Exploitation Plan

B. Dziugiel, M. Maczka, W. Miksa (ILOT), S. Bravo Munoz (APSYS), L.J.P. Speijker (NLR), T. Longhurst (CAAi), J.P. Magny (JPM)

ASCOS safety certification

The objective of this deliverable is to ensure that the project results of the EC Project ASCOS are exploited to the maximum extent possible, by providing the necessary preconditions for successful exploitation. Such preconditions are basically feasibility, efficiency and acceptability.

Coordinator	L.J.P. Speijker (NLR)
Work Package Manager	M. Heiligers (CertiFlyer)

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Organisation	Names
European Commission	M. Kyriakopoulos
NLR	L. Speijker, A. Rutten, M.A. Piers, P.J. van der Geest, A.L.C. Roelen, J.G. Verstraeten, A.D. Balk, E. van de Sluis, M. Stuip
Thales Air Systems GmbH	G. Schichtel, J.-M. Kraus
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CertiFlyer	G. Temme, M. Heiligers
Avanssa	N. Aghdassi
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JPM	J. P. Magny
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Institute of Aviation	K. Piwek, A. Iwaniuk, B. Dziugiel, M. Maczka, W. Miksa
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Acronyms

Acronym	Definition
ACFT	Aircraft
AMC	Acceptable Means of Compliance
ANSP	Air Navigation Service Provider
AoC	Area of Change
AOG	Aircraft on ground
ARP	Aerospace Recommended Practice
ASCOS	Aviation Safety and Certification of new Operations and Systems
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATM	Air Traffic Management
ATM-NEMMO	ATM Network MacroMOdel
CATS	Causal Model for Air Transport Safety
CRM	Crew Resource Management
EASA	European Aviation Safety Agency
EASp	European Aviation Safety plan
ESD	Event Sequence Diagram
ESSI	European Strategic Safety Initiative
FAA	Federal Aviation Administration
FAST	Future Aviation Safety Team
FDM	Flight Data Monitoring
FT	Fault Tree
ICAO	International Civil Aviation Organisation
HHI	Human Human Interface
HMI	Human Machine Interface
JPM	Jean-Pierre Magny
LLR	Lessons Learned Requirements
NLR	National Aerospace Laboratory of the Netherlands
PIC	Pilot In Command
PF	Pilot Flying

PNF	Pilot Not Flying
ROI	Return On Investment
SM IGC	Safety Management International Collaboration Group
SMM	Safety Management Manual (ICAO)
SMS	Safety Management System
SPI	Safety Performance Indicator
SSA	System Safety Analyses
TAS	Total Aviation System

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Executive Summary

ASCOS is an innovative EU funded research project and, as its full title suggest, it deals with Aviation Safety and Certification of new Operations and Systems. ASCOS contributes to the Area/Topic Operational Safety in the Activity Ensuring Customer Satisfaction and Safety of the EU 7th Framework Programme Aeronautics and Air Transport.

The objective of ASCOS is to develop innovative certification process adaptations and supporting safety driven design methods and tools to ease the certification of safety enhancement systems and operations while, at the same time, increasing safety. ASCOS aims to better account for the human element, already from the early stages of the certification process, and thus reducing consequences of human error and increasing safety. The project will follow a total system approach, dealing with all aviation system elements in an integrated way over the complete life-cycle.

ASCOS contains work packages on Certification processes, Continuous Safety Monitoring, and Safety Risk Management. Four case studies will be conducted to validate the processes, methods and tools proposed. The case studies deal with the certification of aircraft failure management systems, a future ATM/CNS system for improved surveillance, aircraft systems for improved controllability in flight, and aircraft ground handling operations.

This deliverable is dedicated to provide the reader with eventual exploitation of the result prepared throughout the project. The ASCOS project results will be used to support operational stakeholders and national authorities, to embark on exploitation projects, namely projects to directly use the ASCOS products and projects to further implement the recommendations from the main deliverables. As the project proceeds, stakeholder expectations and constraints are worked on by means of interaction with the Users Group.

The results will be exploited by incorporating them in research, products and training developments of the partners as well as in their international collaboration projects. A key exploitable output of this project will be the newly proposed certification and approval process and its incorporation in the e-learning environment initiated in ASCOS. The initial version of this e-learning environment will initially, during its development, be available to selected ASCOS Users Group members. It will be made fully accessible to the aviation community after its completion for further use and exploitation.

This deliverable is a specific Exploitation Plan. Research institutes as well as the Universities will use the results in their future research. Potential users of enhanced safety management techniques are candidates for using ASCOS outputs either directly in applying methodology and tools and/or through the application of standards.

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1 Introduction

1.1 Background

Several developments call for the adaptation of existing certification processes. These developments include fundamental changes in the institutional arrangements for aviation regulation in Europe, the introduction of new technologies and operations, and demands for higher levels of safety performance.

The European Commission (EC) sponsored ASCOS project[1] to contribute to the efforts of removal of certification obstacles. By this, it also aims to contribute to realising the EU ACARE Vision 2020 [7] and Flight Path 2050 goals [4]. The ASCOS proposed approach to certification features could be summarised within the following:

- It is more flexible with regard to the introduction of new operations, systems and products;
- It is more efficient, in terms of cost, time and safety, than the current certification processes;
- It considers the impact on safety of all elements of the Total Aviation System (TAS) and the entire system lifecycle in a complete and integrated way.

1.2 Objective

The objective of this study is to develop the exploitation plan of ASCOS. The plan describes how the ASCOS partners do intend to ensure that maximum benefits are derived from the project results. The plan considers activities to be taken by the ASCOS partners following the project end.

1.3 Approach in planning exploitation

The purpose of this activity is ensuring that the project results are exploited to the maximum extent possible. It is achieved by providing the necessary preconditions for successful exploitation. Such preconditions are basically feasibility, efficiency, and acceptability. Feasibility means a result is relatively easy to apply by customers. Efficiency is linked to Return On Investment (ROI) and to the way ASCOS practices are made understandable. Acceptability includes the above plus psychological acceptance by potential users. It is linked to compatibility with existing practices, organization, existing culture and capacity of ASCOS to make proposal understandable and practical to use. Acceptability is linked to the way decision makers will be convinced and ready to implement. In support of successful exploitation, the following activities are carried out:

- Provision of a convincing assessment of the potential to exploit the project results in a future commercial context (including market potential and overview on relevant sectors);
- Evaluation of e-learning web-environment with its potential users to support exploitation;
- Evaluation of the safety based design systems and tools with its potential users;
- Evaluation of the capability to improve existing Safety Management Systems;
- Keep up working relationships with safety teams and certification bodies for cross fertilization and paving the way for the successful exploitation of all ASCOS results.

[1] ASCOS - Aviation Safety and Certification of new Operations and Systems

The above covers the exploitation strategy containing considerations on the factors being of huge importance for effective and, what is even more crucial, successful project exploitation. For each of these key elements a separate subsection is devoted.

The deliverable also presents a synthetized approach to presentation of ASCOS exploitation plan which is in accordance with commonly accepted standards. The plan follows the standards and was developed as follows:

- The exploitable results of ASCOS are identified;
- Each project result are analysed to determine how the results are best exploited;
- Each project partner considers how to contribute to the exploitation of each project result;
- Uniform templates are used to document the exploitation plan per project results, and per project partner. The template combines the strength of the exploitation format that was required to be used for EC FP5 and FP6 projects and the exploitation handbook available from the TIPS project. Furthermore, it is related to the Strategic Research and Innovation Agenda recommendations.

1.4 Document structure

This document is structured as follows:

- Section 2 provides a general description of the ASCOS project and its main results and impact;
- Section 3 provides Exploitation Strategy containing the following subsections:
    - a convincing assessment of the potential to exploit the project results in a future commercial context (including market potential and overview on relevant sectors);
    - evaluation of the ASCOS e-learning web-environment with its potential users to support exploitation;
    - evaluation of the ASCOS safety based design systems and tools with its potential users;
    - Evaluation of the capability to improve existing SMSs;
    - Keep up working relationships with safety teams and certification bodies for cross fertilization and paving the way for the successful exploitation of all the ASCOS results.
- Section 4 describes the project results and their planned exploitation;
- Section 5 describes the exploitation plan per partner;
- Section 6 provides the references.

2 Project description

2.1 Project data

Project title	Aviation Safety and Certification of Operations and Systems
Project acronym	ASCOS
Project type	Small or medium-scale focused research project
Grant agreement no.	ACP2-GA-2012-314299-ASCOS
EU Programme	FP7 Transport - Aeronautics and Air Transport (AAT)
EU area/ topic	7.1.3.4 - Operational Safety
EU Subprogramme area	AAT.2012.3.4-1 - Design Systems and Tools
Project website	https://www.ascos-project.eu/
Start date	1 July 2012
Duration	39 months
Total cost	EUR 4 618 591
Maximum EU contribution	EUR 3 365 884
Coordinator details	Name: Lennaert Speijker Organisation: National Aerospace Laboratory NLR Address: Anthony Fokkerweg 2, 1059CM Amsterdam PO Box 90502, 1006 BM Amsterdam the Netherlands Telephone: +31 (0) 88 511 3654 E-mail: lennaert.speijker@nlr.nl
Partner names (PSC Members):	Stichting Nationaal Lucht- en Ruimtevaartlaboratorium (NLR): L. Speijker Thales Air Systems & Electronic Devices (TATM): J.M. Kraus Thales Air Systems SAS (TR6): O. Adrian APSYS SA: T. Morteveille Civil Aviation Authority (CAAi): L. Young Ingeniera de Sistemas Para la Defensa de Espana SA (ISDEFE): C. Regidor Gil CertiFlyer (CFLY): G. Temme Avanssa: N. Aghdassi Ebeni: A. Simpson Deep Blue (DBL): L. Save Joint Research Centre (JRC): W. Post Jean Pierre Claude Magny (JPM): J.P. Magny Technische Universiteit Delft (TUD): R. Curran Instytut Lotnictwa (ILOT): K. Piwek
EC Project officer:	Dr. Michael Kyriakopoulos

2.2 Executive summary

Summary:

Fundamental changes in the institutional arrangements for aviation regulation in Europe, the introduction of new technologies and operations, and demands for higher levels of safety performance, call for the adaptation of existing certification processes.

The objective of ASCOS is to develop innovative certification process adaptations and supporting safety driven design methods and tools to ease the certification of safety enhancement systems and operations while, at the same time, increasing safety. ASCOS aims to better account for the human element, already from the early stages of the certification process, and thus reducing consequences of human error and increasing safety. The project will follow a total system approach, dealing with all aviation system elements in an integrated way over the complete life-cycle.

To investigate how dealing with all safety and certification aspects in an integrated manner may be made possible using a new process, new methods and new tools, ASCOS contains work packages on Certification processes, Continuous Safety Monitoring, and Safety Risk Management. Four case studies were conducted to validate the processes, methods and tools proposed. The case studies dealt with the certification of aircraft failure management systems, a future ATM/CNS system for improved surveillance, aircraft systems for improved controllability in flight, and aircraft ground handling operations. A User Group kept the project focused and facilitated the uptake of project results.

Objectives:

To develop certification process adaptations, with supporting tools for safety based design and safety monitoring, so as to ease the introduction and certification of safety enhancements. To achieve this, six measureable and verifiable objectives are defined:

- To analyse the existing European certification and rulemaking process and propose potential adaptations to ease certification of safety enhancement systems and operations;
- To develop a methodology and supporting tools for multi-stakeholder Continuous Safety Monitoring, using a baseline risk picture for all the parts of the total aviation system;
- To develop a total aviation system safety assessment method and supporting tools that can be used for safety based design of new systems, products and/or operations;
- To apply proposed certification process adaptations and the design systems and tools in case studies, so as to show how they can be used by operators and manufacturers;
- To validate key results: a) new certification approach, b) method and tools for Continuous Safety Monitoring, and c) all the supporting safety based design systems and tools.; and
- To inform air transport stakeholders on the proposed certification approach through promotion workshops, supported by exercises and an e-learning web-site environment.

Work

Methodology and approach: the project is divided in the following five phases

- The first phase analysed existing European certification and rulemaking processes and identified potential shortcomings and bottlenecks in view of the foreseen regulatory changes and technological developments. Following this analysis, new and innovative approaches to certification were defined and

evaluated. The results of this evaluation was used to select and further develop affordable innovative certification processes;

- The second phase set up a baseline for the current risk level of the various parts of the total aviation system (TAS) during its complete life cycle. Aviation safety data were used to establish a baseline risk picture for the main operational issues identified in the European Aviation Safety plan (EASp) using Safety Performance Indicators (SPIs). This risk picture was used as baseline to set up a process for continuous safety monitoring;
- The third phase established a good view on potential emergent and future risks not present in today's aviation system. A TAS safety assessment method with supporting safety based design systems and tools was developed. A proactive approach was taken to ensure that potential future hazards and risks can be mitigated and safety will be maintained or even increased as compared to the baseline risk picture;
- The fourth phase applied he newly proposed certification process adaptations, and its supporting methods and tools for continuous safety monitoring and safety based design, in a number of case studies selected with the ASCOS User Group. This was followed by quantification of the safety impact of introduction of new operations and systems in Europe;
- The fifth phase validated the scientific and technological advance that the proposed project is expected to bring:
    - New affordable certification processes to make certification easier;
    - Innovative safety based design systems and tools; and
    - New methods and tools to support continuous safety monitoring.

2.3 Overview of main project results

Overview of main project results				
No.	**Description**	**Category A, B, or C***	**Result owners****	**Exploitation lead**
1	Proposed certification approach	A, B	**Ebeni**, CAA UK, TR6, NLR	Ebeni
2	Framework safety performance indicators	A, B	**NLR**, DBL, Avanssa	NLR
3	Process safety performance monitoring	A, B	**ILOT**, NLR, Avanssa, DBL, JRC	ILOT
4	Tool for continuous safety monitoring	A, B	**JRC**	JRC
5	Risk model	A, B	**NLR/CAA NL**	NLR
6	Tool for risk assessment	A, B	**TU Delft**, NLR	TU Delft
7	Safety assurance process in operation	A, B	**APSYS**	APSYS
8	Lessons learned requirements process	A, B	**APSYS**	APSYS
9	Overall safety impact assessment method	B	**ISDEFE**	ISDEFE

*: A: results usable outside the consortium; B: results usable within the consortium; C: non usable results.

**: Referring particularly to specific patents, copyrights, etc.

Table 1 Overview of main project results

2.4 Assessment of project impact

The project impact is best assessed in relation to the overall European visions and objectives for aviation, and the associated European research agenda.

European vision and objective for aviation, and research agenda (source: [OPTICS D2.1])

In 2000 a Group of Personalities from key stakeholders was installed in Europe to agree on how aviation could better serve society's needs, and on how Europe can become a global leader in the field of aeronautics. The result was the "European Aeronautics: A vision for 2020" report [8], which was published in January 2001. This vision included the following objectives for safety:

- A reduction of the accident rate by 80%; and
- A drastic reduction of impact of human errors and its consequences.

The Group of Personalities also agreed to establish ACARE (Advisory Council for Aviation Research and Innovation in Europe), to develop and maintain a Strategic Research Agenda (SRA) that would help achieve the goals of Vision 2020.

Some years later, the European Commission convened a High Level Group on Aviation Research, who formulated a new vision beyond 2020: "Flightpath 2050", released in March 2011 [4]. Flightpath 2050 sets out the vision for the ambitions of European aviation transport over the next three decades. This vision includes five principal pillars: mobility, competitiveness, environmental protection, education and infrastructure, and safety & security. The safety & security pillar of Flightpath 2050 includes six goals, of which the following three relate to safety:

- Overall, the European air transport system has less than one accident per ten million commercial aircraft flights. For specific operations, such as search and rescue, the aim is to reduce the number of accidents by 80% compared to 2000 taking into account increasing traffic;
- Weather and other hazards from the environment are precisely evaluated and risks are properly mitigated;
- The European air transport system operates seamlessly through fully interoperable and networked systems allowing manned and unmanned air vehicles to safely operate in the same airspace.

ACARE next elaborated a new Strategic Research and Innovation Agenda (SRIA – two volumes) in response to this new vision. This agenda identifies and clusters meaningful enablers to reach the goals ('what is required to achieve the goals?'). For safety, the names of these enablers are:

1. System-wide Safety Management Systems;
2. Safety radar;
3. Operational mission management systems and procedures;
4. System behaviour monitoring and health management;
5. Forensic analysis;

6. Standardisation and certification;
7. Resilience by design;
8. Human-centred automation;
9. New crew and team concepts; and
10. Passenger management.

The SRIA decomposes enablers into main capabilities ('how can it be achieved?') and concepts services & technologies ('with what can the goals be reached?'). Furthermore, the SRIA provides a high level scheduling of which achievements should be realised by 2020, which by 2035, and which by 2050.

ASCOS impact expectations at project start

The ASCOS Description of Work (DoW) demonstrates that the historic safety improvement in terms of the fatal accident rate is stagnating. ASCOS aims to break the chain of stagnation of safety improvement through introduction of novel and innovative certification adaptations, which will ease the certification and approval process of safety enhancement systems and operations. Furthermore, a significant impact can only be realised if the priorities are focused on areas that exhibit a high risk; hence ASCOS aims to address the identified priority areas by applying the new certification processes and tools in case studies to enable accelerated and easier certification of safety enhancement systems and operations. ASCOS aims to connect to contribute to the above visions and research agenda, amongst others by aiming for a holistic, total system approach to aviation safety, integrated across all components and stakeholders.

Assessment of ASCOS impact

In 2014, the ASCOS project developed a self-assessment of the ASCOS contribution to the activities of the SRIA [20]. The approach used for this self-assessment was based on the approach developed by OPTICS, a Coordination and Support Action (CSA) funded by the European Commission to provide oversight of the progress in Research and Innovation targeting aviation safety improvement in relation to the Flightpath 2050 goals. While the OPTICS project developed an initial assessment of the contribution of ASCOS to the activities of the SRIA based on publicly available material, the ASCOS self-assessment was based on all project material.

