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CAATS

Cooperative Approach to Air Traffic Services

Publishable Final Activity Report



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CAATS Consortium:

CAATS Team Members:

Isdefe	Ingeniería de Sistemas para la Defensa de España, S.A.	SP
Aena	Aeropuertos Españoles y Navegación Aérea	SP
EEC	The European Organisation for Safety of Air Navigation	BE
Ineco	Ingeniería y Economía del Transporte, S.A.	SP
NERL	NATS En Route Ltd.	UK
NLR	Stichting Nationaal Lucht-en Ruimtevaartlaboratorium	NL

CAATS Team Experts:

CDV	Centrum Dopravního Vyzkumu	CZ
Deep Blue	Deep Blue	IT
Deimos	DEIMOS Space, S.L.	SP
DFS	DFS Deutsch Flugsicherung	GER
Nickleby HFE	Nickleby HFE Ltd.	UK
RC AUEB	Research Centre of the Athens University of Economics and Business	GR
Slot Consulting	Slot Consulting Ltd.	HUN
TUD	Dresden University of Technology	GE

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Executive Summary

This document is the Publishable Final Activity Report of the Cooperative Approach to Air Traffic Systems (CAATS) Project. It contains a summary of the objectives set at the beginning of the project, explain briefly the work performed and show the main results obtained and the most important recommendations derived from the assessments performed during the project.

The objective of the Cooperative Approach to Air Traffic Services (CAATS) was the identification of best practices across EC's, FP6 ATM projects in relation to Safety, Human Factors and Validation domains and their dissemination among the ATM community. On the basis of the information obtained in CAATS, the Validation Best Practices Manual was produced; by intense contact of CAATS experts with ATM R&D projects, the use of the best practices was strongly promoted; and, through well-attended workshops, the best practices have reached to a significant part to the ATM R&D community.

The overall working method used in CAATS consisted of 4 main tasks:

- *Definition of the work scope of each area.*
 - *Identification of source/target projects.*
 - *Selection of key elements of study.*
- *Collection of information from source and target projects.*
- *Analysis of collected information from two perspectives:*
 - *Identification of best practices/emerging good practices; and*
 - *Identification of gaps/needs for improvement.*
- *Dissemination activities among the ATM community. Best Practices/ Good Practices were communicated to target projects in a proactive way with the aim of supporting target projects in realising their project objectives.*

The main outcomes of the CAATS have been:

- *Manuals, guides and studies.*
 - *The Validation Best Practices Manual. This document includes:*
 - * *Best Practices for Validation.*
 - * *Good practices for Safety.*
 - * *Good practices for Human Factors.*
 - *The Guide to a Comprehensive Incorporation of Validation in ATM R&D Projects.*
 - *Business Case Study.*
 - *Guidance for Stakeholders Identification and Analysis*
 - *Validation Gaps and recommendations to improve the best practices or good practices in the areas of Validation, Safety and Human Factors.*
- *A widespread awareness of the Best Practices Manual among the ATM R&D community reached through CAATS-promoted workshops, Safety and Human Factors workshops, conferences and active interaction with target projects.*



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Contributing partners	Team Member	Team Expert	Authors
Isdefe	X		Isdefe

Contact Information

Isdefe, Ingeniería de Sistemas para la Defensa de España, S.A.
Attn. Mr. Marcial Valmorisco
Edison 4
28006 Madrid
Spain
Tel.: +34 91 271 1752
Fax: +34 91 564 5108
E-mail: mvalmorisco@isdefe.es

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To/cc	Code	Organization	Name
To		Project Manager	M. Valmorisco
To		Aena	J.M. Pablo, M. Antón
To		EEC	N. Makins
To		NERL	R. Peachey
To		BOEING	R.J. Kennedy
To		CDV	O. Kadlec
To		DEIMOS	I. López
To		INECO	A. Urech, V. Bustos
To		NLR	R. Jansen
To		AUEB-RC/TRANSLOG	K. Zografos, M. Madas
To		EC	M. Jensen

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Project Manager	M. Valmorisco	12/06/2006
Work Package Leader	A. Gómez/D. Julián	12/06/2006
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1. INTRODUCTION

1.1. Purpose

This document is the Publishable Final Activity Report of the Cooperative Approach to Air Traffic Systems (CAATS) Project. The purpose of the document is to make a summary of the objectives set at the beginning of the project, explain briefly the work performed and show the main results obtained and the most important conclusions derived from the assessments performed during the project.

1.2. Background

As stated in the CAATS Technical Annex [1], the European Commission has launched a new paradigm shift “collaborative decision-making in a complete air and airport environment, including innovative research to increase the efficiency of air transport service provision” and wants it to be applied across the European Commission’s Sixth Framework (FP6) ATM projects. This will imply the co-ordination of the processes and methodologies and will concern the following research areas in FP6:

- Co-operative ATM.
- Advanced airborne system applications.
- Reduced separation minima.
- Airport efficiency.
- Advanced Surface Movement Guidance and Control System.
- Advanced approach and landing concepts.
- Innovative ATM research.

The research proposed by the EC combines Human Factors, Safety and airport efficiency with coordinated validation methodologies, supported by business cases and safety assessments. More specifically, the Commission has proposed a cluster of seven research areas, ranging from airport efficiency to Cooperative Air Traffic Management (ATM). The projects implementing these research areas in FP6 have been based on previous knowledge and, in turn, produced new knowledge.

Within this framework, the objective of the Cooperative Approach to Air Traffic Services (CAATS) was the identification of best practices across EC’s, FP6 ATM projects in relation to Safety, Human Factors and Validation domains. On the basis of the information obtained in CAATS, the Validation Best Practices Manual was produced; by intense contact of CAATS experts with ATM R&D projects, the use of the best practices was strongly promoted; and, through well-attended workshops, the best practices have reached to a significant part to the ATM R&D community.

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1.3. Partnership

The following companies have participated in the CAATS project:

Party	Contact Person	Mailing, Fax and e-mail Address
Isdefe	Marcial Valmorisco	Edison 4 28006 Madrid, Spain +34-91-564-5108 mvalmorisco@isdefe.es
Aena	José Miguel de Pablo	Juan Ignacio Luca de Tena 14 28027 Madrid, Spain +34-91-321-3120 jmdepablo@aena.es
CDV	Josef Kraus	Lisenská 33a 63600 Brno, Czech Republic +420-548-423-757 kraus@cdv.cz
Deep Blue	Alberto Pasquini	Via Basento 52d 00198 Rome, Italy +39-06-855-4801 alberto@dblue.it
DEIMOS	Ismael Lopez	Ronda de Poniente, 19 28760 Tres Cantos (Madrid), Spain +34-91-806-3451 ismael.lopez@deimos-space.com
DFS	Andreas Udovic	AM DFS Campus 5 63225 Langen, Germany +49-6103-707-5741 andreas.udovic@dfs.de
TUD	Hartmut Fricke	Technical University Dresden 01062 Dresden, Germany +49-351-4633-6898 fricke@ifl.tu-dresden.de
EUROCONTROL	Nigel Makins	Centre de Bois des Bordes, BP15 91222 Brétigny Sur Orge, France +33-1-6988-7333 nigel.making@eurocontrol.int
INECO	Alvaro Urech	Avenida del Partenon 4 28042 Madrid, Spain +34-91-452-1306 alvaro.urech@ineco.es
NERL	Rosalind Eveleigh	NATS-Hurn, Bournemouth Airport Christchurch BH23 6DF, United Kingdom +44-1202-472-475 rosalind.eveleigh@nats.co.uk
NLR	R.B.H.J. Jansen	Anthony Fokkerweg 2 1059 CM Amsterdam, Netherlands +31-20-511-3210 rjansen@nlr.nl

Party	Contact Person	Mailing, Fax and e-mail Address
RC-AUEB	Konstantinos Zografos	Transportation Systems and Logistics Laboratory Evelpidon 47A & Lefkados 33 11362 Athens, Greece +30-210-820-3684 kostas.zografos@aueb.gr
Nickleby	Ronald McLeod	1 Ainslie Road, Hillington Park Glasgow, G52 4RU, Scotland +44-141-585-6301 ron@nickleby.com
Slot	Roland Guraly	Nagyszolos u. 12 1185 Budapest, Hungary +36-1-292-2052 rolandguraly@ssslotconsulting.hu

Table 1 CAATS Participant List

1.4. Document Structure

This document is divided into the following chapters:

- Chapter 1 “Introduction”: Summarises the purpose and background of the document. It also provides a glossary and a list of reference documents.
- Chapter 2 “CAATS Objectives and Overall Methodology”: Explains the overall CAATS objectives and the working methodology used to reach them.
- Chapter 3 “Work Performed and Results”: Estates the working method used in the main the package to get the CAATS objectives and the results obtained.
- Chapter 4 “General CAATS Dissemination Activities”: Includes the detail of the dissemination activities and tools such as the website and workshops.
- Chapter 5 “Overall Conclusions”: Resumes the main results of the project and the future activities on validation.

1.5. Acronyms

Term	Description
AIRNET	Airport Network.
AMAN	Arrival Manager.
ATC	Air Traffic Control.
ATM	Air Traffic Management.
CAATS	Co-operative Approach to ATS.
C-ATM	Co-operative ATM.
CBA	Cost Benefit Analysis.

Term	Description
CBT	Computer-based training.
CORA	Conflict Resolution Assistant.
EC	European Commission.
EEC	Eurocontrol Experimental Center.
EMMA	European Airport Movement Management by A-SMGCS.
EPV	European Validation Program.
FP6	European Commission's Sixth Framework Programme.
FRIENDCOPTER	Integration of Technologies in Support of a Passenger and Environmentally Friendly Helicopter.
G2G	Gate to Gate.
HF	Human Factors.
JPB	Joint Programme Board.
ISMAEL	Intelligent Surveillance and Management Functions for Airfield Applications Based on Low Cost Magnetic Field Detectors.
MAEVA	Master ATM European Validation Plan.
MFF	Mediterranean Free Flight.
OC	Operational Concept.
OCVM	Operational Concept Validation Methodology.
OI	Operational Improvement.
OPAL	Optimisation Platform for Airports.
OPTIMAL	Optimised Procedures and Techniques for the Improvement of Approach and Landing.
R&D	Research and Development.
SAFEE	Security of Aircraft in the Future European Environment.
SPADE	Supporting Platform for Airport Decision-Making and Efficiency Analysis.
THEATRE	Thematic Network on Air Transport for ATM Validation Activities.
VGH	Validation Guideline Handbook.
VMP	Validation Master Plan.



