident / accident causes and their contributing factors) to R&D and technological developments.

Other renowned organisations are working along comparable lines. The US Military expressed their view at the 2010 International Helicopter Safety Symposium (Ref. 9), stating that both the rotorcraft loss rates and fatality rates are far too high. The majority of US military helicopter losses is attributable to mishaps (and not to combat hostile actions), with human factors and engine/power train failures being the leading causes. The AHS Technical Council decided at its October 2010 meeting to undertake a special assignment to characterise and contextualise Rotorcraft Technology Generations, with the goal to postulate a shared future vision of vertical flight technology development. The Council observed that the rotary wing community needs to dramatically improve its ability to convey historical and future technology advances to their stakeholders.

5.2 Specialist Team on Technology

Technology can be a powerful means to improve safety, as it brings solutions to known safety problems, including those of operational nature. The EHSIT Specialist Team (ST) Technology has been created in March 2011 to assess the potential of technologies to mitigate safety issues. The main goal of the team is to list technologies and link them with accident causes and contributing factors as identified in the EHSAT analyses.

The main tasks of the team, as described in the Description of Work, are the following:

- define, develop, and update a specific tool;
- list technologies of interest;
- rate the technologies;
- disseminate the results;

- continuous updating.

A basic and very important principle is to involve a range of stakeholders and expertise in the process. The team should ideally assemble different backgrounds, including partners from the following fields:

- manufacturers (airframe and equipment manufacturers);
- research organisations;
- universities;
- authorities.

Currently the team consists of the following organisations:

- DLR, research organisation;
- Eurocopter Deutschland (representing Eurocopter Group), airframe and equipment manufacturer;
- NLR, research organisation;
- ONERA, research organisation;
- Rockwell Collins, equipment manufacturer.

Other partners such as UK CAA, EHAC and City University, London have shown interest, but have not yet confirmed participation. Cooperation with IHST is envisaged. Teaming with other ESSI teams, e.g. the European General Aviation Safety Team (EGAST), could also be considered. More participants are welcomed.

5.3 Qualitative Description

The ST Technology has developed a tool, consisting of an Excel-file containing two tab sheets. The first sheet contains a list of technologies (technology database) and the second sheet contains a technology – safety matrix providing rows with technologies and columns with Standard Problem Statements (SPS's) and accident categories developed by the CAST/ICAO Common Taxonomy Team (CICTT) (Ref. 10).

As the total number of SPS items is rather large, a selection had to be made. The current selection contains the top 20 (level 2) SPS items revealed by the EHSAT analysis of more than 300 accidents.

The process consists of two steps:

- list relevant technologies: the technology matrix will be filled with relevant technologies for the period 2006 – present;

- determine technology scores: the listed technologies will be scored against each of the SPS and CICT items.

Both steps will have to be repeated at regular intervals. Technologies can evolve and their applicability can change with time, and so will the scores. These two steps are independent and should ideally be carried out by independent teams. Each step will be described in detail.
The process is started by making a listing of technologies that can possibly mitigate safety issues. The basic criteria for the selection of technologies are:

- new (emerging) technologies;
- existing technologies not yet used on helicopters;
- existing technologies used on large helicopters but not yet on small helicopters.

The exact process on how to select appropriate or relevant technologies is still in definition. At the moment this is left to the individual contributors. Practical sources identified are a.o. papers presented at symposia and alike, press releases, interviews, etc. In a later stage the scope can be expanded to include other technologies/concepts (for instance those which are in a rather premature development stage).

All technologies are listed on the ‘Technology database’ tab sheet. This sheet contains a.o.:

- Technology name;
- Category (selected from a drop-down box);
- Short description;
- Technology Readiness Level (TRL), Ref. 10;
- Reference (hyperlink to a paper, presentation, web page or other document).

A linkage between the technology listing sheet and technology rating sheet is provided in the form of ‘go to’ hyperlinks. When clicked it automatically sets the focus to the relevant technology in the other sheet. This functionality is automatically included when the file is opened or when using the update link button (all such functionalities use Visual Basic).

Listed technologies can be imported into the technology rating sheet using an Import Technology button. These will then be grouped by their assigned category. For each technology the tool will perform a check to determine whether or not that technology is already available on the technology rating tab sheet. If not, the technology is automatically copied to that sheet under the assigned category.

To assist the industry and regulatory Agencies in determining the most advantageous technology for each safety issue, it is necessary to provide scorings. The process for this evaluation involves two rating elements: Impact and Usability.

When a relevant rating cell is activated a window pops-up providing guidance through the process.

Each Technology must be rated against each SPS and CICT category regarding ‘Impact’ and ‘Usability’ on a scale from 0 to 5:

- Impact (see Table 1) is a measure of how well the particular technology can mitigate the specific SPS or CICT category.

Table 1 Impact scoring

Impact:	
0	None
1	Slightly effective
2	Moderately effective
3	Quite effective
4	Completely effective, but with limited applicability (e.g. only for Aerial work, GA, etc.)
5	Completely effective

- Usability (see Table 2) is the measure indicating whether the technology can be utilised for a specific SPS or CICT category (taking into account the TRL level) and against what (relative) cost.