The self-assessment characterises the impact of ASCOS [20]. In summary, ASCOS mainly contributes to the following enablers and supporting capabilities:

Enabler 1:

- System-wide Safety Management Systems: The identification and implementation of a Safety Management System to operate throughout the whole chain of Air Transport activities.

  Capability 1:

  - Understanding the safety related influence factors on the overall air transport system and its connections with other transport nodes.

Capability 2:

- Implementation of an operational risk management system which demonstrates the ability of the ATS to anticipate, react, respond and recover with respect to safety threats within a multi-modal transportation system.

Capability 11:

- Safety performance indicators are systemically linked to safety outcomes, allowing measurement of system safety performance. Credible measurement of progress towards 2050 targets becomes possible.

Enabler 6:

- Standardisation and Certification
- Innovative approach to standardisation, certification and approval processes. Advanced methodologies including simulation tools applied to compliance demonstration of safety / security requirements at component, product, system and system of systems level, including human, social and technical aspects, leading to efficiency and shorter time to market of new products, services and operations. Improved methodologies for standardised approval and licensing.

Capability 1:

- Common framework for Certification / Approvals which embrace new technologies and their integration within the systems to be certified and the use of new technologies and methods in the certification / approval processes.

Additionally, ASCOS also contributes also to the following additional Enablers (and associated Capabilities):

- Enabler 2 “Safety radar”
- Enabler 5 “Forensic analysis”
- Enabler 7 “Resilience by design”

3 Exploitation Strategy

3.1 Assessment of the potential to exploit the project results

Historically certification and safety activities have been developed in a fragmentary way, often as a result of certain accident of incident that has fostered the creation of regulation in certain directions. Consequently, nowadays, the certification panorama can be described as a patchwork. Even when each one of the pieces of the certification (regulation for aircraft manufactures, procedures to create an operation, etc.) are coherent intrinsically, they are not necessarily coherent as a whole. This creates a complex regulation system that presents ambiguities, duplicities and gaps as presented in D1.1 [1]. A common certification approach and a common safety regulation will solve this situation and improve the cost effectiveness of the overall certification process. Besides, the introduction of new products, that often demands a high interaction among partners (e.g.. RPAS), requires a coherent regulation among domains.

ASCOS presents a new certification methodology in D1.3 [2] (and D1.5 [12]) and a procedure of improving current standards in D3.5 [3] that enables users to work together and that take benefit from in service experience. This certification approaches supported by an enriched safety process that includes elements to early detect the root causes of a hazard (use of precursors) and the continuous safety monitoring (safety performance indicators - SPI), these elements are used transversally in all aviation domains and they enable safety practitioner to understand and measure the interactions among domains. ASCOS results are consistent with European strategy, see the contribution of ASCOS to ACARE 2020 0 and Flight Plan 2050 [4] goals:

ASCOS can support goals stated by ACARE 2020: (ACARE European Aeronautics a vision for 2020, meetings society's needs and winning global leadership, January 2001). Example goals targeted by WP3 are as follow:

GOAL	ASCOS CONTRIBUTION
Aircraft achieve a five-fold reduction in the average accident rate of global operators	Aircraft standards can be improved with the lessons learned process and the safety assurance in operation. These ASCOS products are considered in the TAS standards. (WP 3.5).
Aircraft will drastically reduce the impact of human error	The tool for continuous monitoring (Result no 4) and the lessons learned process (Result no 8) provide information about human behaviour. These information is later used to proposed improvements to regulations (D3.5) [16] Note that result 4 is based on result 2 and result 3.
Higher standards of training for aircraft operation and maintenance for ATM	The tool for continuous monitoring (Result no 4) and the lessons learned process (Result no 8) provide information about human behaviour. These information is later used to propose improvements to regulations (D3.5) [16] Note that Result no 4 is based in Result no 2 and Result no 3.

Table 2 ASCOS WP3 contribution to ACARE 2020

FligthPath 2050 vision of European skies in 2050 describes a "*holistic total system where safety is totally integrated across all components and* stakeholders". In this European vision, "*manned, unmanned, autonomous aircraft and all types of rotorcraft operate simultaneously in the same airspace and in most severe weather conditions" (Flightpath 2050 Europe's Vision for Aviation).* ASCOS supports this vision by building a regulation framework (D3.5) [16][3] that enables all stakeholders to work together. ASCOS also provides a common certification approach (D1.3) [2] shared by all stakeholders. All ASCOS products are intended to be applied by all of the stakeholders.

The improvement in certification and in safety by building a common certification approach stands on its own, but it also improves the cost efficiency associated to certification and safety. FlightPath 2050 forecasts a picture of new commercial areas in the aviation: the increase of aircraft diversity. In 2050, European skies are expected to be crowded with unmanned aircraft, and rotorcraft. Different types of aircraft with different performance that needs to be guided and managed. ACARE 2020 also presents a vision of commercial aviation future: the more diverse and cheaper air transportation. "*There will be more routes and more flights to and from destinations*". As a consequence of the supply increase, the European airline system is supposed to be operating with a greater economic efficiency to provide a more affordable transport solution. Buying an aircraft, and, especially, maintaining the aircraft worthiness is expected to be much more popular and affordable. It is expected that certification and safety activities are more cost efficient and avoid overlaps among domain or ambiguities.

ASCOS products offer a double benefit in terms of certification of complex aviation systems: the first, the methodology proposed by ASCOS to the overall TAS community impossible to quantify, and the second, linked to ASCOS products. This simplification eases a high level economic understanding and it is developed in detail in the next sub-chapters.

3.1.1 Overview of ASCOS products

Any safety issue as well as major performances problems shall be sorted out anyway, sooner or later. 'Sooner' means cheaper, and the 'later' can be dramatically expensive and safety critical. In this sense, ASCOS products intend to anticipate, to the maximum possible extent, possible events and therefore combine safety improvements and money saving.

Each program's investment curve versus time and phases provides a picture of costs needed to correct design definition sooner or later. The ROI depends on anticipation, more precisely on earlier application in the program phases

The investment breakdown can be as follows:

- Integration of methods in the organization;

- Identification of organization of structure and standards to clean up;
- Staff training;
- In some cases, creating a new function, (e.g. ATC-ATM/ACFTs coordination);
- Tools;
- Additional studies in early program phases (Note 1);

The ASCOS ROI is meant as saving costs of anticipated corrective actions, e.g.:

- Direct costs:
  - User (airlines): price to pay after accident or incident, cost of Aircraft on ground (AOGs);
  - Industry: technical and production costs, including costs resulting from delays and contract / guarantee links with customers;
- Indirect costs
  - Degraded Image ➔ commercial impact;
  - Reduced Activity, AOGs

The ROI can be improved in the certification domain. Currently certification ends up at a late programs' milestone and frequently reveals problems not sorted out before. Corrective actions initiated **at that** late program milestone generate unforeseen engineering tasks, qualification, production and retrofit that induce costs and delays concerning failed elements and interfaced systems (e.g. engines delays affect aircraft). Induced costs grow exponentially with time. The best possible anticipation is to make good decisions and Risk Mitigations **in early program phases, where relatively cheap options** may prevent costly corrective measures resulting from incidents or accidents. Therefore the demonstration hereafter is placed in project phasing and planning Program phase definition for the demonstration Phases are defined as:

Phase 0	Concept phase
Phase A	Preliminary design
Phase B	Detailed design
Phase C	Prototype, first flight, first operation
Phase D1	Type certificate, approval of operation
Phase D 2/E	Production (D) and operations (E) (overlaps)

Refer to chapter	ASCOS products	Impact on Program Phase
4.1	Proposed certification approach	From Phase 0 to Phase D
4.2	Framework safety performance indicators	Implemented in the design phase (Phase B)
4.3	Process safety performance monitoring	Used to provide feedback from experience in phase B
4.4	Tool for continuous safety monitoring	Used to provide feedback from experience in phase B
4.5	Risk model	Used in the concept Phase and preliminary design. Phase 0, Phase A
4.6	Tool for risk assessment	Used in the concept Phase and preliminary design. Phase 0, Phase A
4.7	Safety assurance process in development and in operation	From Phase 0 to Phase D Improve certification standards
4.8	Lessons learned requirement process	From Phase 0 to Phase D Improve certification standards
4.9	Overall safety impact assessment method	From Phase D1

Table 3 Use of ASCOS products in early program phases

The economic impact of the implementation of ASCOS results is difficult to be proven, however, as presented here, ASCOS proposes products that identify potential hazards and root causes in the early phases of aviation programs. Experience shows that the early identification produces the highest ROI in terms of the described meaning.

Note 1: Example of impact on early identification of hazards:

Risk of fuel icing at engine FCU (Fuel Control Unit) depends on fuel temperature. Fuel temperature at engine FCU inlet depends on many events. Aircraft fuel system, flight atmospheric conditions, flight duration, remaining fuel quantity, heat exchangers characteristics, themselves tied up to engine oil temperature associated to multiple engine characteristics including power setting, (e.g. long idle descent) Mach number etc. Fuel characteristics may also reach limits.

The worst case study is needed for demonstrating that at the probability defined by CS-25/1309 of icing is not reached. The worst case study should be associated with a sensitivity evaluation of characteristics (well known in engines design to determine the confidence level of the analysis). This is a certification issue as tagged by ASCOS.

Fuel icing is an event of low probability but of high severity (catastrophic) that may affect all aircraft engines together.

The engineering analysis components:

- It involves fuel producers, engine makers, aircraft makers, airlines (4 main partners);
- It is valid for one type of aircraft with one type of engine;
- It is the design justification for certification. It shall supersede or update existing certification regulations that are no more adapted to each and every situation (ASCOS recommended certification concept);
- It has to be done to the latest, in the detailed definition phase. Update or validity verification shall be required in the changes and waivers management with involvement of the 4 partners;
- As a low probability event, crash may happen after millions of flight cycles and trigger a huge batch of interventions, operational limitations, and retrofit of important elements. The ROI of the above described process is the sum of all costs, crash included;
- However application of “Performance based Certification scheme” can trigger an audit process intending to revisit cases where verification of existing certification regulations against a complete design justification has not be done.
- An audit recommendation should apply a systematic “sensitivity analysis of characteristics”. The analysis of fuel oil heat exchanger mentioned above is a good example;

The table below has the same lay out than the previous showing clearly costs savings.

Event	Useable process to anticipate				Cost at the program phase where corrective action is taken				
	AoC 1	AoC 2	Precursors	Certification	0/A	B	C/D1	D2	E/10 years
All engines flame out due to fuel icing	Mission changes, longer flights, optimised possibly Idle descent profiles	High technology engines more sensitive	Any event in program developmen t Experience from other users	Performance based Certification scheme	0	0	Retrofit + AOG = 0.2M€	Retrofit + AOG =	Retrofit + AOG = 0.2M€ /ACFT (1000) Cost of a crash 250M€ + operational constraints +
Investment costs in early phases look negligible compared to costs mentioned above, considered as ROI.									

Table 4 Cost savings resulted from early identification of hazards - example

3.2 Evaluation of e-learning web-environment with its potential users

3.2.1 ASCOS e-learning web-environment

ASCOS 'E-learning web-environment' is an e-learning platform intend to train potential users of the ASCOS proposed certification and approval processes. This online course, when completed, should offer training in 12 topics and requires a computer connected to the internet with a web browser (Internet Explorer or Mozilla Firefox). The course is intended to be integrated into the ASCOS website and should become accessible through the URL: https://www.ascos-project.eu/e-learning/

The access is free, only user management and the restricted documents require login and password, which may be obtained by contacting the Coordinator of the ASCOS Project (at lennaert.speijker@nlr.nl).

E-learning services mean all forms of electronic supported learning and teaching, which are procedural in character and aim to effect the perception and awareness with reference to individual experience, practice and knowledge of the learner. Information and communication systems, whether networked or not, serve as specific media to implement the learning process.

The e-learning platform intended technical features are:

- It is publicly available;
- It has editable content online ('course curriculum');
- It supports and integrates various media types (i.e. MS PowerPoint, PDF, video, audio files and links);
- It allows students' progress assessment;
- It has intuitive interface.

3.2.2 Evaluation of the tool

The e-learning platform will be an interface between the innovative methodologies developed in ASCOS project and practitioners involved in their implementation. Therefore it facilitates ASCOS results dissemination.

The analysis should focus on evaluation of the platform functionality and the efficiency of learning process. It shall highlight the advantages of current best practices and provides some suggestions concerning further development of the tool as well as its future improvements. It has to be noted that complexity and range of evaluation presented in this section has to be significantly reduced due to current lessons content advancement level.

Criteria of e-learning evaluation

There are e-learning platforms providing aviation safety training (including ICAO SMS) and aviation quality dedicated software. Some of them are, more or less, comparable to ASCOS e-learning and could be benchmarks for the evaluated ASCOS e-learning using Web Based E-learning System Alternatives criteria.

Amongst them the following providers can be distinguished:

1) ICAO Computer Based Training;
2) EASA Learning Gateway;
3) FAA Academy;
4) EUROCONTROL Headquaters;
5) IATA eLearning;
6) OAG web-based SMS training courses;
7) NBAA SMS e-Learning Course;
8) Gael Academy;
9) Southern California Safety Institute.

However, only two of them (OAG –a sample - and EUROCONTROL) provide free of charge e-learning platforms.

Evaluation

The proposed e-learning environment was overviewed in ASCOS D1.4 "E-learning environment to support certification processes" [5] report. At the time of writing this report no actual lessons were available and only limited evaluation could be done. The proposed set of lessons covers the necessary material required by the description of work. Lesson breakdown and organisation, however need improvement.

Lesson 1, "Introduction to the e-learning environment" is not a real learning content. The content could be relocated to a more proper place in a help file or e-learning main menu as it is.

The organisation of lessons, as depicted in Figure below: Knowledge tree shows the relationship between the courses. The knowledge tree illustrates which previous knowledge from the curriculum a student requires in order to follow a course [5]. In Figure 1, an (updated) knowledge tree for the e-learning environment is shown.

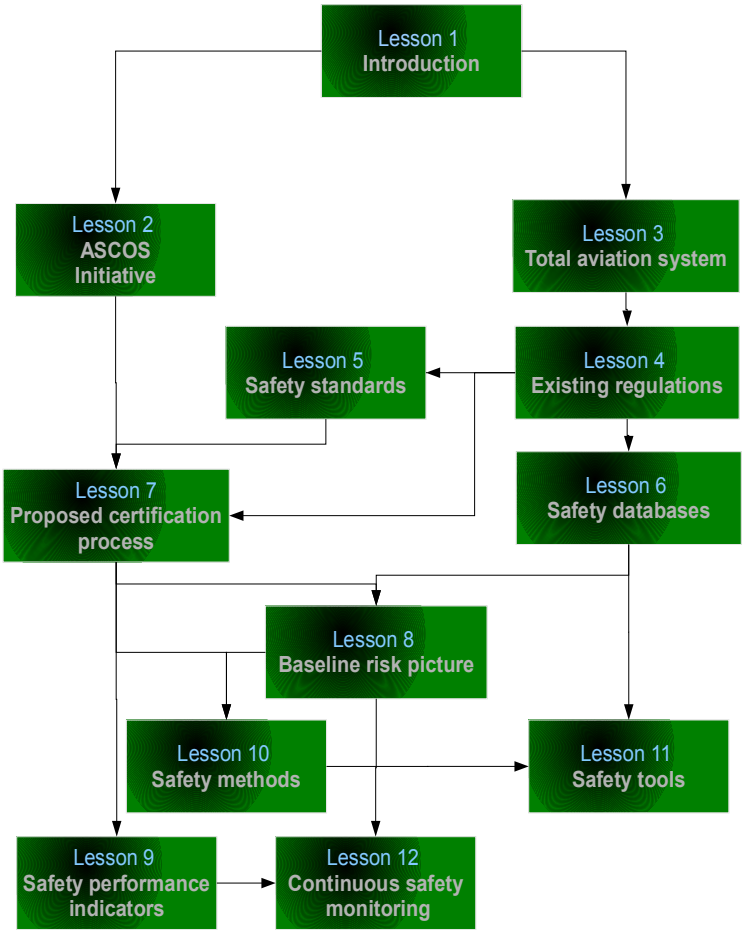


Figure 1 Knowledge tree (updated) with lessons sequence

Suggestions

Presented below are suggestions concerning potential improvements of the existing ASCOS e-learning platform. They refer to the early stage of e-learning content definition and can be easily fixed.

- The D1.4 deliverable contains defined learning objectives, type of material, but lacks proper definition of target audience. Two target groups are mentioned, but these are only vaguely described as students and instructors;
- There is no information what skills do the target group is assumed to have or who they might be. Answering to whom e-learning is addressed to, as well as, audience assumed capabilities is necessary for proper design and evaluation of the e-learning environment;
- There is no clear information, whether the course is intended to be asynchronous or synchronous (instructors are mentioned), it is said it is going to be distributed online;
- The Blackboard environment was initially chosen but dropped later as e-learning platform. While the Blackboard is considered one of the best platforms in terms of number of features that it can provide, it is also known for its complexity and the amount of programmers labour required to deploy it [6].

3.2.3 Potential users

Currently available estimates indicate nearly 700 thousand of workers employed in EU Commercial Aviation [9]. It is forecasted that significant share of them throughout all TAS domains would be expected target users of ASCOS E-learning platform.

3.3 Evaluation safety based design systems and tools with potential users

The task aiming at evaluation of ASCOS project products concerning safety based design systems is further continued with the results of WP3 'Safety Risk Management'. For most of the products, the evaluation is focussed on general benefits, especially social, safety and standardisation related.