2. CAATS OBJECTIVES AND OVERALL METHODOLOGY

As stated earlier, the objective of the Cooperative Approach to Air Traffic Services (CAATS) was the identification of best practices across EC's, FP6 ATM projects in relation to Safety, Human Factors and Validation domains and their dissemination among the ATM community.

The Work Plan to achieve this objective was established in two packages, both active during the entire project, that comprised closely related activities.

WP0: Project Management and Dissemination. The goal of this work package was twofold. Firstly, WP0 assured project progress according to the planning, control the quality and delivery of deliverables on time, and control the budgets in the project. Secondly, it managed the dissemination of the outcomes of CAATS by providing the infrastructure needed to operate the CAATS website and by organising the forums and workshops.

WP1: Knowledge Management and Consolidation, a number of activities were performed to interact with the projects in order to collect, collate, analyse and harmonise the knowledge produced by FP6 projects in the areas of Safety, Human Factors and Validation with the aim to identify best practices or gaps/needs for improvement.

A specialised team was assigned to each of these areas consisting of Team Members and Team Experts. Associated Measures Experts were also available to assist the members of the team in particular subjects.

The interrelationships between CAATS Work Packages are illustrated in Figure 1.

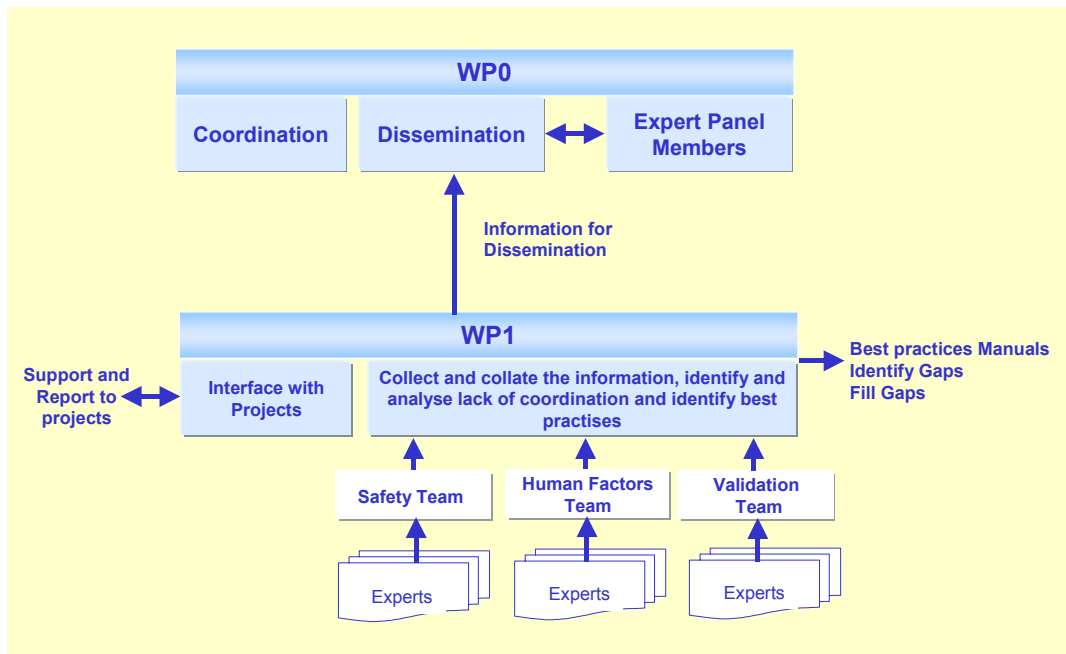


Figure 1 CAATS Work Packages Relationship

A more detailed explanation about CAATS work plan can be found in CAATS Technical Annex [1].

3. WORK PERFORMED AND RESULTS

3.1. Description of Working Method

The CAATS Knowledge Management package included all the activities, other than project management and dissemination, needed to reach CAATS objectives. These activities involved:

- Collecting and collating the information generated by the projects in the areas of Safety (e.g., regarding safety levels and safety regulations), Human Factors (e.g., regarding human machine interaction and stakeholders usability/acceptance) and Validation (e.g., regarding validation methodologies and airborne, airport, ATC and live trials).
- Identifying best practises of the projects in the areas of Safety, Human Factors and Validation.
- Identifying, analysing and possibly filling gaps.
- Producing a Best Practices Manual that consolidated the knowledge identified.
- Technical support under request to the VI Framework project in the expert domain.

CAATS Knowledge Management work was concentrated in the areas of Validation, Safety and Human Factors. As stated before, a specialised team was assigned to each of these areas. The working method used was identical for Safety and Human Factors, given their similar maturity level. In the case of the Validation area, a more mature area where several important studies had been done (MAEVA [6], THEATRE [15], the working method used was slightly different.

The overall working method used in CAATS consisted of 4 main tasks:

- Definition of the work scope of each area.
 - Identification of source/target projects.
 - Selection of key elements of study.
- Collection of information from source and target projects.
- Analysis of collected information from two perspectives:
 - Identification of best practices/emerging good practices; and
 - Identification of gaps/needs for improvement.
- Dissemination activities among the ATM community. Best Practices/Emerging Good Practices were communicated to target projects in a proactive way with the aim of supporting target projects in realising their project objectives.

Figure 2 illustrates the working method and the processes involved, including the relationships between the different activities and their relations with the outside world.

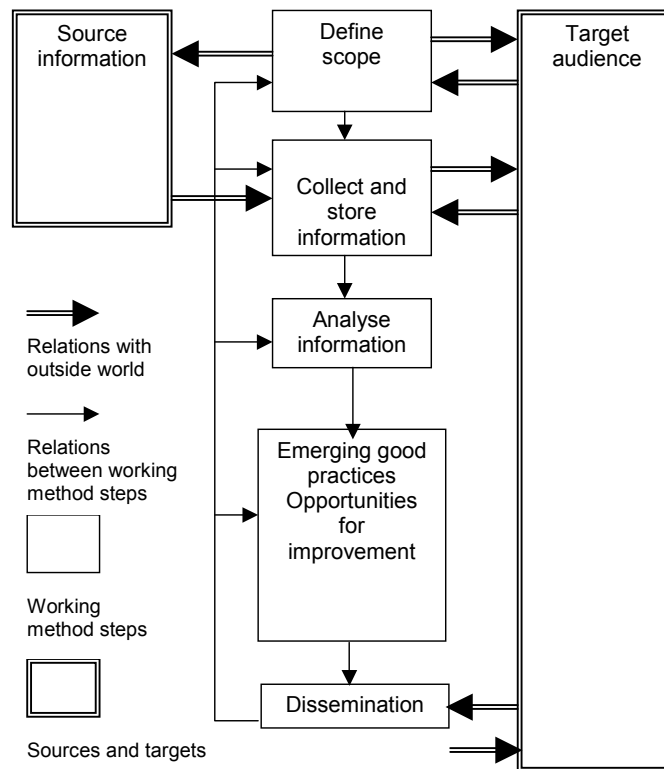


Figure 2 CAATS Working Method

3.2. Integrated Approach

In addition to the working method described previously for each area of expertise, CAATS had always considered the interaction between the three areas of expertise: Validation, Safety and Human Factors. Through close communication among the three teams, an integrated approach was the goal of the CAATS project.

CAATS considered the Validation area itself as the umbrella under which the validation best practices, the Safety and Human Factors best practices should be integrated.

Figure 3 shows the interrelationship between the three CAATS areas: Validation is the umbrella under which the Human Factor and Safety areas were to be integrated.

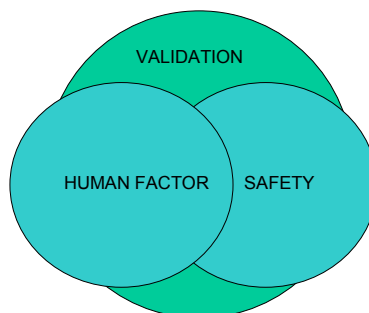


Figure 3 Interrelationships between the Three CAATS Domains

3.3. Source and Target Projects for CAATS

One of the main tasks in defining the scope of the Project was the identification of source and target ATM R&D projects and source information.

Source information refers to projects, documents, processes, groups et cetera where relevant information can be collected. Source information serves as input to the CAATS activities, and will be used to analyse the results or content and to extract the Best Practices and recommendations.

Table 2 shows some of the projects used by CAATS source projects for the initial identification of the best practices.

	Name of the Project
EC Projects	RHEA (Role of the Human in the Evolution of ATM systems)
	VINTECH II (Visual interaction and human effectiveness in the cockpit, part II)
	BETA (operational Benefit Evaluation by Testing an A-SMGCS)
	SAFEE
	OPTAG (Improving Airport Efficiency, Security and Passenger Flow by Enhanced Passenger Monitoring)
	MFF (Mediterranean Free Flight)
	OPAL (Optimisation Platform for Airports, including Land-side)
	MANTEA
	CAST (Consequences of Future Air Traffic Management Systems for Air Traffic Controller Training and selection)
	ECOTTRIS (European Collaboration on Transition Training Research for Improved Safety)
	SRATM (Stress Reduction, Safety and Efficiency in Future ATM through Flight Progress Information)
	MAEVA – Validation Guideline Handbook (VGH)
EUROCONTROL	CoRe (Core Requirements for ATM working Positions)
	EATMP Guidelines
	SHAPE (Solutions fro Human-Automation Partnership in European ATM)
	CISM (Critical Incident Stress Management)
	CARE-CREA (CREative environments for ATM) http://www.dblue.it/CARE_crea.htm
	TOAST (Team Oriented ATC Simulator Training)
	HERA (Human Error Management)
	ITA (Integrated Task Analysis)

Table 2 CAATS Source Projects

The **target projects** referred to the projects identified by EC and the CAATS consortium, as the projects to which CAATS, first of all, had to communicate the identified Best Practices by supporting them in realising their project objectives as far as reasonably practicable.

A preliminary list of target projects was identified in the Team Leader Co-ordination Committee 2 [10]. This list was refined with inputs from the EC and from EUROCONTROL. Rationale for the choice of some other projects can be found in the CAATS Management Board and Team

Leader Co-ordination Committee Meeting minutes 1 [2] and CAATS Management Board and Team Leader Co-ordination Committee Meeting minutes 2 [3].

Table 3 shows the projects selected as CAATS target projects.