Table 2 Usability scoring

Usability:	
0	Not usable now, nor in the (near) future
1	Not usable now, possibly in the future (> 5 years)
2	Not usable now, possibly in the near future (<5 years), but at relative high cost
3	Not usable now , possibly in the near future (<5 years) at relative low cost
4	Now usable (TRL ≥ 8) but at relative high cost
5	Now usable (TRL ≥ 8) at relative low cost

The individual ratings for Impact and Usability are automatically summed to arrive at a total score (0-10). If either one of the ratings is zero, the overall score also becomes zero. This method is considered intuitive, enabling a quick interpretation of the results. Colours as indicated in Table 3 below will automatically appear once the score is available.

Table 3 Scoring colour code and meaning

Score	Colour	Meaning
0-3	(Red)	Not or slightly promising
4-6	(Amber)	Moderately promising
7-10	(Green)	Highly promising

Figure 2 provides an example of several scored technologies (included for information only). To assist the further analysis and possible future re-scoring of technologies, the initial rating elements (i.e. Impact and Usability), including the date and time of rating are automatically included as comment in the relevant cell. The comment becomes visible when hovering over a specific cell.

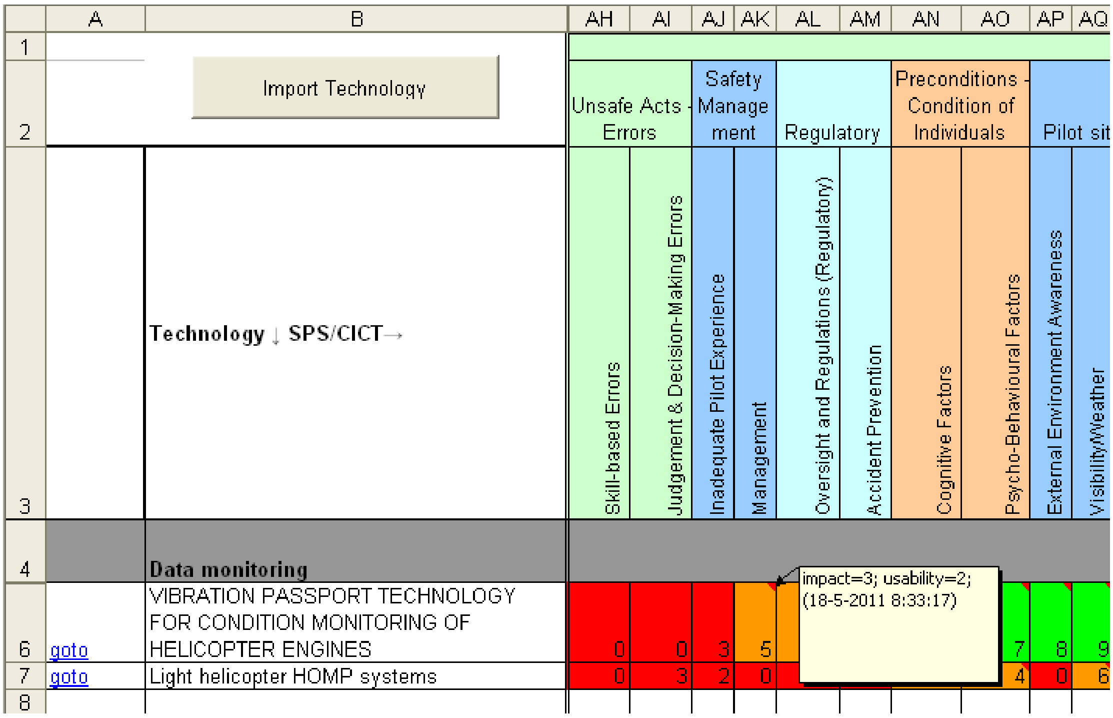

Figure 2 Technology rating screen preview (example only)

5.4 Usability of Results

Once the scores are available, the results on the 'Technologies - Safety Matrix' tab sheet can be used in three ways:

- *Which technology (best) addresses a specific safety problem.* This can easily be determined by identifying the technology with the (highest) ratings associated with a specific SPS or CICT category. By scanning the coloured cells one can easily identify the highest rated technologies. This has the clear safety benefit of identifying specific technologies with the highest potential in mitigating a certain (or the most) safety issues. These technologies can then be promoted to make them more widely available.
- *Where can safety benefits be expected from a technology.* If a new technology is introduced it is predominantly aimed at a specific problem. By rating this technology against the top SPS's and CICT categories it could become clear that the technology also can be used to mitigate other (lesser known) safety issues. For instance, a manufacturer has developed a sensor aiming to mitigate visibility / weather related problems. Through this rating system other safety issues can come to light that, to a varying degree, could be mitigated by this sensor (e.g. mitigate unsafe flight profiles and aid landing procedures).
- *Which safety problems are not (sufficiently) addressed by technology.* Once the matrix is filled with rated technologies, safety issues lacking (sufficiently promising) technological mitigation means stand out as a result of the colours used. Once these blanks are identified manufacturers, research organisations and alike can be supported to address these specific safety issues. This could create new incentives and justification to perform research and to develop mitigating technologies.