WP3 was dedicated to develop safety based design methods and tools that enable handling of current, future and emerging risks which through addressing the TAS are expected to support derivation of Safety Objectives and Safety Requirements for any proposed change within the TAS (e.g. new technologies, operations, systems and/or products).

The products developed in ASCOS project meet the needs listed in D3.1 [10]. They are:

A. The methodology addresses the TAS and provides the means to address all the interfaces and the interactions between the different aviation system domains.
B. The methodology uses of more integrated supporting tools for safety assessment.
C. The methodology addresses current and future risks.

D. The methodology is appropriate for supporting the certification process developed in WP1.
E. The methodology addresses all lifecycle phases.
F. The methodology is appropriate for developing safety assessments of good quality.
G. The methodology uses the inputs from experts with appropriate qualifications and
H. The methodology adopts stakeholders' wishes

Within the scope of this evaluation five tools and safety design system are analysed. They are:

1. ASCOS Risk model
2. Tool for risk assessment
3. Safety assurance process in operation
4. Lesson learned requirement
5. Overall safety impact assessment method

3.3.1 Risk model

The ASCOS Risk Model was developed in D3.1 [10] on the basis of CATS – Causal Model of Air Transport Safety developed for Dutch Ministry of Transport – and specified as *"Promoting the prevention of aircraft accidents through better understanding of aviation risks in terms of causes and magnitude"*.

Facts about CATS – ASCOS Risk Model:

It covers and characterizes all historical commercial air transport accidents (in details). It is based on historic and expert opinion-derived data. It contains accident scenarios which are reflected by 29 Event Sequence Diagrams (ESDs) and Fault Trees (FTs). They cover TAS comprising virtually all major aviation safety risks.

The ESDs are grouped into 5 EASp categories:

- Runway Excursion (RE);
- Mid-air-collision (MAC);
- Controlled Flight into Terrain (CFIT);
- Loss of Control In-Flight (LOC-I); and
- Ground Collision (GC).

The ASCOS risk model is of quantitative type. It assesses probability of occurrence of each of the different pathways in the scenarios. The typical generic representation is depicted on Figure 2. More detail on ASCOS Risk model specification can be found in D3.2 [11].

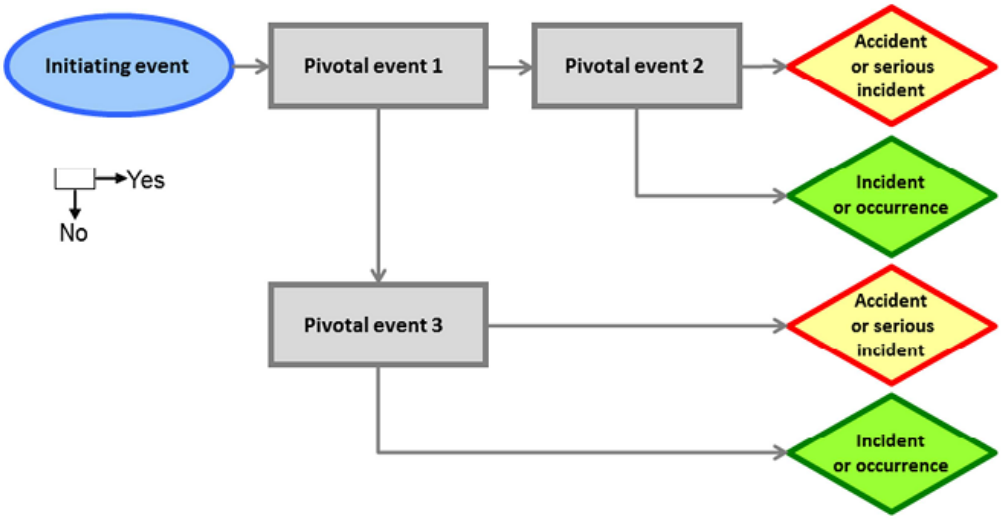


Figure 2 Generic representation of an ESD.

It constitutes important component of all tools and safety design methods evaluated in this section.

Evaluation of the exploitation potential

ASCOS Risk model should be considered as a very valuable tool in terms of potential for exploitation. The ASCOS deliverables provide numerous examples of current (within the project scope) as well as possible future uses of the model. Its value shall be evaluated taking widely into consideration various model features including the data flow it provides. Surely, safety assessment process perspective will play dominating role within the evaluation, due to ASCOS project scope.

Five major potential ways for ASCOS Risk Model exploitation were identified. They focus both on the potential results of the further tool development as well as on its potential users.

1. Towards Total Aviation System approach

As one of the most important features of ASCOS Risk model, its scope should be considered. It covers Total Aviation System including all processes and organisations involved directly and indirectly in Commercial Aviation Transport. In addition it connects different domains focussing on interfaces between them enabling efficient safety analysis from the Total Aviation System perspective, as a one system – TAS.

In the light of the above, the expected ways for ASCOS Risk Model exploitation are as follow:

- As it is often said, the regulations in aviation are written in blood. The ASCOS Risk model is a specific envelope of commercial aviation accidents and incidents and, therefore, it can be considered as the one that constitutes the very basis of regulatory content. Additionally, highlighting bottlenecks and shortcomings of current system, it can be used for deriving conclusions leading to regulations improvement.

  In this context, regulatory bodies and standards providers should be expected as potential users.

- ASCOS Risk model represents large potential for development. Documents delivered within the scope of ASCOS Work Package 3 and 4 clearly indicate the benefits resulting from combining the model with identified precursors, system FTs, data received from Flight Data Monitoring (FDM) system (i.e. potential precursors) or safety assessment analyses. All these ways for model extension, together with possibilities of taking a TAS perspective, create the basis for development of safety optimisation methods – safety engineering at the level of TAS.

  Here, regulatory bodies, but also aviation systems (in different domains) manufacturers and procedure designers should be expected as potential users of (extended / improved) ASCOS Risk Model.

- ASCOS Risk model can be seen as a skeleton of TAS, single Fault Tree. Continuously updated, extended with detailed system, items as well as procedures, the Fault Tree can evolve into a very valuable and complex data base. It could be a tool enabling relatively easy analyses which are very cumbersome and often not sufficiently reliable today at the level of TAS.

  Regulatory bodies should be expected amongst possible users. Additionally, the complete TAS Fault Tree or some of its parts would be helpful for all organisations involved in commercial aviation transport. The model can be also used by organisations involved in facilitating change of certification process according to safety argument method presented in D1.5 [12].

2. Supporting Safety Assessment processes

Just as it was mentioned above and within WP3 deliverables, the features of ASCOS Safety Risk Model lead to a conclusion that the model should be also considered as a mean for current standards improvement. The rich model database enabling various analyses and results validation can be mentioned as an important argument to support the above statement. Additionally, combining Fault Tree used in FTA with ASCOS Risk Model ESDs allows for cascading the safety objectives according to suggestions included in D4.1 [13] and evaluation of system or item safety on Total Aviation System (other its components). For this purpose the Total Aviation System Fault Tree would be very helpful.

In addition, provided that Safety Monitoring records (indicators/precursors) are available and employed, the model can be used to build a posteriori risk analysis.

3. Supporting continuous safety monitoring

One of the aims of ASCOS is to progress beyond the state-of-the-art. It could be achieved by developing and validating a continuous monitoring process in which selected safety occurrences distributed along the ASCOS Risk Model pathways would be used measure of safety performance, i.e. as SPIs or precursors to accidents (end events in ASCOS Risk Model).

The ASCOS Risk Model can be used to improve the continuous oversight function by identifying a more complete and correct set of monitoring requirements by inspection of the complete model. The inspection

also has the potential to improve the identification of the boundary of influence of a proposed change. It could be done according to the method described in D1.5 [12] and thereby it would improve the management of change. It has the potential to provide a clear understanding of the safety significance of a service, supporting service or system which is then used in the determination of an appropriate level of oversight.

Regulatory bodies as well as organisations involved in airworthiness and maintenance of systems in Commercial Aviation Transport would users of ASCOS Risk Model extended with SPIs and precursors.

4. Supporting human impact on aviation safety

The ASCOS Risk model covers both technology and human related issues (also organisation and system of organisations related). It is envisioned that one of the directions of the model exploitation is the optimisation of human domain safety in TAS. The model is a solid base for such analysis completely covering all human activities within the TAS including both Human Machine Interface (HMI) and Human Human Interface (HHI). E.g. Pilot Flying (PF) vs Air Traffic Control Officer (ATCO) or PF vs Pilot Non Flying (PNF) – Crew Resource Management (CRM). It enables better understanding of human role in safety assessment process.

Research institutes, academies as well as regulatory bodies and standard providers should consider exploitation of the ASCOS Risk Model in this direction.

5. Data source for (statistical) analyses

ASCOS Risk Model can be used as tool supporting various analyses for deriving valuable conclusions. It is supported by the following facts:

- It Illustrates two decades of Commercial Air Transport development;
- It can be considered as constituting basis for Regulatory content;
- It highlights bottlenecks and shortcomings of current system enabling reliable improvements;
- It provides reliable probabilities on the level of TAS;
- It can be employed for various analyses related to safety assessment (SSA, cascading of safety objectives, identification of AoCs, affected TAS elements).

This way for ASCOS Risk Model exploitation should be mainly in the scope of interest of organisations conducting research activities supporting decision-making entities and academies or research institutes.

Potential users of the ASCOS Risk Model

Since the model covers TAS, i.e. amongst its potential users all of the aviation organisations involved in Commercial Air Transport can be considered:

- Aircraft and systems designers: The model supports better System Safety Analyses (SSA) including wider perspective enabling TAS approach; It benefits from covering impact on other domains;

- Manufacturers: It supports more efficient safety management including wider perspective of safety assessment;
- Regulators: The model indicates system bottlenecks and shortcomings; It points areas that need to be improved; It creates possibility to consider all domains as cooperating within one system – TAS.
- Training organisations: It offers improvement of training process base on the ASCOS Risk Model findings;
- Standards providers: It supports standard improvement (extending with model / model outputs);
- Maintenance and airworthiness organisations:. Improvement / extending SMSs;
- Other service providers – airports, ground service, ANSPs and others: similar benefits.

Summary

ASCOS Risk model represents huge potential in terms of safety assessment process. It can be widely used by various organisation and entities. Additionally, it can be seen as a starting point for development of more detailed model of Total Aviation System (TAS). It is creating a real possibility to exercise the benefits of safety assessment at the highest, unavailable today, TAS level. One of the examples of possible ways for ASCOS Risk model exploitation is the Tool for Risk assessment described in the next section.

3.3.2 Tool for risk assessment

According to the D3.3 [15] Tool for Risk Assessment is software tool for risk assessment embodying the ASCOS risk models and representing the accidents scenarios. The tool allows the user to access, explore and modify the ASCOS risk models and accident scenarios. It allows of utilizing some of the methodologies developed for the proposed improved certification process (WP3.2 as basis) [14].

Since it supports exploitation of the results presented in previous sections, the tool can be potentially used in most of the already described ways. They can be expressed via presentation of possible applications of the tool. The document D3.3 [15] lists the following:

1. Support safety based design of technologies, operations and systems
2. Handle current, emerging and future risks
3. Representation of risk for the certification process
4. Represent current risk in accident and accident avoidance scenarios
5. Identify accident scenarios linked to EASp operational issues
6. Develop a safety picture of the future
7. Anticipate future risks based on existing precursors
8. Assess necessary changes resulting from desired safety performance levels
9. Derive safety objectives and safety requirements for new technologies, operations and systems
10. Model new Event Sequence Diagram (ESDs) for scenarios unique to new technologies, systems, products or operations
11. Modify and update ESDs

12. Modify FTs
13. Identify the impacts of future, emerging and current risks
14. Identify future and emerging risks resulting from precursors
15. Show and overview of all base events
16. Visualize ESDs and FTs
17. Represent changes to the TAS by modifying ESDs/FTs
18. Calculate accident probabilities
19. Show the influence of stakeholders on parts of the model
20. Modify Elements probabilities

They present the complete scope of usability of the tool also in the context of potential exploitation. With regards to the fact that the ASCOS Tool for risk assessment differs from the ASCOS Risk model in terms of form of presentation only, all ways of product exploitation expected for the model are also applicable to the tool.

More details can be found in D3.3 [15]

The expected users can be the same as in the case of ASCOS Risk model.

3.3.3 Safety assurance process in operation

According to the result of D3.5 [16] the aim of the ASCOS Harmonized Safety Standards process was to develop a method to improve safety of the TAS by improving development processes and safety assurance processes of TAS elements (product or system) trough improvement of applicable safety standards. This approach:

- Identified the safety standards used by the different stakeholders of the TAS for product/service development and certification;
- Identified and evaluated the application status of the safety standards used by the different stakeholders of the TAS for in operation safety assurance and lessons learned feedback;
- Proposed a common framework for safety standards organization generic enough to be applied all over the different stakeholders of the TAS.

The Product Safety Assurance in Operation merged two main models for Assurance Operation, one of ICAO Safety Management Manual (ICAO SMM) and one of Aerospace Recommended Practice (ARP) and used the results form WP 3.2 [14] (precursors) to support the identification of monitoring parameters, the incident detection and the risk assessment.

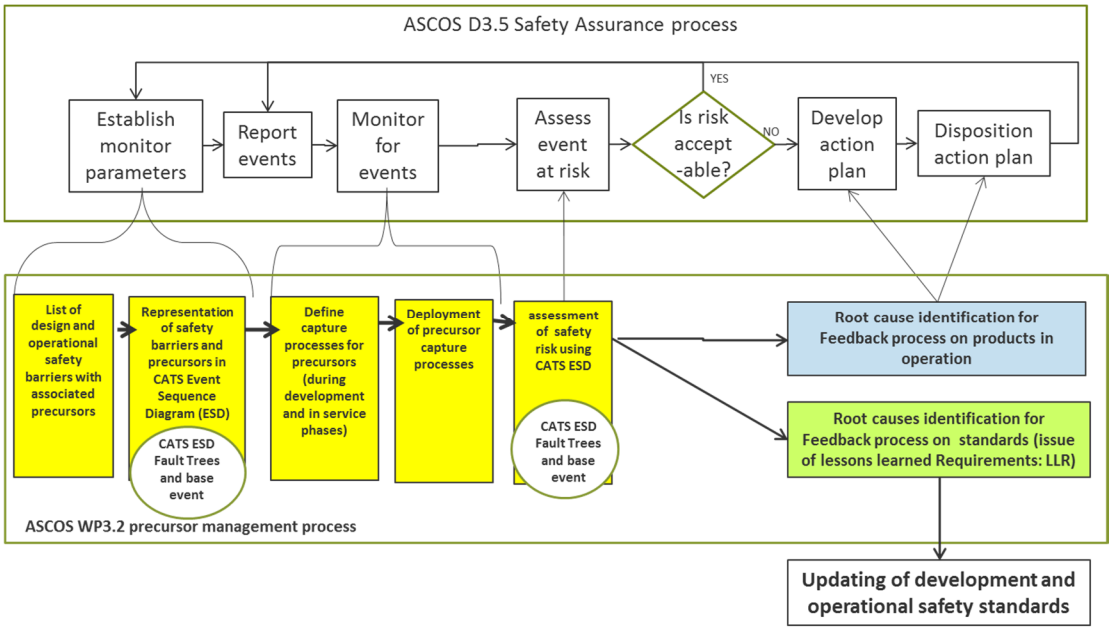


Figure 3 Detailed safety assurance process in operation (D3.5 [16])

ASCOS process Product Safety Assurance in Operation ends up with a continuous feedback from in operation lessons learned process aiming at improvement of the products in operational and at improvement of standards used for product development (see Figure of the Lessons Learned Requirements section).

More details on Safety Assurance process in operation can be found in D3.5 [16].

Evaluation of the potential for exploitation of Safety assurance process in operation

Evaluation of the potential for the exploitation concerns mainly further development of the presented solution with special focus placed on fulfilment of recommendations and providing the conditions necessary for that.

Including in safety standards

A seamless certification process at TAS implies coordination and coherency between the different stakeholders of the TAS. Therefore:

- It should be expected that this coordination and coherency will be reflected in the safety standards used by each stakeholder of the TAS and in the TAS Safety organization;
- Additionally, it should be expected that requirement of coherency in interface entails the need for revision of: the ED78A standards used for TAS level and ATM stakeholder level and the standard used at other stakeholder level (for example the ARP4754A/ED79A standard used at aircraft stakeholder level) in order to make them consistent in term of requirement validation, requirement exchange, DAL assignment;
- Moreover, the aircraft development standard (ARP 4654A) the failure/error severity repercussion should be extended for consideration of aircraft failure/error repercussion on ATM operations.

Product development process support

Applying methodology behind the Safety assurance process in operation can lead to significance decrease in the cost of product development (see section 3.1). Efficient early identification of hazards minimises the risk related to accident appeared during operation.

Potential users of Safety assurance process in operation

All safety practitioners in aviation, especially representatives of certification bodies, EUROCAE and SAE, should be considered as potential users of this tool.

3.3.4 Lessons learned requirements process

According to D3.5 [16] the aim of the lessons learned feedback process is to derive from events of development phase and of operation phase requests for improvements to be included in the development process in order to avoid event reoccurrence on new developments. To be applied efficiently, these requests should take the form of Lessons Learned Requirements (LLR). LLR application and verification of its application is to be made using the standard requirement management process implemented in the development process.