	Name of the Project
EC Projects	EMMA
	SPADE I
	BETA (operational Benefit Evaluation by Testing an A-SMGCS)
	SAFE E
	OPTIMAL
	MFF (Mediterranean Free Flight)
	GATE TO GATE
	C-ATM
	FRIENDCOPTER
	SATE Airport
	ISMAEL
EUROCONTROL	AIRNET
	CORA
	AMAN RTS Rome
DEP MET	

Table 3 CAATS Target Projects

3.4. Validation Area

3.4.1. Validation Objectives

The overall objective of the Validation Team on the CAATS project was to **identify** and **consolidate** best practices for the operational concept validation of ATM R&D projects.

This objective was covered through the following activities:

- Identification of best practices in the validation domain. By studying methodologies and practices in EC and EUROCONTROL projects.
- Identification of gaps in the best practices by interacting with target projects and validation experts.
- Drafting of recommendations to fill the gaps and improve the best practices on validation.
- Dissemination of the validation best practices into the ATM community.

3.4.2. Activities and Results

In order to achieve the validation objectives, the activities of the validation team were divided in two stages:

- **In the first stage**, the main goal was to **identify** the validation best practices based on previous experience and expertise.
- **In a second stage**, the main goal was to **consolidate** the validation best practices. To try to reach this objective, the actions taken were twofold:
 - Identify needs for improvement on the best practices by interacting proactively with target projects in order to get their feedback an experience in applying validation techniques. The details on how CAATS members have communicated with target projects are described in the document “Procedure for Liaisons with projects” [4].
 - Disseminate the existing best practices within the ATM R&D community.

Figure 4 shows a scheme of the Validation Working Method.

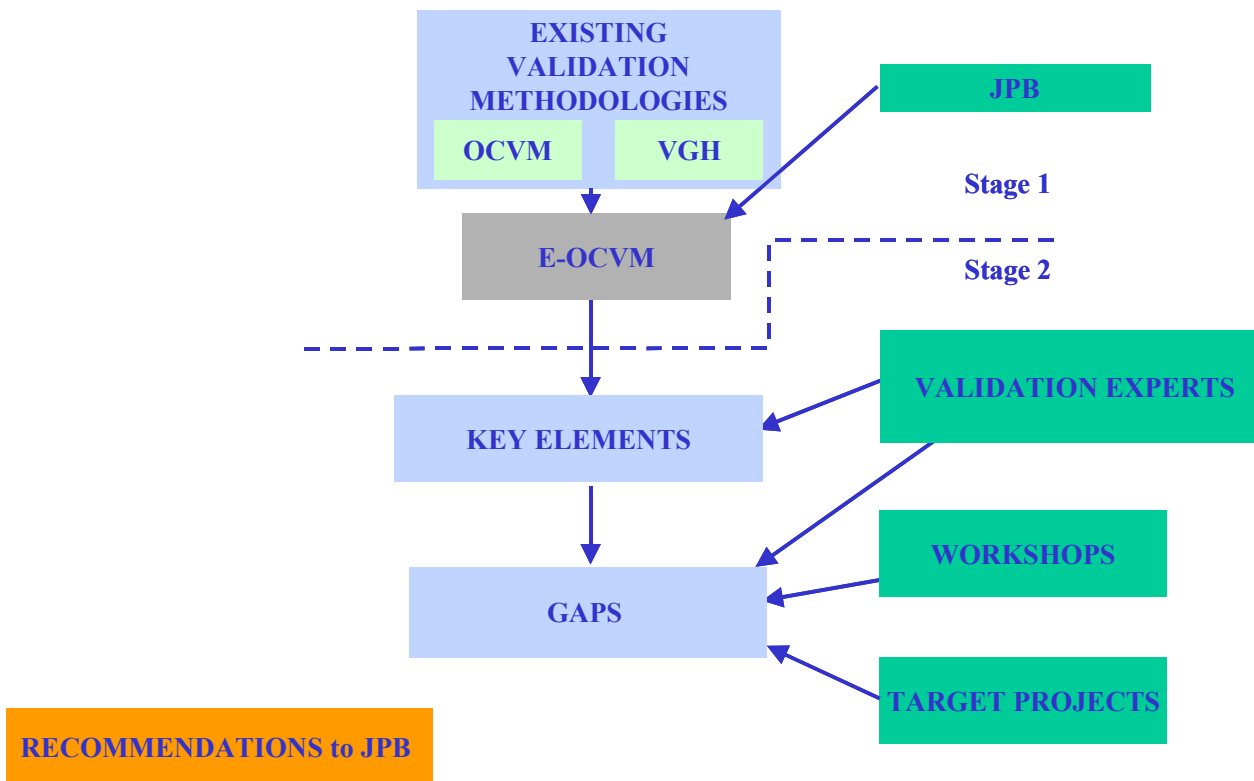


Figure 4 Validation Working Method

3.4.2.1. Identification of Validation Best Practices

Given the maturity level of the Validation area, where previous studies had been done, a first identification and analysis of existing validation methodologies was undertaken. This first step was not done for the Human Factors and Safety, given the lack of existing methods for these areas.

The activities undertaken to reach were:

- The OCVM [5] and VGH [16] were the methodologies to be considered as baseline for the work to be done.
- The validation methodologies of source projects were analyzed. A complete list of source projects is presented in Section 3.3 of this document.
- The Validation Team Members and validation experts based on their experience on validation methodologies performed the merging between OCVM and VGH. The merging criteria established by the validation team experts were established in the document "Merge of Source Methodologies" [7].
- EUROCONTROL and EC participated actively with the CAATS experts and members during this process.

The consolidated methodology, transformed in the European Concept Validation Methodology (E-OCVM), was submitted to the Joint Programme Board (JPB)¹ for endorsement and approved by the EC on the 24/01/2005. The E-OCVM became the Best Practices for the Validation area [8].

3.4.2.2. Consolidation of Validation Best Practices

At this stage, the activities undertaken were:

- **Identification of Validation Key Elements (VKE).** VKE are those areas in the validation domain that, having a key role in the process, are not sufficiently considered in the existing methodologies. These key elements were the focus of analysis in the interaction with the projects and validation to get feedback in the form of gaps and final recommendations to refine the Best Practices Manual.

During the CAATS lifetime, the main key elements being studied (and where more gaps and recommendations have been proposed) correspond to the first four key elements listed in Table 4.

¹ The JPB was set-up under the European Commission (EC) and EUROCONTROL Memorandum of co-operation. The purpose of the JPB is to increase co-operation on on-going research and supporting the implementation of the ATM component of the Advisory Council for Aeronautics Research in Europe (ACARE) strategic research agenda (SRA) and the research part of the European ATM Master Plan by developing a joint approach to the European Commission's and Eurocontrol's ATM research whilst ensuring complementarities, avoidance of duplication and optimisation of resources.

KEY ELEMENT	DESCRIPTION
Management	Related to how and when to manage validation activities within the overall project plan.
Training/Guidance	Knowledge base to be able to use the validation best practices
Stakeholders	All the issues related to stakeholders: identification, communications, milestones, ...
Validation objectives / Aims	Related to identification and traceability of objectives.
Identification of Metrics and Indicators	Identification of the adequate metrics and Indicators.
Selection of Technique	Selection of Validation technique.
Live Trials	Identification of live Trials (when needed).
Scenario Specification	Techniques for scenario specification.
Validation Framework definition	Definition on the scope of the proposed validation.
Data collection methods	Data collection methods.
Identification of sources of error	Identification of elements in the validation process that can affect the reliability of the validation results.
Validation checklist	Guidelines in supporting every expert role in doing their job.
Validation data and results	Standards in presentation of significant result to stakeholders.

Table 4 Validation Key Elements

- **Interaction with validation target projects**

The overall procedure to get information and to relate with target projects is described in detail in the document “Procedures for liaison with target Projects” [4].

Overall, the following means have been used to gather information:

- Visits, interviews and questionnaires;
- Telephone interviews and questionnaires;
- CAATS workshop results; and
- Network of the CAATS Validation group members and experts.

3.4.2.3. Analysis of Gathered Information

Table 5 shows the final documents gathered from those target projects that interacted effectively with the CAATS Validation Team. These documents, to be used within the CAATS scope, and not public, are used as the basis, in addition to workshops conclusions, for identifying gaps and recommendations with the final objective of the consolidation of the validation best practices.



PROJECT	INFO RECEIVED	COMMENTS
AMAN EPV	<ul style="list-style-type: none"> Validation plan. Project Management Plan. Presentation from 1st workshop. 	
C-ATM	<ul style="list-style-type: none"> Summary of 1st interview. 1st validation questionnaire. Presentation from 1st workshop. 2nd validation questionnaire. 	Follows the E-OCVM.
EMMA	<ul style="list-style-type: none"> Summary of 1st interview. 1st validation questionnaire. Presentation from 1st workshop. 2nd validation questionnaire. Validation methodology. Validation indicators and metrics. 	Follows the E-OCVM.
G2G	<ul style="list-style-type: none"> Summary of 1st interview. 1st validation questionnaire. Presentation from 1st workshop. 2nd validation questionnaire. 	Follows the E-OCVM.
OPTIMAL	<ul style="list-style-type: none"> Summary of 1st interview. 1st validation questionnaire. Presentation from 1st workshop. 2nd validation questionnaire. 	Follows the E-OCVM.
SAFFEE	<ul style="list-style-type: none"> Summary of 1st interview. 1st validation questionnaire. Presentation from 1st workshop. 2nd validation questionnaire. 	Validation plan still in draft. Probably it will not make public. Follows the E-OCVM.
SPADE (phase I)	<ul style="list-style-type: none"> Summary of 1st interview. 1st validation questionnaire. Presentation from 1st workshop. 2nd validation questionnaire. Validation methodology. 	Follows the E-OCVM.

Table 5 Validation Documentation gathered from Target Projects

3.4.2.4. Identified Gaps and Recommendations for Improving the Best Practices

CAATS understands a gap as an area where best practices are wanted but no best practices were identified. Gaps in the Validation Domain can be identified from:

- Gaps identified a priori based on the implicit knowledge.
- Gaps identified by the target projects.

- Gaps identified by the CAATS Validation Team after analysis of projects and methodologies.
- Gaps identified by the CAATS Validation Team in the two CAATS workshops.

The analysis method of gathered information from target projects is detailed in the document "Gap Identification and Analysis" [9]. Table 6 shows the identified gaps signified by the validation team.