6 Interim Results

This paper describes the status of the EHSIT ST Technology and its work at the beginning of July 2011. The work done so far is just the start of the process. The lay-out of the matrix has been finalised, and a Description of Work with a process manual have been drafted. Only a rather limited number of technologies have been listed and scored so far. Examples of some promising technologies are:

- Predictive ground collision avoidance using digital terrain referenced navigation; a system prototype has been demonstrated in an operational environment; the system will bring improved situational awareness to the pilot, thereby reducing his workload.
- Flight data monitoring for light helicopters (Helicopter Operations Monitoring Program, HOMP); the system records predefined events, thereby helping to set priorities on

training and maximising awareness of potential dangers; the actual system has been flight proven through successful mission operations on various helicopter types.
- Synthetic vision system (vision augmentation); the system will bring improved situational awareness to the pilot, through a 3D terrain and obstacles rendering on a head-up or helmet-mounted display; a prototype of this system has been demonstrated in a representative environment.

Based on the preliminary results it can already be concluded that the concept of a technology-safety issues matrix is a powerful tool to prioritise technological solutions from a safety perspective. At a glance the scored results can be interpreted and the effort be focussed on developing the most promising technologies.

7 Way Forward

The question from the 2009 ERF (what kind of safety benefits can be expected from existing and new technologies?) is still valid. The helicopter accident rate is (too) high, but may be reduced in part through the use of technologies. The process of mapping safety issues with technological solutions has only recently started. More work will be carried out in the coming months, and beyond. The technology listing tab sheet must be filled with all kinds of relevant technologies. And the technology rating tab sheet must be filled with their total scores against the SPS's and CICT categories. Results of this process are expected to be published in future ERF editions or similar forums. The work is challenging. Other organisations willing to join the effort are welcomed.

8 Concluding Remarks

The European Helicopter Safety Team (EHEST) started their work in 2006 as the helicopter component of the European Strategic Safety Initiative (ESSI) and the European branch of the International Helicopter Safety Team (IHST). The team is committed to the IHST objective to reduce the helicopter accident rate by 80 percent by 2016 worldwide, with emphasis on improving European safety.

Within EHEST the European Helicopter Safety Analysis Team (EHSAT) analyses accident investigation reports and identifies suggestions for safety enhancement. The accident analysis aims at identifying all factors, causal or contributory, that played a role in the accident. The top three categories identified for the 2000-2005 period are ‘Pilot judgement and actions’, ‘Safety Culture and Management’ and ‘Ground duties’.

Technology is not high on this list, but it can provide a variety of solutions that address these safety issues and contribute to prevent different types of accidents or to increase survivability. To assess the benefit of technologies on mitigating safety issues, the EHSIT Specialist Team Technology has developed a dedicated tool (technology - safety issues matrix). The tool mutually links the results of the EHSAT analysis (accident causes and their contributing factors) to R&D and technological developments.

The work has only recently started but preliminary results show that the concept of a technology-safety issues matrix is a powerful tool to prioritise technological solutions from a safety perspective. But in the end it will be the operators who have to accept and apply those solutions.

References

1. http://www.ihst.org/
2. http://www.easa.europa.eu/essi/
3. Masson, M. and Trapp, D. (2010). A Year For Flight Safety. 4Rotors, the European Rotor Journal, No. 2, p. 10-14.
4. Masson, M., Van Hijum, M., Evans, A. (2009). Human factors in helicopter accidents: results from the analysis performed by the European Helicopter Safety Analysis Team within IHST. AHS 65th Annual Forum and Technology Display, Grapevine (Texas), United States, May 27-19.
5. Masson, M., Van Hijum, M., Bernandersson, M., and Evans, A (2009). The European Helicopter Safety Team (EHEST): 2008/2009 achievements. European Rotorcraft Forum (ERF), Hamburg, Germany, September 22025.
6. Black, J., Masson, M., Steel, J., and Trapp, D. (2010). The European Helicopter Safety Team (EHEST): 2010 Achievements and Plans. 4th EASA Rotorcraft Symposium, 8-9 Dec 2010, Cologne. http://www.easa.europa.eu/ws_prod/g/g_events.php
7. Van Hijum, M. and coll. (2010). Final Report - EHEST Analysis of 2000-2005 European Helicopter Accidents. http://www.easa.europa.eu/essi/ehestEN.html
8. Shappell, S.A. and Wiegmann, D.A. (2000). The Human Factors Analysis and Classification System – HFACS. DOT/FAA/AM-00/7, U.S. Department
9. Couch M., Lindell D. Study on Rotorcraft Safety and Survivability. International Helicopter Safety Symposium, October 3-4, 2010.
10. http://intlaviationstandards.org/
11. Mankins, J.C. (1995). Technology Readiness Levels - a white paper, NASA.