The ASCOS methodology proposes a standardized process among all aviation stakeholders to improve safety standards using lesson learned from operation. The process consists of four steps:

Step 1: Safety significant event identification
Step 2: Root cause investigation
Step 3: LLR elaboration
Step 4: LLR implementation on development standards

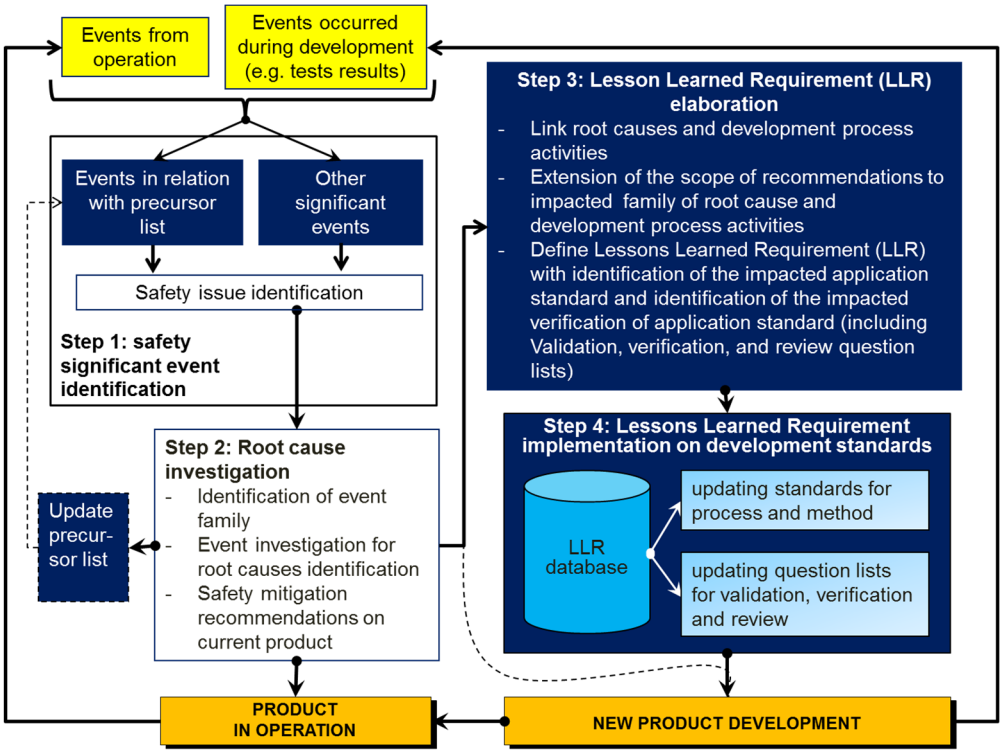


Figure 4 Complete process for in operation product assurance and for Lessons Learned feedback loop on development standards (D3.5 [16]).

More details on the LLR can be found in D3.5 [16]

Evaluation of the potential for exploitation of Lesson Learned Requirement in operation

Evaluation of the potential for the exploitation concerns mainly further development of the presented solution with special focus placed on fulfilment of recommendations and providing the conditions necessary for that.

Including safety standards

A seamless certification process at TAS implies coordination and coherency between the different stakeholders of the TAS. Therefore:

- A safety management should be implemented at organization and at TAS level to assure safety standards harmonization and to assure application of a harmonized lessons learned feedback process from in-operation results to product and item development standards;
- Requests for the feedback loop and the associated management principles should be incorporated in the ED78A and developed in the safety assurance standards used at the level of each stakeholder (e.g. ED79A/ARP 4754A and ARP 5150A for ACFT stakeholder);
- The recommended standard framework for product development and the methods described for standard improvement are generic enough to be applied by each partner of the TAS allowing more efficient exchanges between the partners and with certification Authorities.

Safety precursor automatic capture and identification

- The developed methodology for lesson learned requirements presents the potential to support the improvement of safety assurance in operation via collecting of safety precursors. It is possible to envisage the implementation of automatic means to detect and to capture safety precursor occurrence.

The exploitation understood in terms of usability and efficiency. Certification standards improvement implies:

- The definition of an harmonized safety standards frameworks applicable at TAS for product development, safety assessment , method standard, software item development, electronic hardware item development standard, procedure and services development standard;
- The identification during development process of precursors event to monitor during operation;
- The collection and analysis of events occurring during development testing and during operation;
- The development of lesson learned requirements for safety standards improvement and product design improvement;
- The identification and the consideration of the impact of novelties and future changes in the TAS organization, standards and operations;
- The possibility of an automatic recognition of safety precursors when events occurs in operation.

Product development process support

Similarly to the Safety assurance process in operation also applying the methodology behind the LLR can lead to significant decrease in the cost of product development (see section 3.1). Efficient early identification of hazards minimises the risk related to accident emerging during operation.

Potential users of Safety assurance process in operation

Certification bodies, EUROCAE, SAE

3.3.5 Overall safety impact assessment method

According to the D3.4 [17] ATM Network MacroMOdel (ATM-NEMMO) is proposed as a simulation tool. It is a mesoscopic approach to modelling European ATM network based on complex systems theory. The model response in the form of output variables (performance Indicators and metrics) is the input to a specific safety module, based on CATS model diagrams, able to translate the outputs in terms of safety level both at network and local levels.

The CATS safety module integrates links directly with the outcomes of the simulations to the probability of occurrence of specific base events that are considered to be sensitive to changes in the level of delay and/ or overloads. The combination of ATM-NEMMO with CATS diagrams allows, therefore, that network-wide performance assessments, capturing propagation patterns and integrating interdependencies between network elements, are transformed into potential variations of local safety risks, enriching the safety picture given by the CATS fault-tree approach.

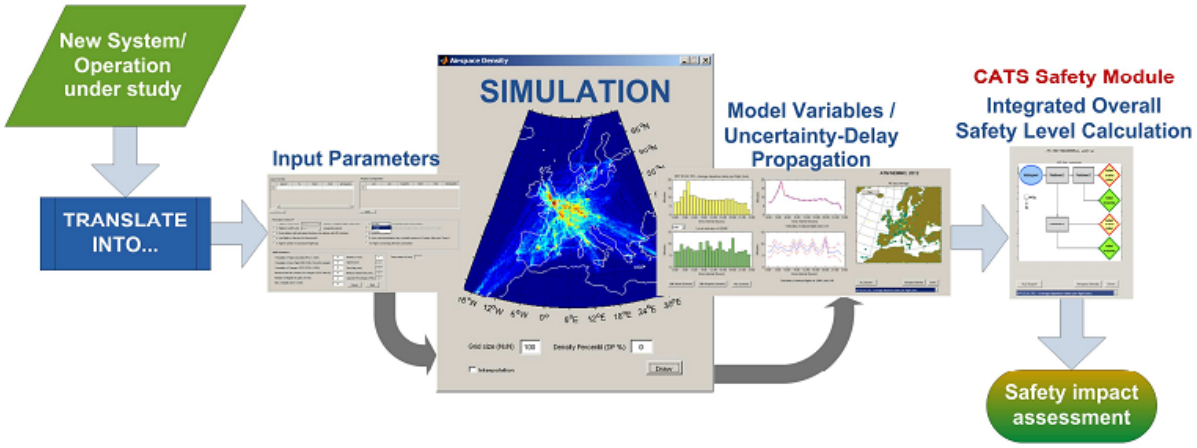


Figure 5 Overall Safety Impact Approach using ATM-NEMMO/ CATS tool [17]

The results of the ATM-NEMMO/ CATS analysis could be an input for safety practitioners to the analysis of the potential hot spots where countermeasures might apply.

Evaluation of the exploitation potential

The presented tool is an example of potential synergy emerging form combining two modules ATM-NEMMO and CATS diagrams. Therefore, some way of its exploitation can be the same as in the case of ASCOS Risk Model. Nevertheless, its specific purpose – evaluation of safety impact resulted from introducing new safety enhancement systems and/or operations in the TAS – also creates a new specific ways for ATM-NEMMO/ CATS Tool exploitation. One of them is:

Further research aimed at tool development

According to recommendations included in D3.4 [17] the tool needs to be further developed and improved. In detail, it is necessary to:

- Discuss with the ATM and safety community a way to obtain useful feedback;
- Implement the proposed approach and test representative cases to reveal strengths and weaknesses of the method; as well as
- Provide more insight into the intricacies of managing the complex air transport network and ensuring that safety risks are minimised.

Other directions of ATM-NEMMO tool exploitation are strictly related to the development and exploitation of CATS / ASCOS Risk model and are presented in previous sections.

Potential users of the ATM-NEMMO / CATS tool

Amongst potential users of the tool one can distinguish:

- researches involved in safety analysis / assessment especially representatives of ATM domain;
- other safety practitioners, representatives of aviation authorities especially those involved in ATM domain.

3.3.6 Summary

With regard to the potential of safety based design systems and tools, and, as it is recommended in D3.1 [10] the exploitation includes:

- Publication of Safety methods as part of safety training material at any organisation level;
- Making available of Safety assessment results to all engineering and decision making levels;
- Integration of CATS model within safety methods and processes;
- Promoting of considering a Safety methods as an explicit part of the early phases of program management to devote more safety effort in early program phases, in combination with engineering and certification, the latter considered as direct product from design justifications.

3.4 Evaluation of capability to improve existing Safety Management Systems

The ASCOS approach is focused on establishing a claim that the proposed “change” to the TAS will be acceptably safe. The core of the ASCOS approach is the development of a logical justification presented as a hierarchical set of claims, supported by evidence. The justification is developed to consider all aspects of the system affected by the change, also referred to as the ‘areas of change’. Key considerations are the interaction between domains and the changes in roles and responsibilities.

From an SMS perspective the ASCOS approach is seen as a way of managing change and as such may be viewed as a component of the SMS. The underlying premise of this section is that an improvement in the management of change has the potential to improve the management of safety.

The following diagram has been included to assist with the component view of the SMS.

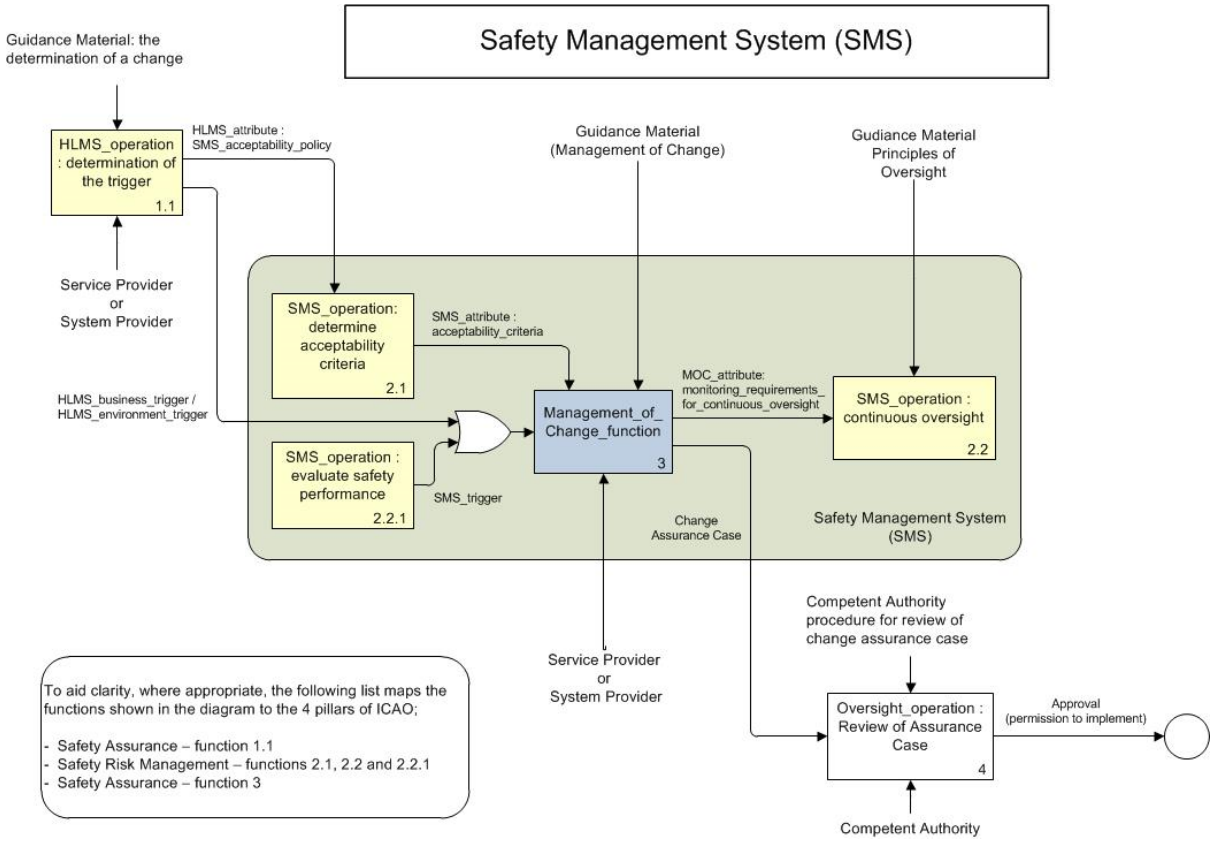


Figure 6 Safety Management System diagram

The Management_of_Change_function (highlighted in blue) is essentially the focus of ASCOS with;

- three triggers, namely a Business needs trigger, a change in Environment trigger, a trigger in response to evaluation of Safety Performance and
- two outputs, namely a change assurance case and a set of monitoring requirements for the continuous oversight function of the SMS.

Whilst not explicitly discussed in this section it is also recognised that the concept of building a logical justification has a wide range of possible applications: in addition to justifying claims about safety, it is also able to address environmental and security claims. The significance of this is that expansion of the ASCOS approach lends itself to the concept of an Integrated Management System within which several constraints may be managed in order that the impact and balance across the constraints may be taken into consideration.

3.4.1 Existing Safety Management Systems and making ASCOS results relevant and accessible

The following is an outline of the approach taken:

Step 1: identification of the areas for improvement through analysis of the results from WP1, categorised in terms of shortcomings and bottlenecks (terminology introduced by WP1 note).

Step 2: the provision of a high level description of the principles of a SMS (in plain language).

Step 3: illustration of where the improvements proposed by ASCOS 'fit in' and how they may be applied in the real world, using the high level description of step 2 as a form of generic reference model.

It is important to understand the following ASCOS definitions;

shortcomings – where existing regulations are either inadequate or simply do not provide the necessary control

bottlenecks – where existing regulations, although adequate on paper, are not adequately implemented throughout Europe; this may include situations where implementation is not uniform in all States

3.4.2 Reported Deficiencies (step 1)

The deficiencies identified in WP 1 were presented as follows where a red bar is seen as a negative influence and a green bar is seen as a positive influence. The length of the bar is proportional to the degree of the influence.

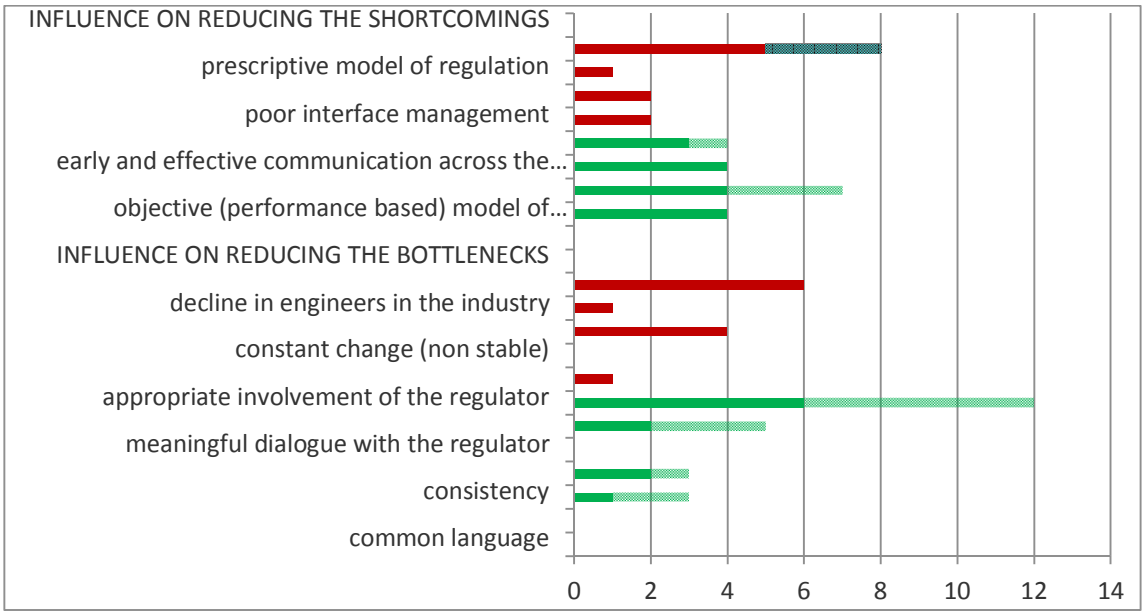


Figure 7 Results of Analysis in ASCOS WP 1

From this the following high level observations are made, it is the second of the observations that highlights the potential for improvement in the implementation of SMS;

> Some states have appropriate legal frameworks for implementing State Safety Plans , SMS, and legal support for just culture but some states do not. There has been no real harmonisation for many years.
>
> While the principles and rules for SMS are reasonably well written down there is little understanding of how to put it into practice and how such systems may be regulated. There is a great need for education and training.

3.4.3 Facilitating access to the benefits of ASCOS through a simple understanding of SMS (step 2)

There are many models to choose from to outline the basic components of a SMS. Rather than use any specific model the following sets out the 'high level' objectives of an SMS;

- A service that is safe will remain safe unless acted upon by an external 'force' … *(not unlike Newton's first law of motion!)*
  - In our case the external 'force' is a change
    - No matter where the change comes from
    - No matter what size or shape the change is
    - No matter whether it is planned or not
  - In other words:
    - A service that is safe will remain safe unless the underlying operational system, a service it uses or its operational environment is changed.
- The SMS provides a culture where it is expected that the people providing the operational service will:
  - do safe things; and
  - monitor the safety of the service in order to detect when unsafe things are being done; and
  - when unsafe things are detected, change the operational system; and
  - proactively monitor the environment in which they work and make changes before safety is affected.
- The Change Management System (CMS) plans the necessary changes to the operational system that, when implemented, leave the system safe enough.