The fields listed in this table correspond to:

Reference: A unique correlative number to identify each of the gaps.

Description: Description of the gap.

Origin: Workshop and/or target project where the gap was identified. WS1 corresponds to the 1st CAATS Workshop. WS2 corresponds to the 2nd CAATS workshop.

Key element: Area where the gaps are included.

Reference	GAP	Origin	KEY ELEMENT
1	Inadequate description of the validation approach at proposal stage	WS1, projects	Management
2	Lack of explicit information regarding the scheduling of the validation activities	WS1	
3	Lack of guidance related to the provision of adequate validation resources	WS2	
4	Lack of guidance for conflict resolution and prioritization of objectives	WS2, SPADE	
5	Lack of matching of tasks to experts roles and stakeholders	WS2	
6	Not clear relationship between maturity level and validation methodology	ASAS, WP2	
7	Validation team-stakeholder communication	WS1, WS2, SAFEE, GTG	Training/Guidance
8	Lack of E-OCVM implementation guidance	WS1, WS2	
9	Lack of reference to methods used for stakeholder identification	WS1, WS2, GTG,	
10	Lack of guidance on how to get the right information from stakeholders	WS2, EMMA, ASAS	Stakeholders
11	Need to involve stakeholders in the entire validation process	ASAS, SAFEE, WS2, GTG	
12	Lack of guidance for decomposing the validation objectives	EMMA, WP1, SPADE	Validation objectives / Aims
13	Low-level objectives: define traceability between low-level, high-level and stakeholders expected outcomes	EMMA, OPTIMAL, SPADE	Metrics and Indicators
14	Lack of interconnection between objectives, metrics and indicators	ALL	
15	Guidance in the selection of tools and techniques.	EMMA, WS2, ASAS	Selection of technique
16	Lack of guidance on the choice and use of controllers for generating subjective data.	WS1	Live Trials
17	Guidance in the selection of platform, scenarios, tools and techniques is required.	WS1, SPADE	Scenario Specification
18	Standard versus framework: make clear the scope of the validation methodology	ALL	Validation Framework definition
19	Confusion in applying the methodology at program/ project level	ASAS, WP2	
20	Lessons learned should be available	ALL	
21	Lack of a validation checklist for project managers	EMMA, WS1	Validation checklist
22	Lack of reference to validation limitations	WS2, EMMA	Validation data and results
23	Need of synthesis of validation results	ALL	
24	Lack of common structure of the validation reporting	ALL	

Table 6 Identified Validation Gaps

Theses gaps have been analysed by the validation experts and some recommendations have been used to fill up these gaps. The recommendations can be found in Section 8 of Validation Team Report [17].

3.4.3. Deliverables, Guides and Studies

Id	Title	Description	Issue Date ²	Approval Date ³
D1.6	CAATS Validation Team Report 6.	CAATS Validation report.	04/4/06	04/04/06
D1.8	Best Practices Manual and Annex A: Validation Best Practices.	Best Practices in Validation.	21/4/06	25/4/06
	Guide to a comprehensive incorporation of Validation, Safety and Human Factors in ATM R&D projects.	Guide on how to use the Best Practices Manual oriented to project managers.	27/10/05	28/11/05
	Business case in validation.	Study on the existing methodologies for creating a validation business case.	10/2/05	NA
	Validation recommendations.	This document presents both the validation methodology gaps identified during the CAATS lifetime by validation experts interacting with target projects as well as their proposed recommendations to fill them.	31/03/06	
	Guidance for Stakeholders Identification and Analysis.	The purpose of this document is therefore to provide some guidelines on addressing the issue of stakeholder identification and analysis to support the validation process.	25/04/06	

3.4.3.1. CAATS Validation Team Report (D1.6)

This report was a living document through the entire CAATS project. It shows the detailed activities performed by the Validation team along the project, the relationship with target projects and the main outcomes in every stage of the project. For more information refer also to the document of reference [17].

3.4.3.2. Validation Best Practices (D1.8)

Best Practices have been defined by the Team Leaders as “Proven solutions supporting the achievement of target project objectives as far as reasonable practicable”. This section includes the description of developed best practices for validation.

This first version came out of the process of merging of the existing validation methodologies (using the OCVM as the baseline of the work) [5]. The Validation Team, in collaboration with EUROCONTROL, has consolidated a single method, namely the E-OCVM. The E-OCVM has been endorsed by the JPB on 24 January 2005. The Best Practice Manual [8] has been approved by the EC on 12/10/05.

² The issue date is the date of the last release of the deliverable.

³ The approval date is the date of approval of the deliverable by the EC or the Project Leader.

- The Best Practices for Validation are included in the Annex A of the CAATS Best Practices Manual.
- The main purpose of the CAATS Best Practice Manual [8] is to present recognised best practices in the areas of ATM Validation, Human Factors and Safety.
- The main body of the Best practices manual explains the rationale of best practices for validation.
- In annex A of the Best Practices Manual, the validation best practices (most recent version of the E-OCVM) are presented.
- In annex B of the Best Practices Manual, good practices for Safety are presented.
- In annex C of the Best Practices Manual, good practices for Human Factors are presented.

3.4.3.3. Guide to a Comprehensive Incorporation of Validation in ATMR&D Projects

The purpose of this guide [11] is to provide support for effective management of the validation, safety and human factors activities as part of the overall ATM R&D project, by issuing clear and concise checklist guidelines.

The guidelines are written from a project management perspective and are applicable to ATM R&D, mainly in the proposal and negotiation phase, but can also be use during the whole life of a project. The objective is to provide a harmonised way to perform validation (including safety and human factors) and to make results comparable and easy to use for Decision Making process and Decision Makers.

The document has considered a main area, validation, and two added areas, safety and human factors, which are under the umbrella of validation. It is necessary to mention that the information included here under validation has been widely influenced by the European Operational Concept Validation Methodology (E-OCVM), considered as best practice in validation.

The “Guide to a comprehensive incorporation of validation in ATM R&D projects” was approved by the EC on 28/11/2005.

3.4.3.4. Business Case Study

The main goal of this document [12] is to draw a landscape of the current situation of the Business Cases related to ATS investments that are being developed in Europe, giving also some hints on how the future should be.

The Validation Team was requested by the EC to perform the work described above. This study is called **CAATS Business Case Study** extension and it has been done under the CAATS project umbrella.

Special interest in this study has been paid at establishing a link between validation exercises outputs and the use on building a Business Case for the project.

Conclusions and recommendations summary:

- The E-OCVM should have an annex containing information that helps program managers to determine an appropriate validation strategy and validation plan.
- The validation strategy and plan must take into account the following items:
 - Type of information required when populating the business case.
 - How to determine which Key Performance activities will be addressed by the business case.
 - The availability and quality of information that could be made available at the different stages of development through experimentation or other investigations.

3.4.3.5. Validation Recommendations

This document [30] presents both gaps in the validation methodology identified during the CAATS lifetime by validation experts interacting with target projects as well as their proposed recommendations to fill them.

In total, there are 24 identified gaps for the validation domain. For each gap, validation experts have issued one or more recommendations. Most of the gaps and recommendations have to deal with validation management, stakeholders' relationships and training/guidance.

The intended final audience of this document is the "Validation Forum" (previously named "Validation User Group" or "VALUG"). The "Validation Forum" was established by the EC / EUROCONTROL Joint Programme Board (JPB) in order to provide a neutral and objective platform to maintain the common assets of the ATM validation community, such as the E-OCVM and the VDR.

The "Validation Forum" will have the opportunity to review the recommendations to refine the E-OCVM presented in this document and to evaluate their adequacy for inclusion in a new version of the E-OCVM.

3.4.3.6. Guidance for Stakeholders Identification and Analysis

One of the main concerns and gaps collected in CAATS has been the need to a more structured approach to stakeholder identification and requirements analysis.

A clear approach and methodology for stakeholders' identification and analysis would help project initiators to assess the 'environment' in which they will operate. A stakeholder analysis should identify relevant stakeholder groups that can influence or be influenced by the system/project/product/organization in question.

The purpose of this document [29] is therefore to provide some guidelines on addressing the issue of stakeholder identification and analysis to support the validation process.

3.4.4. *Dissemination Activities*

The main objective of the dissemination activities was to ensure that the new knowledge on validation was made available to all the ATM community, European and / or International.

The dissemination was performed through different means:

- Dissemination workshops to spread all Validation related Knowledge and Best Practices. See the section 7.1.1 of this document for detailed information about CAATS workshops.
- The development of a CBT with the E-OCVM.
- Training Sessions: to give specific technical support to users based on their specific needs.

3.4.4.1. Computer Based Training on Validation Best Practices

A computer based training course was developed in order to allow any member of an ATM R&D or Eurocontrol project to be aware of and master the validation methodology considered by the EC as best practice.

3.4.4.2. Training Sessions on Validation Best Practices

Two 30-hour course on E-OCVM were given by the validation experts to the project leaders of the following companies:

- Boeing RTC.
- EADS.

3.4.5. *Conclusions*

The objective of the Validation Team on the CAATS project was to **identify** and **consolidate** best practices for the operational concept validation of ATM R&D projects.

The work performed and results obtained were in line with the objectives proposed for the Validation Area because:

- Interaction, done by validation experts, with a number of European ATM R&D projects, proposed by the European Commission and EUROCONTROL, gave way to a first version of a global methodology in operational concept validation for all ATM R&D projects: the E-OCVM.
- The E-OCVM was endorsed by the JPB as the one to be used by all EC and EUROCONTROL funded projects.



- Active dissemination and supporting of the best practices implementation among the ATM community. As result, the E-OCVM has been adopted by a sizable number of projects in the ATM R& D community.
- By interacting actively with target projects, gaps in the validation methodology were identified.
- As result of the analysis done by the validation team on the identified gaps, a series of recommendations to improve them and make it more efficient were issued. Details of the recommendations can be found on the Validation Team Report [17] and the document with the CAATS Validation Recommendations [18].

The E-OCVM, a unified validation methodology, with a clear stepped approach, will make the concept validation in ATM R&D projects easier, facilitating earlier and more consistent evaluation of the fitness for purpose and adequacy of the concept, both for stakeholders and project managers, allowing adjustment to take place at a earlier stage, making possible and significant comparisons among different project and, in summary, saving considerable resources.

3.5. Safety Area

3.5.1. Safety Objectives

The safety domain in the CAATS project was initiated to develop and disseminate best practices for safety topics in Air Traffic Management. Additionally, recommendations for future safety R&D activities for identified gaps between safety needs on one hand, and the lack of appropriate available safety results to answer these needs on the other hand.

3.5.2. Activities and Results

The working method followed by the SAFETY area follows the overall working method described in Section 3.1 of this document and that consisted of 4 main tasks:

- Definition of the work scope of each area.
 - Identification of source/target projects.
 - Selection of key elements of study.
- Collection of information from source and target projects.
- Analysis of collected information from two perspectives:
 - Identification of best practices/emerging good practices; and
 - Identification of gaps/needs for improvement.
- Dissemination activities among the ATM community. Best Practices/Emerging Good Practices will be communicated to target projects in a proactive way with the aim of supporting target projects in realising their project objectives.

3.5.2.1. Safety Scope Definition

The main activities for the definition of the Safety scope were the selection of safety key elements & safety projects that will be addressed within CAATS. This step includes approval of the defined scope by the European Commission.

- **Identification of Source/Target projects.** Section 3.3. Of this document lists the CAATS source and target projects.
- **Identification of Safety Key Elements (SKE).** SKE are those areas in Safety that, having a key role in the process, are not sufficiently considered in the existing methodologies. During CAATS lifetime, thirty-four potential SKE were identified. They were grouped into 10 clusters of related key elements. The clusters were the following: 1) Safety assessment methodologies; 2) Safety management; 3) Safety regulation; 4) Safety culture; 5) Safety monitoring/ measurement; 6) Dimensions of safety; 7) Safety R&D; 8) Operational safety improvements; 9) Safety communication; and 10) Safety metrics and indicators. More complete information about the Safety SKEs and their clustering can be found in Annex C of the CAATS Safety Report 6 [31].

Given the time and resources constrains, four of the identified SKE clusters were selected for a more detailed analysis in the interaction with the projects within CAATS lifetime. These clusters were:

- **SKE I - Safety Management.** Safety Management can be considered as the management of activities to secure high standards of safety performance meeting, as a minimum, the provisions of safety regulatory requirements.
- **SKE II – Safety Assessment Methodologies.** Safety assessment methodologies can be considered as means to assess the safety impact of new or proposed changes in (air transport) operations.
- **SKE III – Safety R&D.** Safety R&D can be considered as those safety topics and activities where safety R&D organisations are working on, with what facilities and resources and what the priorities are.
- **SKE IV – Safety Regulation.** A safety regulation requirement can be considered as a formal stipulation by the regulator of a safety related specification, which, if complied with, will lead to acknowledgement of safety competence in that respect.

The remaining clusters analysis will be achieved during CAATS II lifetime.

3.5.2.2. Interaction with Safety Target Projects

The overall procedure to get information and to relate with target projects is described in detail in the document “Procedures for liaison with target Projects” [4].

The following means have been used to gather information:

- Literature review;
- CAATS workshop results;

- Visits, interviews and questionnaires;
- Telephone interviews and questionnaires; and
- Network and information available to the CAATS Safety group members.

An overview of safety plans and activities of these target projects are described in [21].

3.5.2.3. Analysis of Gathered Information

Table 7 shows the final documents gathered from those target projects that interacted effectively with the CAATS Validation Team. These documents, to be used within the CAATS scope and, not public, are used as the basis, with the CAATS workshops conclusions, for identifying gaps and recommendations with the final objective of the consolidation of the Safety best practices.

The analysis of gathered information was done for each SKE individually. The intention of the analysis was to take care that the identification of emerging good practices was as objective as possible.

PROJECT	INFO RECEIVED	COMMENTS
EMMA (Phase I)	<ul style="list-style-type: none"> • Presentation of EMMA results at 1st CAATS workshop. • Participation at 2nd workshop. 	<ul style="list-style-type: none"> • Safety management. • Safety assessment methodologies. • Safety regulation.
C-ATM	<ul style="list-style-type: none"> • Safety plan received. 	<ul style="list-style-type: none"> • Safety assessment methodologies.
SAFE	<ul style="list-style-type: none"> • Presentation of SAFE at Safety R&D workshop, October 2005. 	<ul style="list-style-type: none"> • Safety assessment methodologies. • Safety regulation.
OPTIMAL	<ul style="list-style-type: none"> • Presentation of EMMA results at 1st CAATS workshop. • Detailed safety plan received. 	<ul style="list-style-type: none"> • Safety management. • Safety assessment methodologies. • Safety regulation.
Gate to Gate	<ul style="list-style-type: none"> • Presentation of Gate-to-Gate results at 1st workshop. • Participation at 2nd CAATS workshop. 	<ul style="list-style-type: none"> • Safety assessment methodologies.
SPADE (phase I)	<ul style="list-style-type: none"> • Interview. 	<ul style="list-style-type: none"> • Safety assessment methodologies (at a later stage).
ISMAEL	<ul style="list-style-type: none"> • Presentation of ISMAEL results at 1st CAATS workshop. • Participation at 2nd workshop. • Participation at ISMAEL meetings. 	<ul style="list-style-type: none"> • Safety assessment methodologies.
AIRNET	<ul style="list-style-type: none"> • Plan for safety activities. 	<ul style="list-style-type: none"> • Safety assessment methodologies.
CORA	<ul style="list-style-type: none"> • Presentation of CORA at 1st CAATS workshop. • Participation at 2nd workshop. 	<ul style="list-style-type: none"> • Safety assessment methodologies.
AMAN RTS Rome	<ul style="list-style-type: none"> • Validation Plan received. 	
ATC Wake	<ul style="list-style-type: none"> • Presentation of ATC WAKE at 2nd CAATS workshop. 	<ul style="list-style-type: none"> • Safety management. • Safety assessment methodologies. • Safety regulation.

Table 7 Safety Documentation gathered from Target Projects

3.5.2.4. Emerging Good Practices and Room for Improvement

Within CAATS, best practices were defined as proven solutions supporting to identify and achieve target project objectives as far as reasonable practicable. During the course of the CAATS project, it became clear that although a lot of developments and activities are ongoing in ATM safety, it is in general too early to talk about “Best Practices for Safety”. The main reason was that there are almost as many safety approaches/ philosophies as there are parties working on safety. This did not give an indication that we can talk about “best practices” as proven solutions in the way CAATS has defined it. Instead it was decided to talk about “Emerging good practices”, and “Needs for improvement”.

The following main emerging good practices had been defined:

- The general principles of a Safety management system for an individual organisation. For ANSPs, the safety management system of NATS and NAV Canada are good candidate best practices;
- A generalised eight-staged process for safety assessment;
- A database containing, at the time of writing, over 600 individual techniques and methods for safety assessment;
- 32 Individual safety assessment techniques and methodologies relevant for parts of the process stages and ATM concept elements; and
- ESARRs and other SRC documentation. In general these are seen as first generation safety regulations for ATM.

The following needs for improvement were identified:

- An integrated Air Transport wide safety management framework for big changes in Air Transport including ownership and responsibilities;
- The steps “Scoping the safety assessment”, “learning from safety feedback”, and “safety communication” as part of the eight-staged safety assessment process;
- Coverage of organisational aspects in safety assessment methodologies;
- Harmonisation of safety assessment methodologies and sharing of safety cases;
- Means to foster re-use of safety R&D results;
- A safety assessment methodology that is fully compliant to all ESARR 4 requirements;
- Lack of harmonisation of ATM safety regulations;
- Safety regulatory community does not include R&D projects in its working space;
- Integrate results of R&D projects in already implemented Safety Management System by an actor like an ANSP or an airline;

- ESARR 4 related needs:
 - The definition of “ATM direct contribution” is subject to interpretation;
 - Rationale for the ECAC Safety Minimum for ATM in ECAC is unavailable;
 - Inconsistent directions to classify severity;
 - ESARR 4 leaves open the possibility to consider in the risk assessment only hazards within the ATM system or even within the constituent part related to the change;
- Compliance reports are confusing and inconsistent;
- There are concerns about SRC Policy Document 2 “Use of safety nets in risk assessment & mitigation in ATM”; and
- There is variation in the terminology in ATM safety certification.

For more detailed information about these topics, there are 5 separate volumes, each of which describes in details the current status of the results of a SKE. The volumes are as follows:

Volume I: “Safety Management”, main author is TRANSLOG/ RCAUEB with support from NLR, EEC, AENA, NERL, Ineco and Slot Consulting [22],

Volume II: “Safety Assessment Methodologies”, main author is NLR with support from EEC, AENA, AUEB, NERL, Deep Blue, Ineco and TU Dresden; [23],

Volume III: “Safety R&D”, main author is EEC with support from NLR, Boeing R&TE and Isdefe; [24] and

Volume IV: “Safety Regulation”, main author is AENA with support from EEC/ SRU, NERL and Ineco [25].

A separate volume has been developed that contains information regarding safety and its relationship to security, human factors and validation. This volume only presents the collected information on these topics without analysis:

Volume V: “Safety and its relationship to Security, Human Factors, and Validation”, main authors are NLR/ Deep Blue with contributions from Slot Consulting, TU Dresden and AENA [26].

3.5.3. Deliverables

Id	Title	Description	Issue Date ⁴	Approval Date ⁵
D1.4	CAATS Safety Team Report.	CAATS Safety Team Report.	04/4/06	04/04/06
D1.8	Best Practices Manual and Annex B: Good Practices for Safety.	Good Practices for Safety as part as the Best Practices Manual.	21/4/06	

3.5.3.1. CAATS Safety Team Report

This report was a living document through the entire CAATS project. It shows the detailed activities performed by the Safety team along the project, the relationship with target projects and the main outcomes in every stage of the project. For more information refer also to the document of reference, [19].

3.5.3.2. Best Practices Manual and Annex B: Good Practices for Safety

The main purpose of the CAATS Best Practice Manual [8] is to present recognised best practices in the areas of ATM Validation, Human Factors and Safety.

- The main body of the Best Practices Manual explains the rationale of best practices for validation.
- In annex A of the document, the validation best practices (most recent version of the E-OCVM) are presented.
- In annex B, good practices for Safety are presented.
- In annex C, good practices for Human Factors are presented.

3.5.4. *Dissemination: Safety- Centred Activities*

3.5.4.1. Presentation of CAATS SKE II initial findings to the SAM Task Force, March 24th, 2005

The SAM Task Force (SAMTF) is responsible for developing a methodology for the safety assessment of Air Navigation Systems. The chairman of the SAMTF (P. Mana of EUROCONTROL) has invited CAATS to present for the SAMTF initial findings and discussion items regarding safety assessment methodologies (with special attention to SAM) and safety regulations (with special attention to ESARR4). The slides of this presentation are listed in the appendix of the Safety Team Report [19].