3.4.4 Help from ASCOS – in improving existing Safety Management Systems (step 3)

To illustrate how the adoption of ASCOS principles has the potential to improve the implementation of SMSs the above is repeated with red highlights indicating how the output from 'change management' should inform the SMS;

- The SMS provides a culture where it is expected that the people providing the operational service will:
  - do safe things; and
  - monitor the safety of the service in order to detect when unsafe things are being done; and
  - when unsafe things are detected, change the operational system; and
  - proactively monitor the environment in which they work and make changes before safety is affected.
- The Change Management System (CMS) plans the necessary changes to the operational system that, when implemented, leave the system safe enough.

3.4.5 Summary

Through consideration of the full impact of change, recognition and management of the interaction between domains the approach proposed by the ASCOS consortium has the potential to fully inform, as appropriate, the overall management of safety.

The following are of particular note:

- A common understanding of the service or system under consideration is enhanced when describing a system or service in terms of where it resides in the TAS and in terms of its relationship to the safety related service.
- Inspection of a complete risk model of the aviation system has the potential to improve the identification of the areas of change of a proposed change and thereby improve the management of change.
- Inspection of a complete risk model will improve the continuous oversight function by identifying a more complete and correct set of monitoring requirements.

Inspection of a complete model of the total system behaviour has the potential to provide a clear understanding of the safety significance of a service, supporting service or system which one is then able to use in the determination of an appropriate level of oversight.

3.5 Keep up working relationships with safety teams and certification bodies

ASCOS presents a methodology to improve current certification in order both to address the certification of new products or operations and to build a seamless process involving all aviation stakeholders. This

certification methodology impacts safety teams, standardization panels and certification bodies. The latter are part of authorities' functions, and have a clearly established role within the aviation system, this role is retained in ASCOS although their tasks can be enlarged (e.g. EUROCAE and SAE, (see table 6 below)

ASCOS project addresses safety as well as it proposes an improvement in the Safety Management and in safety tools. The safety process is enriched by the introduction of precursors as identification of causal factors and the improvemed continuous monitoring process. Results from safety groups are considered as having a clear interface with ASCOS project (e.g. FAST and AoC in D1.3 methodology [2]).

Some ASCOS participants were and are still involved in these safety and certification teams, bringing experience on methods, working arrangements of these teams and inform on remaining issues for which ASCOS is due to develop solutions.This subchapter presents main ASCOS outputs and its interface with relevant safety and certification bodies.

WP 1: D1.3&D1.5 Outline Proposed Certification Approach

D1.3 [2] & D1.5 [12] present a certification methodology based on a logical argument approach. This logical approach introduces the concept of modularization, where the overall argument is decomposed into manageable modules that can be allocated to different stakeholders. If required, each stakeholder can plug the existing standards into the proper module. The D1.3 [2] & D1.5 [12] methodology proposes to manage the interface between modules by establishing assurance contracts between modules.

The methodology D1.3&D1.5 follows a progressive application from the high level certification argument, at the level of the TAS, to the lowest level, at the level of equipment. Therefore, D1.3&D1.5 is addressed to all certification and safety bodies (e.g. EUROCAE and SAE).

WP 2: D2.3 Continuous Monitoring Approach

WP 2 presents methods to measure safety performance monitoring process of a product, a service provider and a State level. This process uses the Continuous Monitoring Approach as an integral part of the stakeholder's life cycle processes. ASCOS D2.3 [18] method is based on SPIs monitoring that are linked to causal factors (precursors). These SPIs can be promoted implemented and reported to the ECCAIRS repository. The SPIs can be automatically recorded (e.g in an ACFT) and used late to identify precursors and improve standards (e.g for continuous airworthiness).

In most cases, information needed for ASCOS SPIs is already required by the EU directive 2003/42/EC on occurrence reporting in civil aviation. This approach to standardized implementation is also advocated by ICAO and SM IGC.

The ASCOS CMA process is addressed to ICAO, EASA as well as safety panel of each aviation stakeholders.

WP 3, D3.1 & D3.5

- WP 3.1

ASCOS within WP 3.1 [10], highlights the high value of methodological research performed by FAST (Future Aviation Safety Teams). Its capacity for bringing more anticipation to most safety and associated engineering decisions, places it among the highest ROI makers, if properly implemented. (Ref. Examples of paragraph 4 above in document WP 6.2). It has been proved that FAST predictions issued 10 years ago, revealed to become reality in recent accidents, showing the major interest of its proposed "Proactive Safety"

FAST produced a lot of material concerning changes with AoCs (Area of Changes), root causes, interactions between systems and precursors' detection. FAST material is available, extensively described in WP 3.1 [10]. but need to be continuously updated. ASCOS WP 3 and examples mentioned above have demonstrated the interest of a strong interaction with management and engineering domains. Examples mentioned above in paragraph 4 show the benefit to apply FAST principles in early program phases. (reference to be updated once WP 6.4 was written)

Integration of FAST practices in engineering and review processes as recommended in WP 3.5 demonstrate the benefit of the synergy between FAST and ASCOS and paves the way for continuing that cooperation with safety teams.

FAST core team continues to work and keeps up working relationships with EASA EME 1.1 & 1.2 and with ATLAS, clone of FAST on US side. Fortunately for our US colleagues ATLAS has been set up with a strong commitment and financing from US Authorities.

EGAST (European General Aviation Safety Team) revealed to be a forum of major interest for ASCOS, for two reasons.

- General Aviation surprisingly, introduces advanced technologies before commercial aviation, mainly in the instruments domain.
- General Aviation is the nursery of the majority of airlines pilots where good practices shall be acquired for life.
- NLR and JPM is are actively participating to EGAST core team. This participation has to be kept up.

As underlined in WP 3.1 [10] and expanded in WP 3.5 [16], standards will play a major role in implementation, therefore standardization committees (SAE/ARP, EUROCAe) are places to keep tight relationships with.

ASCOS already introduced experience and methods from FAST, from program management experience, from standardization committees (SAE/ARP, EUROCAe).

WP 3.5

ASCOS (WP 3.5) develops a process to improve the safety standards used at TAS level and by each stakeholder of the TAS. This is done by defining a common safety standard framework to be used at TAS level and by each stakeholder and by implementing a feedback loop from in operation experience to allow continuous safety standard improvement. The process introduces activities to implement at TAS level (inter-stakeholder) and at each stakeholder level to improve safety standard organization by:

- Setting a common safety standard framework and developing coherent safety standards applicable at inter-stakeholder level and at each stakeholder level
- Implementing a continuous safety standard improvement loop based on a safety precursor capture and on application of lessons learned from in operation events. Consideration of implementation of a safety precursor automatic capture/coding system
- Implementing at inter-stakeholder level a safety and engineering activity to coordinate stakeholder safety activities and integrate safety stakeholder results at TAS level

Main certification bodies impacted are EUROCAE WG 53/ WG 91 and SAE S18/ EUROCAE WG 63. These certification bodies are suggested to modify and harmonize the certification standards.

Action REF	Action description	Action owner
1- Safety standards organization		
1.1 Safety standard framework	1.1.1 Implement in ED78A to be applicable stakeholder level and covering both product development and in operation safety assurance1.1.2 Extend the application of the ED78A to other development activities than Data Link	EUROCAE WG 53/ WG 91 EUROCAE WG 53/ WG 91
1.2 Safety standards development	1.2.1 Revisit ED78A and ARP4754A/ED79A .Make them consistent in term of requirement exchange, requirement validation, DAL assignment and severity classification. 1.2.2 Implement the ASCOS Standard framework and Develop/identify and implement, at the level of each stakeholder, a coherent safety standards for: - Product development - Safety assessment/analysis applicable methods - Software Item development - Hardware item development, - Procedure and service development - Safety assurance in operation For ACFT stakeholder: review ARP 4754A/ED 79A, ARP 5150. For other TAS stakeholders: identify standards and make them coherent with revisited ED 78A directives	EUROCAE WG 53/ WG 91 SAE S18/ EUROCAE WG 63 SAE S18/ EUROCAE WG 63 To be defined

2- Safety standard continuous improvement loop using a safety precursor approach–		
2.1 Safety precursor identification at TAS level	In ED78A at TAS (inter-stakeholder) level implement a process for safety precursor identification based on CATS ESDs	EUROCAE WG 53/ WG 91
2.2 Safety Precursor identification at stakeholder level	At each stakeholder level Develop a process for safety precursor identification during product development/implementation phases (results from safety assessments) using safety assessment results and CATS ESDs (for ACFT stakeholder update ARP 4754A/ED 79A, ARP 4761/ED and ARP 5150	SAE S18/ EUROCAE WG 63
2.3 Safety standard continuous improvement	Implement, in Safety Assurance standard at TAS level and stakeholder level, a continuous improvement loop based on lessons learned from in operation events	EUROCAE WG 53/ WG 91 SAE S18/ EUROCAE WG 63
2.4 future risk consideration	In Safety Assurance standard at TAS level and stakeholder level implement a process for future risks identification and mitigation	EUROCAE WG 53/ WG 91 SAE S18/ EUROCAE WG 63
2.5 Precursor automatic capture/coding	At TAS level as well as each stakeholder level promote a process for automatic detection and capture/coding of the precursor events when they occurs	EUROCAE WG 53/ WG 91 SAE S18/ EUROCAE WG 63
3- Safety management at TAS (inter-stakeholder) level		
3.1 Safety management at TAS (inter-stakeholder) level I	Implement In ED78A at TAS (inter-stakeholder) level a safety management group to: - Enforce the activities and processes recommended in action item 1.1 to 2.5 in this table - Assure and Coordinate development of CATS ESDs at TAS level - Coordinate stakeholder safety activities - Integrate stakeholder safety activities at TAS level - Manage relations with certification and operational authorities and with ICAO	EUROCAE WG 53/ WG 91

Table 5 Standards owners / providers - main addressees of the actions

Note that the improvement of the existing standards as defined in WP 3.5 [16] takes on board main elements of ASCOS. The precursors identification considers FAST and ICAO taxonomy:

- **Consider AoC** identified in WP3.1(from FAST press) to select those to monitor as precursor, and define means of detection
- Check if the **precursors** are already part of **SPIs** (from ASCOSS WP2) and if they have already a code in the **ICAO taxonomy**. Complete the ICAO taxonomy if necessary

Conclusion

ASCOS certification process is addressed to all safety team and certification bodies in the aviation domain. Working Relationships have to be kept with:

- FAST core team and derived initiatives (ATLAS in USA) EASA (Safety Road Maps, EME 1.1, 1.2, ESSI)
- European commission initiatives, in particular OPTICS as a coordination body within Framework Programs Standardization committees
- EUROCAE WG 53/ WG 91
- SAE S18/ EUROCAE WG 63
- ICAO
- SMIGC
- ECCAIRS
- ESSI (ECAST, EHEST, EGAST)

4 Project results and their exploitation

4.1 Result no. 1: Proposed certification approach

Project result description	
No.	1
Title	Consolidated New Approval Method
Contact person	Name: Alan Simpson Organisation: Ebeni Ltd Address: Hartham Park, Corsham, UK Telephone: +44 (0) 1249 700 507 E-mail: alan.simpson@ebeni.com
Result url	*http://www.ascos-project.eu/publications/deliverables (D1.3 & D1.5)*
Summary	The document D1.5 presents the consolidated approval approach for the total aviation system (TAS), generated by refining the D1.3 approach following feedback from the case studies (WP4) and from validation exercises (WP5). This document represents the final output from the ASCOS project in respect of a consolidated approval approach. This approach does not require any changes to regulations; rather it provides a proposed means for the industry to meet the existing and emerging approval requirements imposed by the EASA rulemaking programme. The approach provides the ability to consider the entire aviation system, and to capture issues at interfaces between sub-elements of the system. The approach also provides the flexibility to encompass the analysis of new concepts and technologies. However, it is expected that there will be an increase in the cost and time requirements to gain approval, at least in the short term while the approach becomes established. Although this approach has been refined taking feedback from the case studies and validation exercises, it has not yet been used in any actual applications within the industry. The approach is presented here as an initial version, ready for application on real systems, but with the expectation that further improvements can be made in the light of experience.
Involved partners	NLR, Thales Air Systems (TR6), CAAi, Ebeni, IoA
Documentation	**Type*** / **Description (title, details)** / **Status**** R / ASCOS D1.5, Consolidated New Approval Approach, S. Bull (Ebeni) et al / PU * R=Report, O=OTHER (e.g. software) ** PU=public, CO= confidential
Targeted stakeholder types	Authorities (EASA and national authorities), Service providers, Air Operators, Aerodromes, Product Manufacturers

Exploitation of project result	
Recommendations from ASCOS WP4/ WP5	WP4.5 and WP5 have made multiple recommendations for improvement of D1.3, which have been incorporated in D1.5. WP4.5 also makes recommendations for changes to be made by EC and EASA to facilitate the exploitation.
Exploitation potential	WP4.5 evaluated the approach (D1.3) against the following Key Performance Areas: efficiency, soundness, cross-domain integration, harmonization, accommodation of innovation, acceptability and flexibility. It was generally rated as high, with a couple of exceptions. It was not rated against acceptability. In these cases, WP4.5 made a number of recommendations which have been addressed in D1.5 and it is intended that this will significantly improve the potential for exploitation in these areas.
Exploitation strategy	Partners in the role of authority to recommend the approach to applicants especially for complex changes. Partners in the role of applicants (e.g. manufacturers) to propose the approach when making applications for approval. Partners in the role of consultants to recommend the approach where applicable when involved in applications for approval. Establishment of a Total Aviation System Engineering and Safety Group (TESG), playing the argument architect role for changes involving multiple organisations, is a precondition that will strongly support the exploitation of the Consolidated New Approval Method [D1.5, D1.6].

4.2 Result no. 2: Framework safety performance indicators

Project result description	
No.	2
Title	Framework safety performance indicators
Contact person	Name: Lennaert Speijker Organisation: National Aerospace Laboratory NLR Address: Anthony Fokkerweg 2, 1059CM Amsterdam, the Netherlands Telephone: +31 (0) 88 511 3654 E-mail: lennaert.speijker@nlr.nl Website: www.nlr.nl
Result url	*http://www.ascos-project.eu/publications/deliverables (D2.1, D2.6)*
Summary	The following project result is achieved: a list of proposed safety performance indicators defined at four different levels: technology, human, organisation, system or organisations. The indicators are also linked to the main operational issues of the European Aviation Safety plan (EASp). To facilitate quantification and semi-continuous updating of the safety performance indicators, it is recommended that each proposed indicator is unambiguously connected to one or more events of the ECCAIRS taxonomy and a suitable denominator from EASA's warehouse for aviation production data. Data from both sources should be assembled, and the safety performance indicator values should be semi-continuously calculated, preferably by using automated tools for continuous safety monitoring. The latter will reduce the

<table>
<tr><td></td><td>costs of data gathering and processing. It should be ensured that monitoring of human actions cannot be misused or abused (e.g. for legal purposes), and that it is not intended to monitor actions of human operators. It is recommended to map of what is considered important to measure (as listed in D2.1) versus the measures that are possible given current data. A gap analysis would then show what data needs to be gathered to ensure that safety can really be monitored effectively.</td></tr>
<tr><td>Involved partners</td><td>NLR, Deep Blue, Avanssa</td></tr>
<tr><td>Documentation</td><td>
<table>
<tr><th>Type*</th><th>Description (title, details)</th><th>Status**</th></tr>
<tr><td>ASCOS D2.1</td><td>A.L.C Roelen, J.G. Verstraeten, L. Save, N. Aghdassi, Framework safety performance indicators, Version 1.5, 14-01-2014</td><td>PU</td></tr>
<tr><td>ASCOS TP-1</td><td>J.G. Verstraeten, A.L.C. Roelen, L.J.P. Speijker, Safety performance indicators for system of organizations in aviation</td><td>PU</td></tr>
</table>
* R=Report, O=OTHER (e.g. software) ** PU=public, CO= confidential
</td></tr>
<tr><td>Targeted stakeholder types</td><td>Service providers, authorities</td></tr>
</table>

<table>
<tr><th colspan="2">Exploitation of project result</th></tr>
<tr><td>Recommendations from ASCOS WP4/ WP5</td><td>The framework safety performance indicators is not assessed in one of the case studies performed in WP4. The framework was subject of one of the workshop held as validation activity in WP5, the results show clear benefits and usefulness.</td></tr>
<tr><td>Exploitation potential***</td><td>The framework safety performance indicators is easy to apply, and does not need significant investments to apply. No acceptability issues are foreseen, although the actual definition of individual indicators might need to be altered to suit specific user needs.</td></tr>
<tr><td>Exploitation strategy</td><td>The indicators and knowledge acquired on how to define indicators will be used in future research and consultancy activities. The framework will be used as starting point in case safety performance indicators need to be defined, either in European research or consultancy for individual service providers or authorities.</td></tr>
<tr><td>Involved partners</td><td>NLR</td></tr>
<tr><td>Planned actions</td><td>
<table>
<tr><th>#</th><th>Action</th><th>Responsible partner</th><th>Due date</th></tr>
<tr><td>1</td><td>Apply lessons learned in Future Sky Safety. Use framework for development Risk Observatory in Project P4: “Total System Risk Assessment”</td><td>NLR</td><td>2015-2018</td></tr>
<tr><td>2</td><td>Apply framework of SPIs (or similar) in consultancy for service providers & authorities</td><td>NLR</td><td>2015 onwards</td></tr>
</table>
</td></tr>
</table>