The conclusion for CAATS regarding this dissemination activity was that the audience (mainly Safety experts from EUROCONTROL and European ANSPs) greatly appreciated the topics and discussion items that were presented. Therefore, this was seen as confirmation that the SKE II initial derived emerging good practices and the identified needs for improvement were well regarded.

3.5.4.2. The Workshop on Safety R&D (SKE III) in Europe 18 - 20th of October 2005, at EUROCONTROL HQ in Brussels

The main objectives of this Safety R&D Workshop were:

- To disseminate and promulgate the identified up to date CAATS best practices on Safety methodologies;



- For stakeholders, ANSP and R&D Organisations and Universities to present current, mid and long term planned activities in the areas of safety R&D, safety practices and culture together with their identified safety needs and priorities; and
- To discuss and identify safety research needs and priorities in order to facilitate better coordination and collaboration on key European ATM Safety R&D issues.

Representatives from many organisations like governmental, agencies & international organisations, Air Navigation Service Providers, industry & aircraft manufacturers, R&D centres and aviation consultants and universities have attended the workshop. In total over 50 individuals have participated.

The workshop confirmed the previously held view of fragmented safety R&D activity state of play across Europe that justifies the need for a Safety R&D Strategic Plan. The main findings of the workshop were formulated along three lines:

- Identification of R&D development processes;
- Key safety R&D threats; and
- Organisational framework.

The key issues identified at “Identification of R&D development processes” were:

- Inject safety into the design;
- Promote safety awareness among operational people; and
- Find a right balance between predictive (safety issues of future emerging concepts) and reactive (accidents, incidents) safety approaches.
- Key Safety R&D threads identified many issues in need of further analysis and resolution.

These issues are summarised by the following actions lines:

- R&D to improve the safety of the ATM systems;
- R&D to improve the safety of ATM system operation;
- R&D to support safety regulation;
- R&D to improve organisational safety culture;
- R&D to improve safety management methods;
- R&D to improve safety analysis methods; and
- R&D to improve learning from safety-related events.

The “Organisational Framework” session discussed a feasible structure including funding for the implementation of the Safety R&D strategic plan. Some key findings are:

- Ideal ownership for the Safety R&D strategic plan was with a consortium representing all stakeholders who were to directly benefit from ensuring ATM safety, ranging from EC, EASA, national regulators and ANSPs, and ATM representatives (e.g., CANSO, IFACTA) to aviation organisations (airlines, manufacturers and industry);
- EUROCONTROL Experimental Centre was seen as best candidate for starting point; and

- Different sources for funding were identified: national Governments and CAAs, EC Framework instruments and private investments from industry and manufacturers.

For a detailed report on the workshop, we refer to the Safety R&D workshop report [28].

3.5.5. **Conclusions**

The safety work package in the CAATS project was initiated to develop and disseminate best practices for safety topics in Air Traffic Management. The main audience consists of a number of European ATM R&D target projects selected by the European Commission and EUROCONTROL as it has been recognised that there is a current lack of coordination of processes and methodologies across these projects.

Another objective was to develop recommendations for future safety R&D activities for identified gaps between safety wishes and needs on one hand, and the lack of appropriate available safety results to answer these wishes and needs on the other hand.

The work performed and results obtained were in line with the objectives proposed for the Safety Area because:

- One of the first conclusions was on the need to define the scope and limitations of the study given the multiple approaches to Safety. During the course of the CAATS project it became clear it is in general too early to talk about “Best Practices for Safety”. The main reason is that there are almost as many safety approaches/ philosophies as there are parties working on safety. This does not give an indication that we can talk about “best practices” as proven solutions in the way CAATS defined it. Instead it was decided to talk about “Emerging good practices”, and “Needs for improvement”.
- Through a very active interaction with a number of target projects and safety experts, a long and rich lists of emerging good practices and needs for improvement for safety key elements in ATM were identified. These emerging good practices are part of the Validation Best Practices Manual.
- Active dissemination and supporting of the “emerging good practices” for Safety took place (see section 3.5.4 of this document). In general, the audience of the dissemination activities was supportive and interested in the safety validation area.

In conclusion, the objectives were fulfilled since a first version of consensual “emerging good practices” for the Safety Area are already in place, “needs for improvement” already issued and a better awareness of the need to continue the work towards a “best practices” in Safety was achieved.

The ATM R&D projects count now with a first version of “emerging good practices” that might guide them from the project beginning in the safety requirements needed to validate the ATM concept.

3.6. Human Factors Area

3.6.1. Human Factors Objectives

The main objective of the Human Factors Area in the CAATS project was to identify best practices in Human Factors Validation, disseminate the best practices, and to provide support to FP6 projects on request.

For Human Factors, CAATS understood the “multi-disciplinary effort to compile and generate knowledge about people at work, and apply that knowledge to the functional relationships between people, tasks, technologies and environment, in order to produce safe and efficient human performance”. In short, “human factors” is “designing for human use”. (McCormick, 1976), i.e. designing technical and work systems, tasks, objects, and places for people, within a wider social and organisational context.

3.6.2. Activities and Results

To achieve the Human Factors objective, and according to the working method describe in section 3.1 of this document, the following activities were undertaken:

- Definition of the work scope of each area.
 - Identification of source/target projects.
 - Selection of key elements of study.
- Collection of information from source and target projects.
- Analysis of collected information from two perspectives:
 - Identification of best practices/emerging good practices; and
 - Identification of gaps/needs for improvement.

Dissemination activities among the ATM community: Best Practices/Emerging Good Practices were communicated to target projects in a proactive way with the aim of supporting target projects in realising their project objectives.

3.6.2.1. Human Factors Scope Definition

The Scope Definition Process had two main parts:

- **Identification of Source/Target projects.** Section 3.3 of this document lists the CAATS source and target projects.
- **Identification of HF Key Elements-** the following elements were considered when identifying the HF Key elements: description of the CAATS Technical Annex [1]; the preferences showed by the EC after the KOM of the project; the identified elements in the analyzed documentation; the expertise from the different team experts and members; and, mainly, what could be useful to the target projects.

CAATS HF has used the EUROCONTROL “gearbox model” to select the HF Key Elements, which are divided into:

The Key Elements for overall HF activity are:

- HF management integration – Understanding and co-ordinating the activities needed to manage human related project risks.
- HF system integration – Understanding the role of people within the overall system, and allocating functions between them and the equipment in order to optimise any trade-off in performance and cost.

The Key Elements for detailed HF activity are:

- Human Machine Interaction – Understanding all aspects where a human interacts with a non-human part of the system (‘the machine’), and how to design the interaction to be effective, reliable and efficient.
- Recovery from failures – Understanding how system disturbances affect the humans on which system operation relies, and how they manage safety throughput, etc when there are system disturbances.
- Teams and communications – Understanding the workings and dynamics of organisational and interpersonal communication and the creation and maintenance of useful teamwork (team building, leadership and so on).

The Key Element for embedding the technical/conceptual solution in the operational system is:

- Stakeholders usability and acceptance of new technologies/concepts – Understanding and facilitating the way that humans coming into contact with the new concept/technology accept its existence and the way in which it operates, including whether it is easy to use and to learn, and efficient for the human to perform key tasks.

The structure of these KEs in three levels can be shown in Figure 5.

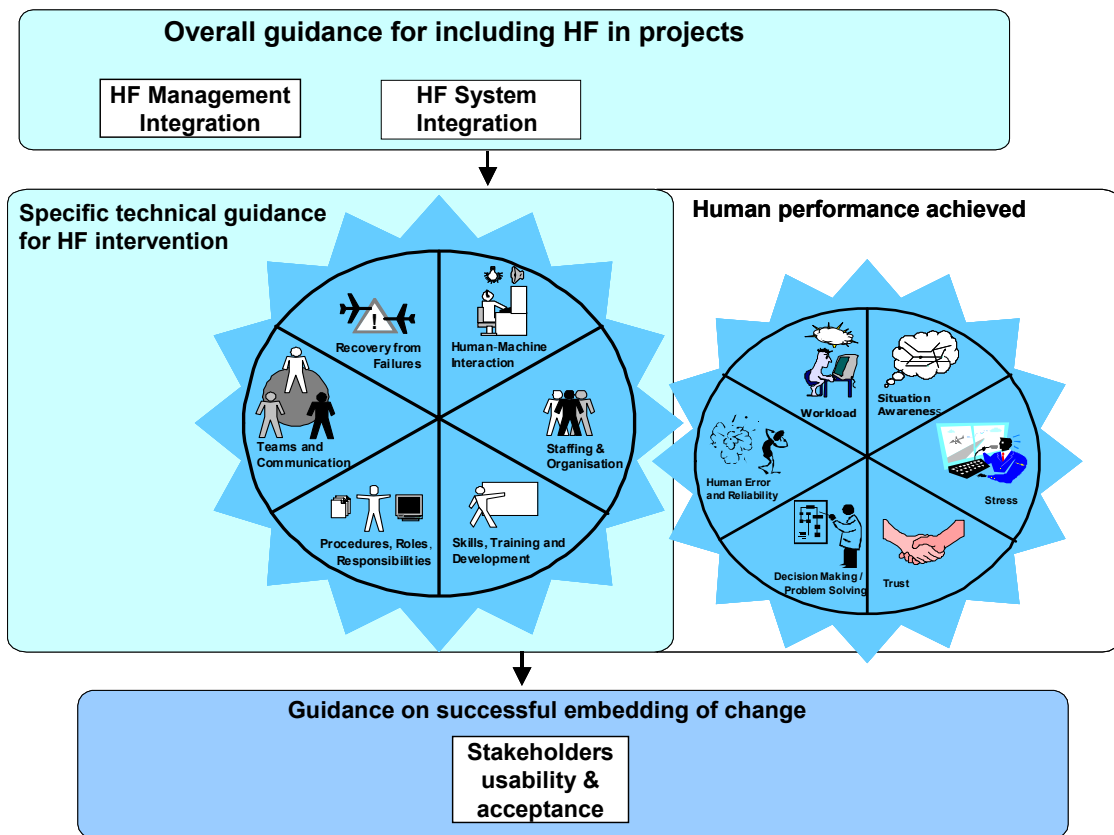


Figure 5 The Gearbox Approach to Human Factors

3.6.2.2. Interaction with Human Factors Target Projects

The Human Factors Team has collected some sources for the different KE, considering projects but also document, articles, etc. There is also some questionnaires and templates used when collecting information from the target projects.

The overall procedure to get information and to relate with target projects is described in detail in the document “Procedures for liaison with target Projects” [4].

More detailed information can be found in the CAATS - HF Interaction Plan with target projects [27].

3.6.2.3. Analysis of Gathered Information

Table 8 shows the final documents gathered from those target projects that interacted effectively with the CAATS Human Factors Team. These documents were analysed from the perspective of the different key elements to identify Human Factors Best Practices and gaps. Furthermore Eurocontrol “HF case” and the “HF Framework” from NATS have been considered.

PROJECT	INFO RECEIVED	COMMENTS
AIRNET	Direct interaction.	Apply CAATS HF Good Practice manual.
ATC-WAKE	Some good HF issues.	Project almost finished when CAATS started.
C-ATM	HF related to safety from high-level perspective.	
CORA	Presentation at 1st workshop.	Project cancelled
EMMA	Presentation of EMMA results at 1 st CAATS workshop.	Almost finished when CAATS started. More interaction expected in EMMA II.
EVP	Direct interaction.	Human Factor issues of potential interest.
FLYSAFE	Participation in expert review.	
FRIENDCOPTER		No interest
GTG	Presentation in 2 nd CAATS WORKSHOP.	Close interaction in some simulations.
K-ATM		Too late for CAATS. National project.
OPTIMAL	Presentation at 1st workshop.	
SPADE	Presentation at 1st workshop.	Active feedback.
SAFEE	Direct interaction.	

Table 8 Human Factors Integration with Target Projects

More information about the results of this analysis can be found in the HF Progress Report 6 [20].

3.6.2.4. Identified Good Practices and Gaps

The terms ‘good practice’ and ‘best practice’ are some times used with the same meaning, but CAATS tries to recognise the difference. Good practice emerges in any field, with experience, when the same practices are shown to work better than others, or to reduce risk more than others. Best Practice presupposes, not just that it has proven to be effective, but that there is agreement on (or regulatory imposition of) how things should be done. For HF it was also decided to talk about “Emerging good practices”, and “Needs for improvement”.

Table 9 summarises the Human Factors Good Practices.



Element	Guidance	Achievement
HF Management Integration	Understand human impact of the project	Better HF scope
	Identify & manage human issues	Risk reduction
	Monitor HF effectiveness	
	Prepare HF Case	Validation
HF system integration	Identify human related system options	Cost effectiveness
	Assess human related risks & trade-offs	
	Allocate functions	
	Determine performance criteria	Validation
Human Machine Interaction	Identify users and others affected by machine	Human and system efficiency
	Develop efficient and effective HMI	Human well-being Human performance
Recovery from failure	Prevent human error	Error tolerance
	Error detection and recovery mechanics	Error resistance
Teams and communications	Analysis of team performance	Human effectiveness and efficiency
	Implement or modify Team and Communications Plan	
Procedures, Roles and Responsibilities	Identify item affected and causes. Check changes and new actions that are needed	Human efficiency Better management of human performance
	Assess coherence of proposed set of procedures	
Skills, training and development	Identify skills affected and training needed	Improved Human performance Managed Human costs
	Develop training programme and evaluate results	
Staffing and organisation	Identify foreseen users and stakeholders	Foreseeing future problems and shortfalls Managing Human cost
	Design for future user change	
Stakeholder usability and acceptance	Identify stakeholders affected	Usable system that meets stakeholder expectations

Table 9 Human Factors Good Practices

3.6.3. Deliverables

Id	Title	Description	Issue Date ⁶	Approval Date ⁷
D1.5	CAATS Human Factors Team Report.	CAATS Human Factors Team Report.	04/04/06	04/04/06
D1.8	Best Practices Manual and Annex C: Human Factors Good Practices.	Good Practices in the Human Factors area.		

3.6.3.1. CAATS Human Factors Team Report

This report was a living document through the entire CAATS project. It shows the detailed activities performed by the Human Factors team along the project, the relationship with target projects and the main outcomes in every stage of the project. For more information refer also to the document of reference, [20].

3.6.3.2. Best Practices Manual and Annex C: Good Practices for Human Factors

The main purpose of the CAATS Best Practice Manual [8] is to present recognised best practices in the areas of ATM Validation, Human Factors and Safety.

- The main body of the Best Practices Manual explains the rationale of best practices for validation.
- In annex A of the document, the validation best practices (most recent version of the E-OCVM) are presented.
- In annex B, good practices for Safety are presented.
- In annex C, good practices for Human Factors are presented.

3.6.4. Dissemination: Human Factors Centred Activities

- Participation to **Human Factors workshops**, showing CAATS ideas and results:
 - “Human Factors in aviation” Workshop: Bonn, 25th May 2005.
 - “People and Systems” Symposium: London, 16th-17th November 2005.

More information can be found in the CAATS Human Factors Report 6 [20].

- Eurocontrol groups:
 - Safety assessment Methodology Task Force (SAM- TF). They showed interested but next meeting is outside CAATS.
 - Human Performance Sub-Group (EUROCONTROL). They showed interested and although the next meeting is outside CAATS, a member from CAATS-HF will present to them the CAATS results.

- Eurocontrol HF case subgroup: CAATS results were presented to them and they were considered as very useful. They will integrate them in the future HF case development.

3.6.5. **Conclusions**

The main objective of the Human Factors Area in the CAATS project was to identify best practices/good practices in Human Factors Validation, disseminate them and provide support to FP6 projects on request.

The results obtained were aligned with the objectives proposed for the Human Factors Area:

- Human Factors were (and still are), in most ATM R&D projects, not explicitly considered. One of the main achievements of this area has been to raise the awareness of the HF among the target projects to explicitly identify good practices for its validation.
- Through a very active interaction with a number of target projects and Human factors experts, good practices were identified. These good practices are part of the Validation Best Practices Manual.

As results of this work, the existing Human Factors “Good Practices”, which are part of the “Validation Best Practices” Manual constitute the most complete and state-of-the-art approach to a validation methodology in this area.

This “Good practices” are the starting point from which to develop a complete HF methodology fully integrated in the E-OCVM and will be of great help to project managers and validation officers to set up the required resources and procedures for HF validation.

4. CAATS DISSEMINATION ACTIVITIES

4.1. CAATS Website

The CAATS project has a website: www.caats.isdefe.es. The site was created at the beginning of the project and it will continue to be active through 2007.

The site is divided in two different areas:

Public area: accessible to everyone on the Internet, its main goal have been to hold all the public deliverables produced by CAATS activities, such as the Best Practices Manual and the "Guide to a comprehensive incorporation of Validation, Safety and Human Factors in ATM R&D projects", CAATS workshops presentations and proceedings and links to other relevant information.

Private area: accessible only to CAATS consortium, it is used by them to exchanging of internal project information.

4.2. CAATS Workshops

4.2.1. 1st CAATS Workshop "CAATS and Projects", 20 – 21 January 2005, Budapest

This workshop was the first event of the European Commission - funded CAATS Coordination Action and has brought together the Safety, Human Factors and Validation community.

The projects and experts participating have:

- Identify needs, issues and typical validation-safety-human factors questions that arise within FP6 / EUROCONTROL projects.
- Bring the safety-validation-human factors experts of the different R&D projects together, in order to let them explain their activities, issues, problems and approaches to each other.
- To present the European Operational Concept Validation Methodology, including its relationship with Safety and Human Factors.

In this workshop there were 19 validation experts, amongst them were 9 representatives from target projects. The following issues were presented from the projects:

1. Overall objectives of the project (briefly).
2. Validation Manager, what is his/her role?
3. Are you using / planning to use validation methodologies? Which ones?
4. Validation objectives of the project, how are they linked to the project objectives?
5. Description of the validation activities and its main outputs.

The proposed main issues for discussion dealt with general issues about the previous presentations, the identification of Best Practices, gaps and concrete needs, recommendations and conclusions.



1st CAATS Workshop Conclusions for Validation:

At the end of the 1st CAATS workshop the validation discussion group provided conclusions and recommendations:

- Good validation practices are available: validation activities are in the “right direction” but a common understanding of validation activities, vocabulary, etc, are required.
- Use the E-OCVM and the VDR.
- Provide guidance for the selection of platform, scenarios, tools and techniques, etc.
- Review the effort dedicated to validation activities in the projects.
- Stakeholders must be brought together (co-operation issues to be solved). There must be a common understanding of the problem and solution.
- The validation best practices document must be “compact” and concise; consolidating a validation structure, common vocabulary, etc.
- Validation activities must start at the very beginning of the project (from proposal to implementation).
- Define templates regarding the structuring of experimental plans and validation results.
- Identify the use of best practice with regard to requirements analysis.
- Integrate safety and Human Factors into validation framework.

Safety Sessions:

During the workshop, safety was addressed in detail in a parallel session with the intention to discuss with safety experts of target projects about the following topics/ questions:

1. What are the overall objectives of the target project and how are the safety objectives formulated?
2. What is the approach to answer the safety objectives? Or, how do you analyse the impact on safety of the design?
3. What are the (planned) safety activities?
4. What is new in the safety approach/ activities and what is re-used?
5. What are the experiences so far from the safety activities? Positive experiences and Problems recognised?
6. Are safety regulators involved? If yes, how (e.g. is the safety plan reviewed)?
7. What is the safety effort in the project? Which percentage is that of the total project effort?

1st CAATS Workshop Conclusions on Safety:

- Safety assessment methodologies (ED78A, EATMP SAM, Scenarios based approaches).
- Involvement of stakeholders in the safety assessment process is crucial.
- Methods for human reliability assessment should be better/ more integrated within safety assessment methodologies.
- Role of regulator and standards.
- Unclear role of the regulator towards research projects, difficult to find the right interface to the safety regulator world.
- Lack of integrated approach to safety regulation between European and national levels.
- Lack of guidelines that are able to cover all the domains (aircraft systems, aircraft operators, Air Traffic Services) considered by research projects.
- Applicability of ESARR4 influenced by lack of guidelines to enable full compliance.
- Lack of criteria to define how much effort must be dedicated to safety assessment by the research projects, considering the level of maturity of the research subject.
- There is a lack of interaction between human factors and safety.
- It is difficult to integrate the results of safety assessment of research projects within implementation projects.
- Maximum re-use of safety assessment results across different research projects should be aimed for.
- There is a lack of enough competent people to cover safety areas.
- Integration of methodologies in the project lifecycle is important.
- Relationship between project managers and safety team Integration of human factor analysis results within safety analysis.
- Synchronise safety assessment within the erratic timescale of research projects.
- Confidentiality affects safety assessment especially when different domains are involved.