4.3 Result no. 3: Process safety performance monitoring

<table>
<tr><th colspan="2">Project result description</th></tr>
<tr><td>No.</td><td>3</td></tr>
<tr><td>Title</td><td>Process safety performance monitoring</td></tr>
<tr><td>Contact person</td><td>Krzysztof Piwek</td></tr>
<tr><td>Result url</td><td>http://www.ascos-project.eu/publications/deliverables (D2.3)</td></tr>
<tr><td>Summary</td><td>ASCOS performance based safety monitoring process corresponds to the Continuous Monitoring Approach used as integral part of the stakeholders' life cycle processes for the purpose of the Safety Assurance SMS component. The monitoring is based on the feedback process known in the literature as the Deming Circle or PDCA Cycle (Plan, do, check, act). The steps defined in the process are as follows: 1. Designation of responsibilities; 2. Review of safety policy and objectives; 3. Definition of indicators and their specifications; 4. Determining data requirements; 5. Collection of information; 6. Analysis of the results; 7. Response to findings; 8. Evaluation and correction of SPIs (within a longer term). The monitored indicators (total 63 SPIs of 4 levels – component, human, organisation and system of organisations) are expected to be collected using ECCAIRS software. The method is more oriented on precursors mitigation approach instead of traditional post-accident and incidents mitigation approach. It enables the prevention, mitigation or elimination of phenomena (precursors) directly leading to high risk events. Some SPIs could be perceived as precursors, but most of them are lagging signals. This is why the following method of response is suggested. When the SPIs records indicate target level of safety is exceeded, then lists of identified precursors support root cause analyse and risk assessment (supported by ASCOS 'Tool for risk assessment') leading to implementation of adequate risk mitigation plans. Raw data for human level of SPIs could be automatically detected (e.g. FDM data). Furthermore, FDM provides feedback on the assumptions made in certification and helps to identify new/changed hazards and assess associated risks. Bow-tie models contain events which can be quantified or associated with FDM parameters and occurrence reports from voluntary reporting programs. ATM related ASCOS SPIs (such as separation infringements, level busts) are easily comparable especially if they are classified with a common scheme such as the EUROCONTROL Risk Analysis Tool (RAT).</td></tr>
<tr><td>Involved partners</td><td>ILOT, Avanssa, NLR, CAAi, Deep Blue, JRC</td></tr>
<tr><td>Documentation</td><td>
<table>
<tr><th>Type*</th><th>Description (title, details)</th><th>Status**</th></tr>
<tr><td>R</td><td>D 2.3 Process performance safety monitoring</td><td></td></tr>
</table>
* R=Report, O=OTHER (e.g. software) ** PU=public, CO= confidential
</td></tr>
<tr><td>Targeted stakeholder types</td><td>Any TAS organisation pursuant to EC 216/2008.</td></tr>
</table>

Exploitation of project result	
Recommendations from ASCOS WP4/ WP5	Product has not been tested in WP4 nor in WP 5
Exploitation potential	Safety assurance process in operation exploitation potential: Feasibility: Quite feasible, mostly covered by current standards, strategically aligned to ICAO GASp Efficiency: Similar to current standards – ICAO SMS Acceptance: Correlated with level of the SMS safety culture implementations
Exploitation strategy	To be implemented by TAS organisation pursuant to EC 216/2008.
Involved partners	ILot, NLR
Planned actions	

#	Action	Partner	Date
1	Further research and validation in Future Sky Safety	NLR	2015-2018
2	Continued research and validation in H2020	ILot	2017-2020

4.4 Result no. 4: Tool for continuous safety monitoring

Project result description	
No.	4
Title	Ascos Tool for Continuous Safety Monitoring (ATCSM)
Contact person	Wietse Post JRC (wietse.post@jrc.ec.europa.eu)
Result url	http://www.ascos-project.eu/publications/deliverables (D2.4)
Summary	The task of the ATCSM is to facilitate the development of SPI's in the context of the continuous monitoring of safety in the aviation system. The ATCSM does so by calculating occurrence rates which combine the results of user defined queries against an ECCAIRS occurrence database with user provided related exposure or production data. The calculated occurrence rates can be exported. They are also displayed in graphical form as a timeline permitting the user to monitor or evaluate the development of the SPI over time. To facilitate this monitoring, the user can, in addition the calculated occurrences rate, display the average and the trend (based on linear regression) of the SPI. Further, lines can be included in the SPI graph to show the value of the average of the displayed rate plus or minus the standard deviation or the confidence interval.
Involved partners	NLR, CAAi, AVA, DBL, IoA
Documentation	

Type*	Description (title, details)	Status**
R	ASCOS D2.4: Reinhard Menzel, Wietse Post (JRC), Simone Rozzi, Luca Save (Deep Blue) Tools for Continuous Safety Monitoring Version 1.1	PU

	<table><tr><td>R</td><td>ASCOS Tool for Continuous Safety Monitoring - User Manual Version 1.2</td><td>PU</td></tr><tr><td>O</td><td>ASCOS Tool for Continuous Safety Monitoring Software Version 1.0.0.8</td><td>CO</td></tr></table> * R=Report, O=OTHER (e.g. software) ** PU=public, CO= confidential
Intellectual property rights	<table><tr><th>Organisation</th><th>Description</th><th>Type***</th></tr><tr><td>JRC</td><td>Owner of the ATCSM software and its source code</td><td>F-IPR</td></tr></table> ***: Background IPR (B-IPR) and/or Foreground IPR (F-IPR)
Targeted stakeholder types	The potential users of the ATCSM are the Competent Aviation Authorities (CAA and/or SIA) in the ECCAIRS community, as well as any other organisation using ECCAIRS as their tool for occurrence reporting.

Exploitation of project result	
Recommendations from ASCOS WP4/ WP5	The ATCSM tool was subject of a validation workshop in Rome. The potential of the tool was recognised in the context of an ECCAIRS based safety data collection framework and the initial ASCOS WP2 requirements. In this light the tool was seen as a welcome enhancement of current practices. The innovative value of the tool, i.e. novel concepts for which no standards and regulations exist, is less clear.
Exploitation potential	The ATCSM tool has been presented to the ECCAIRS community during the 2014 ECCAIRS Steering Committee Meeting in a dedicated workshop. It was well received and the competent NAAs and SIAs showed interest in deploying the tool in their organisations. Once deployed further development is expected based on actual user feedback.
Exploitation strategy	The ATCSM tool will be made available free of costs to the European and International ECCAIRS community. It will be considered one of the standard tools of the ECCAIRS suite.
Involved partners	JRC, ECCAIRS community
Planned actions	<table><tr><th>#</th><th>Action</th><th>Partner</th><th>Date</th></tr><tr><td>1</td><td>The ATCSM software will be made to the ECCAIRS community in May 2015 via the ECCAIRS web portal</td><td>JRC</td><td>May 2015</td></tr></table>

4.5 Result no. 5: Risk model

Project result description	
No.	5
Title	ASCOS Risk model (improved Causal model for Air Transport Safety (CATS))
Contact person	Lennaert Speijker (lennaert.speijker@nlr.nl)
Result url	*http://www.ascos-project.eu/publications/deliverables (D3.2)*
Summary	The objective of the ASCOS risk model is to provide an integrated approach to risk

<table>
<tr><td></td><td>modelling in which human factors and cultural aspects are considered in connection with technical and procedural aspects and with specific emphasis on the representation of emerging and future risks. The accident scenarios are represented as event sequence diagrams and fault trees. The ASCOS model is based on the CATS model and consists of 29 accident scenarios that represent virtually all major aviation safety risks. The model is quantified in the sense that probabilities of occurrence are assigned to the various elements of the different pathways of the accident scenarios. The representation and the evaluation of the emerging/future risks using CATS ESDs can be done if each base event of the fault tree is linked to precursors and if a dedicated capture process is defined for these precursors. The application of the precursors capture process allows calculating the precursors' occurrence rates and then emerging/future risks with Event Sequence Diagrams.</td></tr>
<tr><td>Involved partners</td><td>NLR, APSYS, Deep Blue, CAA UK</td></tr>
<tr><td>Documentation</td><td>
<table>
<tr><th>Type*</th><th>Description (title, details)</th><th>Status**</th></tr>
<tr><td>D3.2</td><td>A.L.C. Roelen et al.;</td><td>RE</td></tr>
<tr><td>Technical publication</td><td>A.L.C. Roelen et al.; Risk models and accident scenarios in the total aviation system, 16-02-2014</td><td>PU</td></tr>
</table>
* R=Report, O=OTHER (e.g. software)
** PU=public, CO= confidential
</td></tr>
<tr><td>Intellectual property rights</td><td>
<table>
<tr><th>Organisation</th><th>Description</th><th>Type***</th></tr>
<tr><td>CAA NL</td><td>Owner of the CATS software tool and model</td><td>B-IPR</td></tr>
<tr><td>NLR/CAA NL</td><td>Development and maintenance of ASCOS risk model (improvement of the CATS model, as listed above)</td><td>F-IPR</td></tr>
</table>
***: Background IPR (B-IPR) and/or Foreground IPR (F-IPR)
</td></tr>
<tr><td>Targeted stakeholder types</td><td>EASA, Civil Aviation Authorities, Operators, Service Providers</td></tr>
</table>

Exploitation of project result	
Recommendations from ASCOS WP4/ WP5	The risk model and associated software tool set was assessed in one of the validation exercises performed in WP5. Additionally, interactions with EASA resulted in a safety risk picture approach, based on ASCOS/CATS, used in EASA. For specific recommendations, please refer to ASCOS D3.2, D5.4, and D5.5.
Exploitation potential	The risk model can be applied directly, and does not need significant investments to apply (although further research/development may be needed, depending on the purpose of the intended use. No major acceptability issues are foreseen, although care should be taken with gathering and analysis of relevant safety data.

Exploitation strategy	The ASCOS risk model, an improved version of the CATS model (and toolset) will be used in future research and consultancy activities. This could e.g. be for H2020 (in Future Sky Safety) or consultancy for operators, service providers or authorities.
Involved partners	NLR
Planned actions	

#	Action	Partner	Date
1	Further research and application in Future Sky Safety, e.g. for development of a Risk Observatory	NLR	2015-2018
2	Research and consultancy for civil aviation authorities	NLR	2015 onwards

4.6 Result no. 6: Tool for risk assessment

Project result description	
No.	6
Title	ASCOS Tool for Risk Assessment
Contact person	Prof. Richard Curran
Result url	*http://www.ascos-project.eu/publications/deliverables (D3.3)*
Summary	The tool for risk assessment is a web-based software tool that can be used by a safety practitioner as support in the risk assessment process. The tool embodies the ASCOS risk model and representation of accident scenarios, which are based on CATS. It uses the Event Sequence Diagram (ESD) and Fault Tree logic to represent the total aviation system risk model that was developed in ASCOS WP3.2. The user can use the tool to explore the risk model developed in ASCOS and to assess the impact of modifications in the Total Aviation System in order to support the certification process. It allows the user to utilize the safety risk method developed to support the new proposed certification approach. It has been validated within ASCOS WP5 Validation.
Involved partners	TUD, NLR, APS
Documentation	

Type*	Description (title, details)	Status**
R	D3.3 Tool for risk assessment and user manual	PU
O	ASCOS Tool for Risk Assessment	PU

* R=Report, O=OTHER (e.g. software)

** PU=public, CO= confidential

Intellectual property rights	

Organisation	Description	Type***
TUD	Delft University of Technology (TUD) has developed the tool, including software architecture, software	F-IPR

		design, software functional flow and software code. TUD is the only organization involved in writing software code. TUD is the owner of the ASCOS Tool for Risk Assessment software and source code.	
	NLR	NLR has developed the risk-model and accident scenarios that are embodied in the tool as part of ASCOS WP3.2. This includes the structure of the risk-model (Event Sequence Diagrams, Fault Trees), and the methods to calculate event probabilities.	B-IPR
	***: Background IPR (B-IPR) and/or Foreground IPR (F-IPR)		
Targeted stakeholder types	All stakeholders involved in safety risk assessment (Certification Authorities, Manufacturers, etc.)		

Exploitation of project result	
Recommendations from ASCOS WP4/ WP5	In WP5 the main areas of improvement have been identified regarding usability of the tool, transparency of analysis, and compatibility with other software. A functionality that provides suggestions for identifying which ESDs/FTs could be affected by a change would help the analyst in cross-domain risk assessment. Support for the graphical exploration of the model elements would ease the model exploration. Easier access to detailed descriptions of model elements is desirable. A different way to update the probability value of an element, other than a keyboard input would reduce user errors. Further development of the integrated audit trail capability would help the analyst making a consistent and transparent safety argument, and make changes traceable to other users. Compatibility with Fault-Tree software in addition to the existing EXCEL export would allow exchanging analysis with existing tools.
Exploitation potential	There are two key contributions made by the ASCOS Tool for Risk Assessment. The tool hosts a model-master, and restricts users to only make “virtual” modifications in their analysis. The model-master is an approved version of the risk-model. All users interact with the same model, which makes analysis easier to compare. This concept is not specific to the ASCOS risk-model and can be transferred for other models as well. The tool runs on a server and is accessible online through a browser. No installation is needed on the user’s computer, which eases the dissemination of and access to the model. The tool can be further improved by implementing the feedback from WP4 and WP5. The two main contributions mentioned above are transferable to other risk-models.
Exploitation strategy	Currently there are no specific further exploitation actions planned.
Involved partners	TU Delft, NLR
Planned actions	None

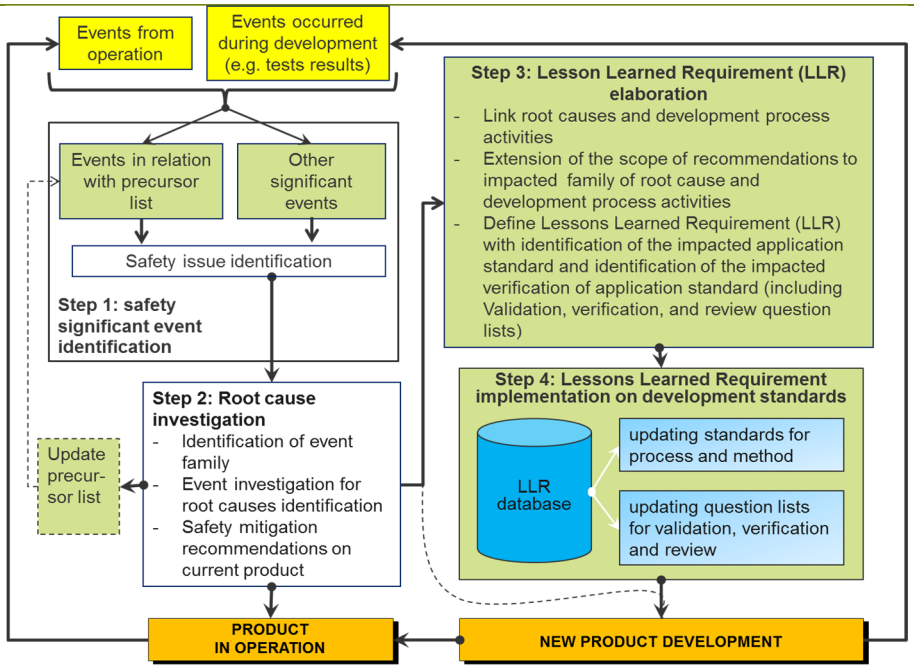
4.7 Result no. 7: Safety assurance process in operation

<table>
<tr><th colspan="2">Project result description</th></tr>
<tr><td>No.</td><td>7</td></tr>
<tr><td>Title</td><td>Harmonized Safety Standards Process and Product Safety Assurance process in operation</td></tr>
<tr><td>Contact person</td><td>Susana Bravo Muñoz, Jean Pierre Heckmann, Matthieu Feuvrier</td></tr>
<tr><td>Result url</td><td>http://www.ascos-project.eu/publications/deliverables (D3.5, D3.6)</td></tr>
<tr><td>Summary</td><td>The aim of the ASCOS Harmonized Safety Standards process is to develop a method to improve safety of the TAS by improving development processes and safety assurance processes of TAS elements (product or system) trough improvement of applicable safety standards. This approach:
Identify the safety standards used by the different stakeholders of the TAS for product/service development and certification,
Identify and evaluate the application status of the safety standards used by the different stakeholders of the TAS for in operation safety assurance and lessons learned feed back
Propose a common framework for safety standards organization generic enough to be applied over the different stakeholders of the TAS.
The Product Safety Assurance in Operation, that merges two main models for Assurance Operation ICAO SMM and ARP, uses the results form WP 3.2 (precursors) to support the identification of monitoring parameters, the incident detection and the risk assessment. ASCOS process Product Safety Assurance in Operation ends up with a continuous feedback from in operation lessons learned process aiming at improvement of the products in operational and at improvement of standards used for product development.</td></tr>
<tr><td>Involved partners</td><td>APSYS, ILOT</td></tr>
<tr><td>Documentation</td><td><table><tr><th>Type*</th><th>Description (title, details)</th><th>Status**</th></tr><tr><td>R</td><td>D 3.5 Total Aviation System Safety Standards</td><td>PU</td></tr></table>* R=Report, O=OTHER (e.g. software)
** PU=public, CO= confidential</td></tr>
<tr><td>Targeted stakeholder types</td><td>Certification bodies, EUROCAE, SAE</td></tr>
</table>

Exploitation of project result	
Recommendations from ASCOS WP4/ WP5	Harmonized Safety Standards Process and Assurance process in operation have not been tested in WP 4 nor in WP 5.
Exploitation potential	Safety assurance process in operation exploitation potential: Feasibility: The application of a safety assurance process in operation requires a common approach to all aviation partners. Efficiency: The improvement of safety can no longer be achieved in isolation, the application of a common assurance process in operation is the next step on the increase of safety. Acceptance: Users have already stated working in cooperation, the creation of a common standard will be welcomed.
Exploitation strategy	To be disseminated in certification bodies
Involved partners	APSYS

4.8 Result no. 8: Lessons learned requirements process

Project result description	
No.	8
Title	Lessons learned requirements process
Contact person	Susana Bravo Muñoz, Jean Pierre Heckmann, Matthieu Feuvrier
Result url	*http://www.ascos-project.eu/publications/deliverables (D3.5, D3.6)*
Summary	The ASCOS methodology proposes an standardized process among all aviation stakeholders to improve safety standards using lesson learned from operation. The process consists on four steps: **Step 1: safety significant event identification** **Step 2: Root cause investigation** **Step 3: Lesson Learned Requirement (LLR) elaboration** **Step 4: Lessons Learned Requirement implementation on development standards**



Involved partners	APSYS, ILOT
Documentation	

Type*	Description (title, details)	Status**
R	D 3.5 Total Aviation System Safety Standards	PU

* R=Report, O=OTHER (e.g. software)

** PU=public, CO= confidential

Targeted stakeholder types	Certification bodies, EUROCAE, SAE

Exploitation of project result	
Recommendations from ASCOS WP4/ WP5	LLR process has not been tested in WP 4 nor in WP 5:
Exploitation potential	Safety assurance process in operation exploitation potential: Feasibility: LLR process in operation requires a common approach to all aviation partners. The feasibility requires the involvement of an entity superior to partners. Efficiency: The improvement of safety can no longer be achieved in isolation, the application of a common LLR requires a common methodology. It is not a question of return of investment Acceptance: Users have already started working in cooperation, the creation of a common methodology for lessons learned requirement will be welcomed.
Exploitation strategy	To be disseminated in certification bodies
Involved partners	APSYS

4.9 Result no. 9: Overall safety impact assessment method

Project result description	
No.	9
Title	Tool for overall safety impact
Contact person	Izaro Etxebarria
Result url	*http://www.ascos-project.eu/publications/deliverables (D3.4)*
Summary	The tool models a macroscopic scenario for network-wide safety analysis, enabling to assess the safety impact of introducing new safety enhancement systems and/or operations in the total aviation system. This can be done by analysing both safety critical points and safety benefits that can arise out of foreseen changes in the total aviation system, as example four safety enhancement will be proposed and analyzed. The starting point is the ATM NEMMO tool, which is a Network Macro Modelling tool to analyze macroscopic behavior of multi-component systems with complex interactions. The theoretical approach is to combine NEMMO and CATS to support the overall safety assessment. A User's guide is available with guidance on how to use the NEMMO-CATS combination tool to support the safety assessments.
Involved partners	Deep Blue, Isdefe, NLR
Documentation	**Type*** / **Description (title, details)** / **Status****: R / Overall Safety Impact (D3.4) / PU * R=Report, O=OTHER (e.g. software) ** PU=public, CO= confidential
Intellectual property rights	**Organisation** / **Description** / **Type***: Isdefe / ATN-NEMMO macro model / B-IPR ***: Background IPR (B-IPR) and/or Foreground IPR (F-IPR)
Targeted stakeholder types	Network Manager, ANPS, Safety experts, ATM experts.

Exploitation of project result	
Recommendations from ASCOS WP4/ WP5	The tool has not been tested in ASCOS WP4 and WP5.
Exploitation potential	The acceptability and potential use by external parties (besides ISDEFE) is currently not clear. ISDEFE is expected to further develop NEMMO in follow-up research
Exploitation strategy	No specific exploitations actions are currently foreseen
Involved partners	Deep Blue, Isdefe, Apsys

5 Exploitation plans of project partners

5.1 Exploitation plan of NLR

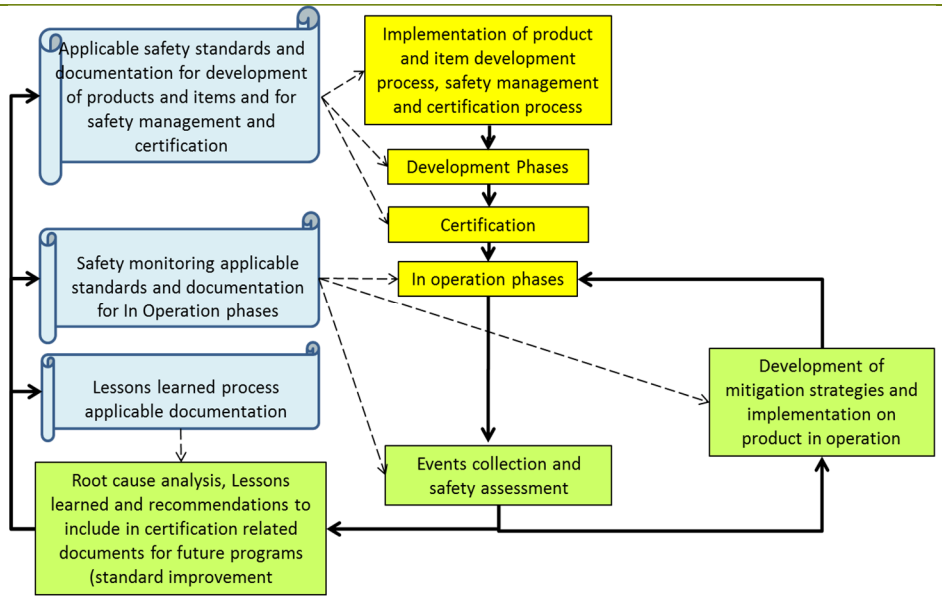
<table>
<tr><th colspan="2">Exploitation plan of NLR</th></tr>
<tr><td>Partner name</td><td>NLR</td></tr>
<tr><td>Contact person</td><td>Lennaert Speijker (lennaert.speijker@nlr.nl)</td></tr>
<tr><td>Partner exploitation strategy</td><td>Through its participation in ASCOS, NLR will (to an even higher extent) be able to support aircraft and aircraft systems manufacturers, operators and regulators with respect to the design and approval of newly proposed aeronautical products and operations. NLR will apply the newly developed safety based design systems and tools in its safety research and consultancy work for its customers. NLR will support the exploitation and use of ASCOS results by EASA, ESSI, FAST, EUROCAE and other User Group members (including e.g. FAA, EUROCONTROL, CAA NL, JARUS).NLR intends to perform further follow-up research in H2020 (e.g. in Future Sky Safety).</td></tr>
<tr><td>Specifically involved in exploitation of results</td><td>1. Proposed certification approach
2. Framework safety performance indicators
3. Process safety performance monitoring
5. Risk model
6. Tool for risk assessment</td></tr>
<tr><td>Concrete exploitation actions (planned)</td><td>
<table>
<tr><th>Activity</th><th>Brief description</th><th>Relevant exploitable results*</th><th>Timescale (months)</th></tr>
<tr><td>Further research</td><td>In Future Sky Safety, an EU-funded transport research programme in the field of European aviation safety, which develops new tools and new approaches to aeronautics safety. Programme initially focuses on:
• Building ultra-resilient vehicles and improving the cabin safety
• Reducing risk of accidents
• Improving processes and technologies to achieve near-total control over the safety risks
• Improving safety performance under unexpected circumstances.
The Programme will also help coordinate the research and innovation agendas of several countries and institutions, as well as create synergies with other EU initiatives in the field (e.g. ACARE SRIA, OPTICS).</td><td>1, 2, 3, 4, 5</td><td>2015-2018</td></tr>
</table>
*: refer to the project result number, as provided in Section 4 (i.e. between 1 and 9)
</td></tr>
</table>

5.2 Exploitation plan of Thales

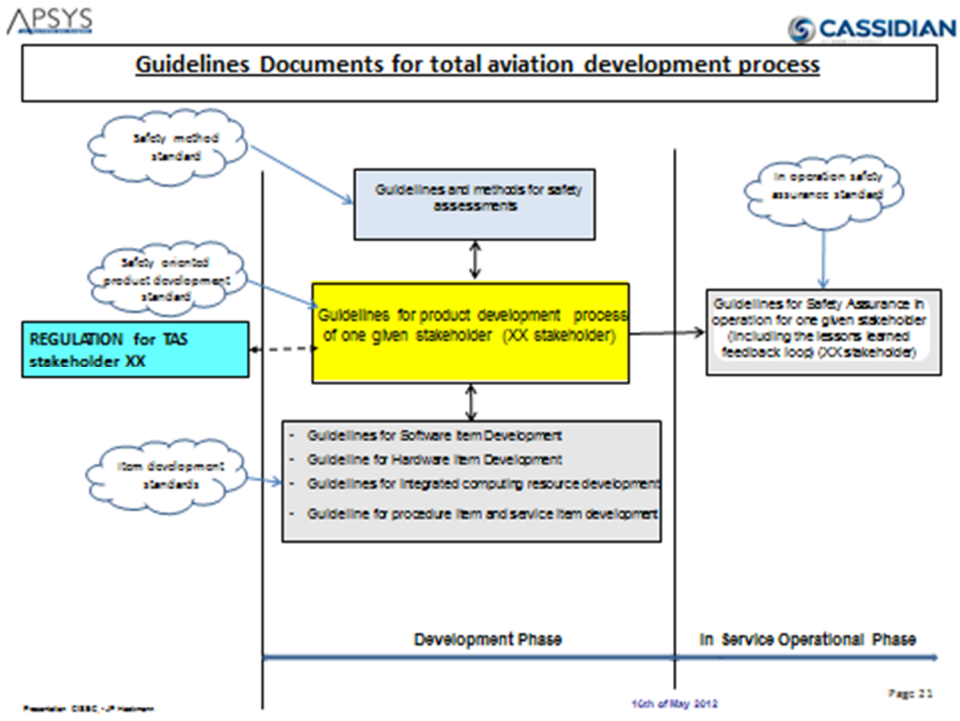
<table>
<tr><th colspan="2">Exploitation plan of Thales</th></tr>
<tr><td>Partner name</td><td>Thales Air Systems (TR6)
Thales Electronic Devices (TATM)</td></tr>
<tr><td>Contact person</td><td>Fateh KAAKAI Phone: +33 (0)1 79 61 18 71 - fateh.kaakai@thalesgroup.com
Fabrice ORLANDI Phone: +33 1 64 91 64 19 – fabrice.orlandi@thalesgroup.com
Holger NEUFELDT Phone: + 49 7156 353 28230 - holger.neufeldt@thalesgroup.com</td></tr>
<tr><td>Partner exploitation strategy</td><td>Thales will make a direct use of ASCOS project results in the development of efficient safety Certification procedures for their future products in the field of ground CNS/ATM systems. Furthermore, as directly involved in several international standardization bodies, Thales will leverage the use of ASCOS results to increase the dissemination of new methodologies and practices throughout the ATM and Aviation community. Finally, through their major involvement in the SESAR programme, Thales will directly contribute to the exploitation of ASCOS results by the SESAR community.</td></tr>
<tr><td>Specifically involved in exploitation of results</td><td>(1) To analyse the existing European certification and rulemaking process and propose potential adaptations to ease certification of safety enhancement systems & operations;
(2) To develop a total aviation system safety assessment method and supporting tools that can be used for safety based design of new systems, products and/or operations;
(3) To apply proposed certification process adaptations and the design systems and tools in case studies, so as to show how they can be used by operators and manufacturers.</td></tr>
<tr><td>Concrete exploitation actions (planned)</td><td>
<table>
<tr><th>Activity</th><th>Brief description</th><th>Relevant exploitable results*</th><th>Timescale (months)</th></tr>
<tr><td>1</td><td>Improve the Understanding of the influence of regulatory framework implementation on safety of products</td><td>Catalogue of arguments in order to better justify balance between performance- based and compliance- based approach</td><td>Permanent</td></tr>
<tr><td>2</td><td>Apply and generalise proposed certification approach</td><td>1. Improve change safety assessment in an operational context
2. Improve interface with customer safety case (Total aviation aspect) thanks to the maturity of arguments architecture
3. Streamline the approval/ certification process whenever possible by taking in consideration operational safety risks</td><td>Next 3 years</td></tr>
</table>
</td></tr>
</table>

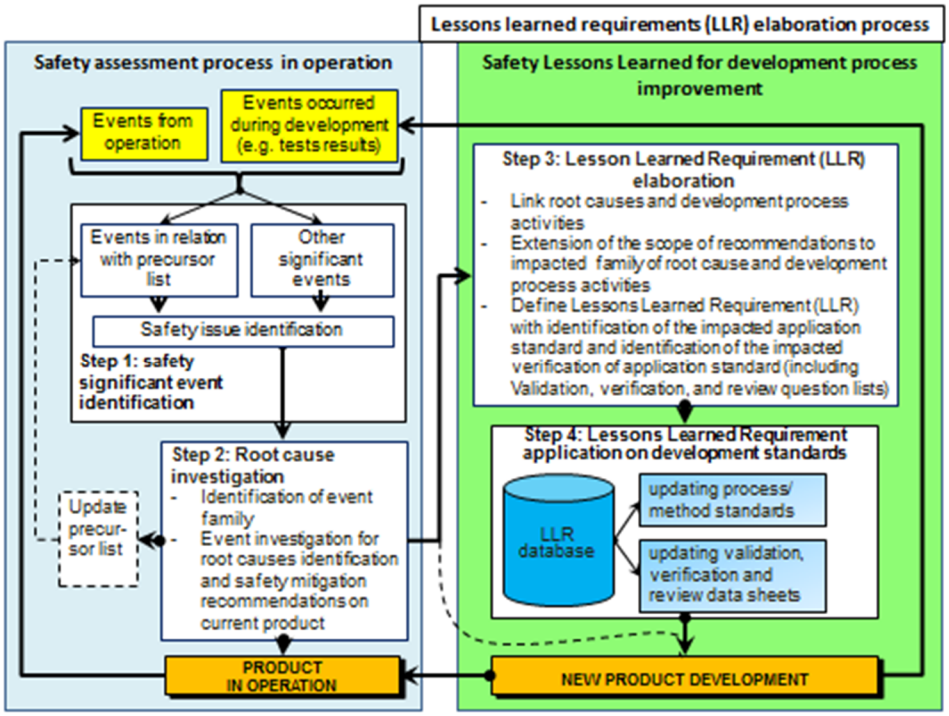
5.3 Exploitation plan of APSYS (Airbus Group)

Exploitation plan of APSYS	
Partner name	APSYS Airbus Group
Contact person	Susana Bravo Muñoz, Jean Pierre Heckmann, Matthieu Feuvrier
Partner exploitation strategy	Development and application of a process to translate identified risks into requirement or AMC applicable in the development cycle of an industrial project (description of the work). (DoW) *Presentation of WP 3.5* With full compliance with ICAO SMS recommendations, APSYS (through WP 3.5) proposes a TAS common safety standard framework of product development and product follow up in operation. It established a comprehensive and logical process to improve the TAS safety standards with a continuous feedback considering experience in operations. Consideration of novelties, change in environment, management and operation (consideration of Area o change from FAST, use of precursor identification by CATS and continuous monitoring) are also addressed. A safety management organization at TAS inter partner level and partner level should be implemented to assure safety standards harmonization and assure application of a harmonized lessons learned feedback process from in operation results to product and item development standards. The recommended standard framework for product development and the methods described for standard improvement are generic enough to be applied by each partner of the TAS allowing more efficient exchanges between the partners and with certification Authorities



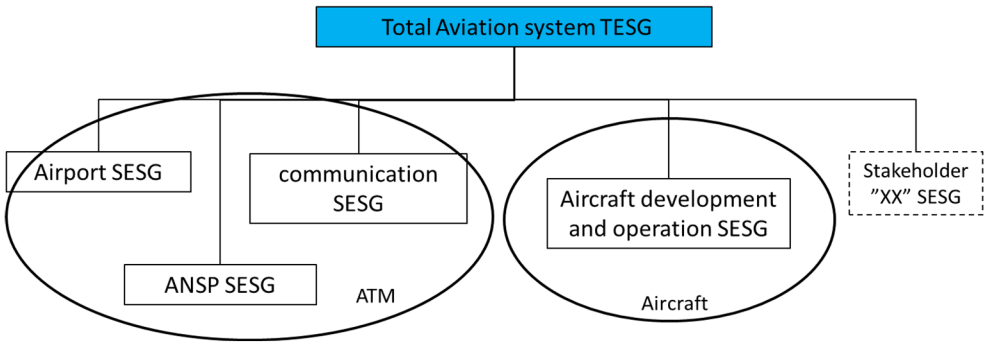
Safety standard Common framework



	Lessons learned loop with recognition of safety precursors for safety monitoring and for safety standards improvement 
Specifically involved in exploitation of results	*<u>Exploitation of WP 3.5</u>* WP 3.5 presents a logical structure to improve current certification standards. The exploitation needs to be understood in terms of usability and efficiency. WP 3.5 certification standards improvements implies: • The definition of an harmonized safety standards frameworks applicable at TAS for product development, safety assessment , method standard, software item development, electronic hardware item development standard, procedure and services development standard. • The identification during development process of precursors event to monitor during operation • The collection and analysis of events occurring during development testing and during operation • The development of lesson learned requirements for safety standards improvement and product design improvement • The identification and the consideration of the impact of novelties and future changes in the TAS organization, standards and operations • The possibility of an automatic recognition of safety precursors when events occurs in operation

This conclusion needs to be introduced in a process to improve standards. The process is presented in terms of tasks in WP 3.5. The tasks are allocated to the respective certification bodies at two levels:

- TAS inter-stakeholder level by a central coordination group called here after "TAS Engineering and Safety Group" (TESG)
- TAS stakeholder level by a stakeholder level coordination group called here after stakeholder "Engineering and safety group" (SESG).



Concrete exploitation actions (planned)

APSYS activities exploitation. Note: projects results (7, Safety assurance process and 8 Lesson Learned requirements) can both be considered as a part of TAS Safety Standards.

Activity	***Brief description***	**Relevant exploitable results***	**Timescale (months)**
	SAE Sevilla October 2013	*Consideration to Incorporate ASCOS results in ARP 5150A*	
	SAE Prague October 2014	*Consideration to Incorporate ASCOS results in ARP 5150A*	
	AIRBUS May 2015		
	EU Brussels May 2015		
	SAE Dublin October 2015		

5.4 Exploitation plan of Civil Aviation Authority UK

<table>
<tr><th colspan="2">Exploitation plan of CAAi</th></tr>
<tr><td>Partner name</td><td>CAA International (CAAi)
http://www.caainternational.com/</td></tr>
<tr><td>Contact person</td><td>http://www.caainternational.com/contact-us</td></tr>
<tr><td>Partner exploitation strategy</td><td>CAAi will share the knowledge obtained through ASCOS with those within the United Kingdom Civil Aviation Authority (UK CAA) who are directly involved in certification processes, aviation safety plans, and the elaboration of SES initiative and EC's Performance Plan.</td></tr>
<tr><td>Specifically involved in exploitation of results</td><td>Communication of the ASCOS result to the following CAA teams;

- Intelligence, Strategy and Policy (ISP)
○ Strategy and Safety Assurance
○ Policy and Programmes

- Aerodrome and Air Traffic Standards Division (AATSD)
○ Strategy, Risk and Business Management
○ Policy and Standards
○ Aerodrome Oversight
○ Air Traffic Service Oversight

- Performance Based Regulation (PBR)</td></tr>
<tr><td>Concrete exploitation actions (planned)</td><td>
<table>
<tr><th>Activity</th><th>Brief description</th><th>Relevant exploitable results*</th><th>Timescale (months)</th></tr>
<tr><td>#1</td><td>Communication of the ASCOS results internal to the CAA</td><td>n/a</td><td>ASCOS completion + 1 month</td></tr>
</table>
*: refer to the project result number, as provided in Section 4 (i.e. between 1 and 9)
</td></tr>
</table>

5.5 Exploitation plan of ISDEFE

<table>
<tr><th colspan="2">Exploitation plan of ISD</th></tr>
<tr><td>Partner name</td><td>Isdefe (ISD)</td></tr>
<tr><td>Contact person</td><td>Izaro Etxebarria</td></tr>
<tr><td>Partner exploitation strategy</td><td>Use of the ASCOS results in continued research and activities related to certification with Advanced research and knowledge transfer, specially focused on Spanish Civil Aviation and INTA (certification Spanish bodies). Use of the E-learning certification environment for didactic and teaching purposes and support to Spanish certification bodies to support innovative approaches for certification. Use of the Network MacroMOdel to continue to build and validate a modelling framework for high-level analysis of hazards and associated caudal factors of introducing new aeronautical products and operations (for certification bodies).</td></tr>
<tr><td>Specifically involved in exploitation of results</td><td>Refer to project exploitable results *
9</td></tr>
<tr><td>Concrete exploitation actions (planned)</td><td>
<table>
<tr><th>Activity</th><th>Brief description</th><th>Relevant exploitable results*</th><th>Timescale (months)</th></tr>
<tr><td>NA (nothing planned)</td><td></td><td></td><td></td></tr>
</table>
*: refer to the project result number, as provided in Section 4 (i.e. between 1 and 9)
</td></tr>
</table>

5.6 Exploitation plan of CertiFlyer

<table>
<tr><th colspan="2">Exploitation plan of Ceriflyer BV</th></tr>
<tr><td>Partner name</td><td>CertiFlyer BV</td></tr>
<tr><td>Contact person</td><td>Gerard Temme</td></tr>
<tr><td>Partner exploitation strategy</td><td>CertiFlyer BV is involved in many product certification programs for the European Aviation Safety Agency. Especially in the last 10 years the borders between different domains (e.g. Product certification, Operation, Air traffic management) have become vague due to the introduction of Avionics that have relevance to all these domains.
Examples:
Datalink
Required Navigation Performance
Various approach modes based on GPS
Electronic Flight Bags
Due to the traditional way the domains are working, there are many items that are required in the different domains, which do not get the proper attention. Moreover, it happens that requirements in different domains are contradictory.
It is believed that the approach studied by ASCOS can harmonize the differences, create a more efficient certification environment and enhance safety.</td></tr>
<tr><td>Specifically involved in exploitation of results</td><td>Introduction of ASCOS results in other EC research projects (e.g. ACROSS)
Work with EASA to introduce ASCOS working proposals in the certification practice of the different domains. EASA is believed to be in a exceptional position for this achievement, as it bears responsibilities</td></tr>
<tr><td>Concrete exploitation actions (planned)</td><td>
<table>
<tr><th>Activity</th><th>Brief description</th><th>Relevant exploitable results*</th><th>Timescale (months)</th></tr>
<tr><td>1</td><td>Introduce the ASCOS way of working in the certification WP of ACROSS</td><td></td><td>12</td></tr>
<tr><td>2</td><td>Introduce the ASCOS certification approach to EASA in specific certification projects</td><td></td><td>24</td></tr>
</table>
*: refer to the project result number, as provided in Section 4 (i.e. between 1 and 9)
</td></tr>
</table>

5.7 Exploitation plan of Avanssa

<table>
<tr><th colspan="2">Exploitation plan of partner Avanssa</th></tr>
<tr><td>Partner name</td><td>Avanssa</td></tr>
<tr><td>Contact person</td><td>Nuno Aghdassi</td></tr>
<tr><td>Partner exploitation strategy</td><td>Avanssa will employ knowledge gained from participating in ASCOS in various ways for future research work, dissemination among the aviation safety community (particularly within the accident investigation context) and development of aviation safety training products.</td></tr>
<tr><td>Specifically involved in exploitation of results</td><td>Avanssa will exploit the framework for Safety Performance Indicators (No. 2) online through its website and seek to support any additional work in this area in the future. A similar approach will be taken with regards to the tools for risk assessment (No. 6). These results will be exploited on Avanssa’s website and support will be provided for further development of risk assessment tools and methodologies for aviation in the future. Both of these results have applications in Safety Management System, an expertise area for Avanssa and will therefore be exploited within this context and as opportunities arise.</td></tr>
<tr><td>Concrete exploitation actions (planned)</td><td>
<table>
<tr><th>Activity</th><th>Brief description</th><th>Relevant exploitable results*</th><th>Timescale (months)</th></tr>
<tr><td>2</td><td>Exploit the framework for safety performance indicators online.</td><td>2</td><td>6</td></tr>
<tr><td>6</td><td>Exploit the tools for risk assessment online within the framework of SMS.</td><td>6</td><td>6</td></tr>
</table>
*: refer to the project result number, as provided in Section 4 (i.e. between 1 and 9)
</td></tr>
</table>

5.8 Exploitation plan of Ebeni

<table>
<tr><th colspan="2">Exploitation plan of Ebeni</th></tr>
<tr><td>Partner name</td><td>Ebeni Limited</td></tr>
<tr><td>Contact person</td><td>Name: Alan Simpson
Organisation: Ebeni Ltd
Address: Hartham Park
Corsham
UK
Telephone: +44 (0) 1249 700 507
E-mail: alan.simpson@ebeni.com</td></tr>
<tr><td>Partner exploitation strategy</td><td>Ebeni will utilise ASCOS results with equipment manufacturers, operators and regulators within the aviation industry to enable them to deploy safety related systems and concepts more quickly and cost effectively whilst contributing to an increase in safety within the European aviation environment.</td></tr>
<tr><td>Specifically involved in exploitation of results</td><td>1. Proposed certification and approval approach/method</td></tr>
<tr><td>Concrete exploitation actions (planned)</td><td>
<table>
<tr><th>Activity</th><th>Brief description</th><th>Relevant exploitable results*</th><th>Timescale (months)</th></tr>
<tr><td></td><td>No specific exploitation actions planned.</td><td></td><td></td></tr>
</table>
*: refer to the project result number, as provided in Section 4 (i.e. between 1 and 9)
</td></tr>
</table>

5.9 Exploitation plan of Deep Blue

<table>
<tr><th colspan="2">Exploitation plan of partner DBL</th></tr>
<tr><td>Partner name</td><td>Deep Blue s.r.l.</td></tr>
<tr><td>Contact person</td><td>Luca Save
luca.save@dblue.it</td></tr>
<tr><td>Partner exploitation strategy</td><td>Deep Blue will use the ASCOS results to reinforce its in-house safety assessment capabilities dedicated to support equipment and software manufactures, operators, and regulators in the, ATC and aviation domains. One of the distinctive element of such capabilities is the systemic consideration of human factors issues. ASCOS focus on the total aviation system directly supports this capability, by promoting a better traceability and consideration of cross-domain issues. Furthermore ASCOS promotes a basic set of enhancements useful to assists organizations to move to a performance based regulation context.</td></tr>
<tr><td>Specifically involved in exploitation of results</td><td>1 .Proposed certification approach
2. Framework safety performance indicators
4. Tool for continuous safety monitoring
5. Risk model</td></tr>
<tr><td>Concrete exploitation actions (planned)</td><td>
<table>
<tr><th>Activity</th><th>Brief description</th><th>Relevant exploitable results*</th><th>Timescale (months)</th></tr>
<tr><td>1</td><td>Identify opportunities for consultancy activities with Air Traffic Providers interested in the transition to performance based certification regulations</td><td>1-2-4-5</td><td>36</td></tr>
<tr><td>2</td><td>Explore ways in which the ASCOS logical argument approach can be used in both consultancy and future research activities to extend current in-house safety methodologies by further considering cross-domain human factors aspects.</td><td>1</td><td>18</td></tr>
<tr><td>3</td><td>Add to current DBL consultancy offer the capability to assist ANSPs in the introduction and improvement of the continuous safety monitoring part of their Safety Management Systems (SMS).</td><td>2-4</td><td>12</td></tr>
<tr><td>4</td><td>Re-adapt ASCOS solutions and ideas in future R&D proposals and projects on similar topics, also exploiting ASCOS partnerships and collaborations.</td><td>1-2-4-5</td><td>36</td></tr>
</table>
*: refer to the project result number, as provided in Section 4 (i.e. between 1 and 9)
</td></tr>
</table>

5.10 Exploitation plan of JRC

<table>
<tr><th colspan="2">Exploitation plan of partner JRC</th></tr>
<tr><td>Partner name</td><td>JRC</td></tr>
<tr><td>Contact person</td><td>Wietse Post (wietse.post@jrc.ec.europa.eu)</td></tr>
<tr><td>Partner exploitation strategy</td><td>The results of the ASCOS project will be used by the JRC as an important additional feedback on the quality of the collected data in terms of Directive 2003/42/EC and Regulation 1321/2007. In addition ASCOS will provide the ECCAIRS community (NAAs and AIBs) with analysis tools and methods that can be used initially at a national level and ultimately to help defining additional European wide safety performance indicators.</td></tr>
<tr><td>Specifically involved in exploitation of results</td><td>A tool and a set of SPI scenario’s has been developed implementing the defined approach for the main operational issues as defined in the European Aviation Safety plan (EASP) framework, focussing in particular on the subjects of the case studies defined in work package 4. The tools uses safety data extracted from an ECCAIRS compatible repository (ECR, ADREP or national occurrence databases) complemented with (historical) exposure data as available from existing sources where applicable completed with numbers based on expert judgement. The tool provides an overview (in the form of tables, charts, visual indicators, etc) of the past evolution of the safety performance. The tool can be used to also monitor these (and other) safety performance indicators in the future.</td></tr>
<tr><td>Concrete exploitation actions (planned)</td><td>
<table>
<tr><th>Activity</th><th>Brief description</th><th>Relevant exploitable results*</th><th>Timescale (months)</th></tr>
<tr><td>1</td><td>Dissemination of ATCSM to the ECCAIRS community</td><td>4</td><td></td></tr>
</table>
*: refer to the project result number, as provided in Section 4 (i.e. between 1 and 9)
</td></tr>
</table>

5.11 Exploitation plan of JPM

<table>
<tr><th colspan="2">Exploitation plan of JPM</th></tr>
<tr><td>Partner name</td><td>JPM</td></tr>
<tr><td>Contact person</td><td>Jean Pierre MAGNY</td></tr>
<tr><td>Partner exploitation strategy</td><td>Strategy is based on JPM previous experience, completed with ASCOS results. Exploitation includes participation to Safety teams, teaching management of complex High Tech multinational aviation and space programs in university masters. Flying as instructor & examiner is tied up to FMS and ATO safety management where ASCOS experience may be disseminated.</td></tr>
<tr><td>Specifically involved in exploitation of results</td><td>Participation to FAST aims to keep AoCs lists updated and to:
Confirm validity of the AoC process, exploiting lessons learned from past 10 years
Amplify links between FAST and project management practices with outputs towards standards and certification in order to complete ASCOS integration recommendations
In cooperation with EASA and ATLAS, investigate further organisation related shortcomings, bottlenecks and safety culture evolution in the future
EGAST: Participation as core team member and in human factors group are opportunities to propose using ASCOS outputs where applicable to GA and to simplify further some processes to the benefit of all aviation domains.
Flight Instructor and Examiner allow to practically assess ASCOS referring to “in flight reality”
Project & Risk management masters intend to improve Aviation safety culture with capacity to exploit ASCOS. This includes participation to teacher’s forums as advisor for education programs update and introduction of FAST and ASCOS outputs. In ENAC and ISAE. 50% of masters’ students are coming from industry and authorities. It is also an opportunity to investigate how and where, more cultural effort is necessary for Safety improvements, in particular for fighting against culture related shortcomings and bottle necks (poor culture = misunderstandings = possible bad decisions and barriers raised against interventions).</td></tr>
<tr><td>Concrete exploitation actions (planned)</td><td>
<table>
<tr><th>Activity</th><th>Brief description</th><th>Relevant exploitable results*</th><th>Timescale (months) (Note 1)</th></tr>
<tr><td>1</td><td>FAST: Participation as experts & executive secretary</td><td>1, 2,5</td><td></td></tr>
<tr><td>2</td><td>EGAST & links with ESSI participation as core team member and in human factors group.</td><td>2, 5, 8, 9</td><td></td></tr>
<tr><td>3</td><td>Teaching Risk Management, Program management in specialised masters</td><td>1, 2, 5, 7, 10</td><td></td></tr>
<tr><td>4</td><td>Flight Instructor 1 Examiner & participation to accidents investigations</td><td>2, 5, 8, 9</td><td></td></tr>
</table>
Note 1: Duration is meant as a permanent activity as long as JPM activity continues
</td></tr>
</table>

5.12 Exploitation plan of TU Delft

<table>
<tr><th colspan="2">Exploitation plan of TUD</th></tr>
<tr><td>Partner name</td><td>Delft University of Technology</td></tr>
<tr><td>Contact person</td><td>Name: Richard Curran
Organisation: Delft University of Technology
Address: Kluyverweg 1, 2629 HS Delft
PO Box 5058, 2600 AC Delft
the Netherlands
Telephone: +31 (0) 15 27 82045
E-mail: r.curran@tudelft.nl
Website: www.tudelft.nl</td></tr>
<tr><td>Partner exploitation strategy</td><td>TUD is primarily interested in exploiting the developed knowledge and expertise associated with emerging risks coupled to new technologies within a life cycle context. This would position TUD at the forefront of a new exploration within the risk and safety domain. The development of this concept would form the basis of a future R&D program that would include basic research funding applications and industrial applied collaborations.
The scientific contribution of the tool-development is limited. The concepts developed for the ASCOS Tool for Risk Assessment might be applied for future tool developments. The tool might be used in teaching activities.</td></tr>
<tr><td>Specifically involved in exploitation of results</td><td>6. Tool for risk assessment</td></tr>
<tr><td>Concrete exploitation actions (planned)</td><td>
<table>
<tr><th>Activity</th><th>Brief description</th><th>Relevant exploitable results*</th><th>Timescale (months)</th></tr>
<tr><td>n/a</td><td>No specific exploitation actions are currently planned</td><td>6</td><td>n/a</td></tr>
</table>
*: refer to the project result number, as provided in Section 4 (i.e. between 1 and 9)
</td></tr>
</table>

5.13 Exploitation plan of Instytut Lotnictwa

<table>
<tr><th colspan="2">Exploitation plan of Institute of Aviation</th></tr>
<tr><td>Partner name</td><td>Institute of Aviation</td></tr>
<tr><td>Contact person</td><td>Krzysztof Piwek</td></tr>
<tr><td>Partner exploitation strategy</td><td>Further development of knowledge through participation in research activities concerning the safety in aviation. IoA will work with CAA PL to transfer the ASCOS results and the knowledge obtained into its certification processes, aviation safety plans, and the elaboration of SES initiative and EC's Performance Plan setting out key performance targets and describing incentive scheme for Poland.</td></tr>
<tr><td>Specifically involved in exploitation of results</td><td><u>Development of knowledge:</u> Mainly transfer of knowledge and developed in ASCOS project methodology concerning Commercial Aviation Transport to Small Aircraft Transport System. Improvement of safety in Small Aircraft and general Aviation. Preparation of papers and PhDs
<u>Cooperation with Polish CAA:</u> Development of cooperation aiming at implementation of ASCOS project results as well as improvement of operational efficiency (support of ILOT in some activities currently conducted by CAA PL)</td></tr>
<tr><td>Concrete exploitation actions (planned)</td><td>
<table>
<tr><th>Activity</th><th>Brief description</th><th>Relevant exploitable results*</th><th>Timescale (months)</th></tr>
<tr><td>PhD</td><td>PhD thesis based on knowledge developed within the project</td><td>3, 5, 7, 8</td><td>12</td></tr>
<tr><td>Publication</td><td>Preparation of an article based on result of the project</td><td>3, 5</td><td>12</td></tr>
</table>
*: refer to the project result number, as provided in Section 4 (i.e. between 1 and 9)
</td></tr>
</table>

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