1st CAATS Workshop Recommendations for Safety:

- For CAATS: Inform SRC of the problem due to unclear role of the regulator towards research projects, and that for research projects it is difficult to find the right interface to the safety regulator world.



- For EC: During the definition of Technical Annexes consider criteria to define how much effort must be dedicated to safety assessment by the research projects, considering the level of maturity of the research subject.
- For CAATS and EUROCONTROL: Consider the problem of interaction between human factor and safety.
- For target projects: How to integrate the results of safety assessment of research projects within implementation projects.
- For CAATS, EC and EUROCONTROL: Consider the issue of maximising the re-use of safety assessment results across different research projects.
- For CAATS: Disseminate information about available safety assessment plans using data Repositories.

The presentations of the 1st CAATS workshop can be accessed on the CAATS website (<http://www.caats.isdefe.es>).

For more information on the 1st CAATS Workshop, please refer to the 1st CAATS Workshop proceedings [13].

4.2.2. 2nd CAATS Workshop “How to Plan a Program Applying Best Practices in ATM Validation”, 16th – 17th February 2006, Lanzarote, Spain

This workshop was the second event of the European Commission - funded CAATS Coordination Action and has brought together the Safety, Human Factors and Validation community and brought together more than 65 professionals involved in validation of ATM R&D projects.

The main objectives of this workshop were to:

- Present the emerging good practices/best practices identified in the areas of Safety, Human Factors and Validation as well as other useful tools that can help ATM projects with the designing of an appropriate Validation Plan;
- Provide ATM community with feedback of projects monitored by Safety, Human Factors and Validation Teams;
- Explain a practical example of the E-OCVM (European Operational Concept Validation Methodology); and
- Carry out an exercise within attendance can consolidate the knowledge of the identified practices acquired throughout the workshop and both give feedback and solve questions regarding the activities and issues addressed by the exercise.

Over 50 persons have participated to the two-day workshop. The presentation of emerging good practices and needs for improvement at the first day was well received by the participants.

At the end of the presentation there was good interaction with the audience. Issues like the goal towards a single European Sky were addressed. It is felt that the exercise the second day, where four groups had to make a validation plan (including safety) for a practical operational problem, was very useful and meaningful. The groups were able to apply the presented good practises from the first day and made steps forward how the integration of safety in the E-OCVM can be improved.

2nd CAATS Workshop conclusions:

The main conclusions from the workshop can be summarized in the following points:

- Need for the best practices manual to provide **examples** on the different areas and validation steps.
- One **big advantage** of the best practices is that provide a **structure** to follow.
- **Clearer definition** and examples on **expected outcomes** and **high-level objectives**.
- Need to prepare carefully and thoroughly the **stakeholders' interview**.
- Provide the manual "*Guide to a comprehensive incorporation of Validation, Safety and Human Factors in ATM R&D projects*" to the projects in the negotiation process.
- A need for a more structured **guidance through electronic tools**.
- Need to make clear to validation practitioners that the Best practices manual has to be used as a **reference rather than a standard**.
- The previous point gives an answer to some concerns about the need for a methodology to get the same results at all times.
- Need to give some **guidelines** in supporting **every expert role** in doing their job.
- Need to integrate **the validation into the development process**.
- Need to clarify the best practices to apply at **program** and **project level**.
- Need to clarify the interface between **maturity level** and **validation** needs in any given project.
- **VDR** is a good idea but it needs to be better explained the added value for the projects for them to make the effort to use it.

The presentations of can be accessed on the CAATS website (<http://www.caats.isdefe.es>).

For more information on the 2nd CAATS Workshop, please refer to please refer to the 2nd CAATS Workshop proceedings [14].

5. OVERALL CONCLUSIONS

5.1. State-of-the-Art: the Validation Debate

Since the 1990's, the lack of clear and understandable information to support decision-making in ATM projects gave way to the "validation debate". The EC provided a platform for that debate bringing together industry, R&D organizations, Air Traffic Service Providers (ATSPs) and the Eurocontrol Agency in a concerted Action on Validation of ATM Systems (CAVA). Following CAVA, several initiatives to deal with ATM R&D validation, had taken place. The most significant ones have been:

- The Master ATM European Validation Plan (MAEVA): This project, finished in May 2004 and sponsored by the EC, had as main objective the establishment of a uniform framework for the validation of the air traffic management system within the European Commission's Fifth framework Programme validation projects. MAEVA produced the Validation Guide Handbook (VGH) that provides guidelines for conducting validation exercises.
- The OCVM: MAEVA organized several dissemination forums for the VGH. Conclusions of these forums in addition to the feedback of applying the VGH to projects concept validation, gave way to the Operational Concept Validation Methodology (OCVM), developed by Eurocontrol. The OCVM integrated its own concept development and performance driven approach into the VGH.

Both the VGH and the OCVM were a step forward towards the development of a unique validation methodology for ATM R&D projects. However, the awareness and use of these methodologies among EC's projects have not been as extended as desired.

This was considered as state-of-the-art in validation, and given the new paradigm of collaborative decision-making in a complete air and airport environment launched by the EC, it became imperative to identify and consolidate validation best practices across ATM projects. This has been the main goal of the CAATS project.

5.2. CAATS Objective and Results

The objective of the Cooperative Approach to Air Traffic Services (CAATS) has been the identification, consolidation and dissemination of validation best practices across EC's, FP6 ATM projects and other ATM projects.

The domains where CAATS have made special emphasis in this first phase have been the Validation, Safety and Human Factors domains. These three domains, when CAATS started, had a very different maturity level:

- In the Validation domain, previous studies had been carried out, such as MAEVA and Eurocontrol initiatives, and validation methodologies already existed. The OCVM [5] and VGH [16] were the methodologies to be considered as baseline for the work to be done.
- In the Safety and Human Factors domains, there were almost as many approaches/philosophies as there were parties working on them.

The main results obtained from the project were:

- The **Validation Best Practices Manual** contains best/good practices for the three areas considered in CAATS. The 'case' format is used to collate this information. Figure 6 shows the CAATS contribution to overall case based view.

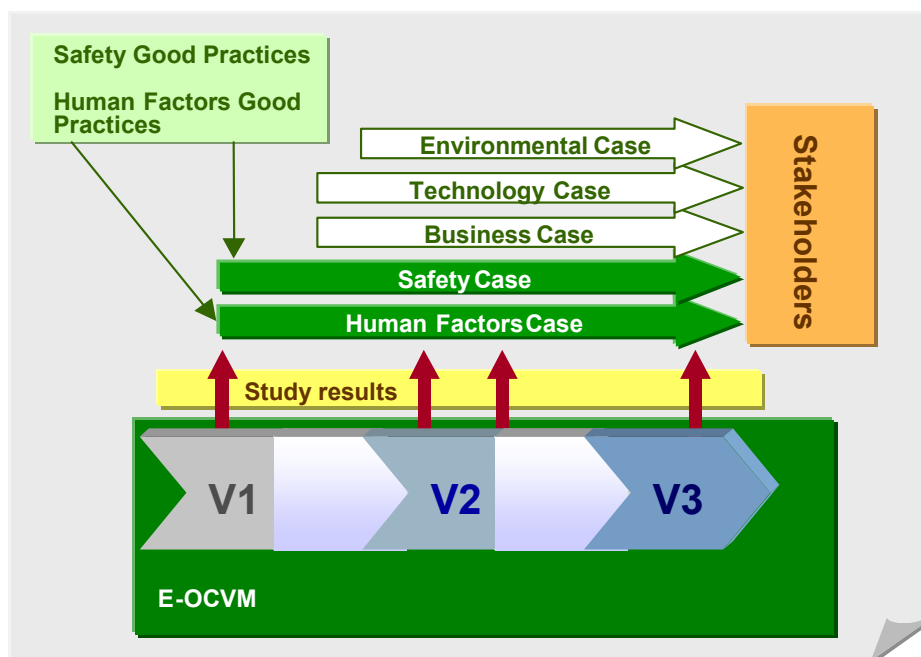


Figure 6 CAATS Contribution to overall Case-based View

- In the Validation domain, best practices in operational concept validation for all ATM R&D projects have formed the E-OCVM. The Joint Programme Board (JPB) in its meeting on 24 January 2005, required the application of E-OCVM and the use of Validation Data Repository (VDR) by all ATM related projects in particular within the collaboration between the EC and EUROCONTROL in the ATM Master Plan and also along the ACARE Strategic Research Agenda SRA-2.
- In the Safety domain, through a very active interaction with a number of target projects and safety experts, a long and rich lists of emerging good practices and needs for improvement for safety key elements in ATM were identified for performing the Safety Case.
- In the Human Factors domain, the Human Factors good practices collected in the Best Practices Manual constitute the most comprehensive and state-of-the-art approach to build the Human Factors Case.
- The **Guide to a Comprehensive Incorporation of Validation in ATM R&D Projects**, to provide support for effective management of the validation, safety and human factors activities as part of the overall ATM R&D project, by issuing clear and concise checklist guidelines.



- **Dissemination activities** have enabled active interaction with target projects through participation to the various CAATS workshops. The results to these activities have been:
 - Increased awareness of the Best Practices Manual (in the areas of Validation, Human Factors and Safety) among EC's and Eurocontrol projects.
 - Gaps identified and recommendations issued to improve the Best Practices Manual.

CAATS has thus achieved its objectives by identifying and consolidating knowledge in the three areas - making it state-of-the-art - and disseminated it to the relevant stakeholders.

5.3. The Integrated Case Approach: CAATS II

The European Commission believes the CAATS co-ordination action should be continued and extended to align the approaches of the ATM projects. This task was included in the final TREN call in FP6. A proposal has been selected and consequently CAATS has a second phase: the Cooperative Approach to Air Traffic Services II (CAATS II).

The main objective of CAATS II will be to continue the work begun within the CAATS project by managing, consolidating and disseminating the knowledge produced in European ATM-related projects. It will focus on five areas namely, safety, human factors, business (cost/benefits), environment and validation. On the basis of the good practices, it will develop 'cases' that can be integrated in the E-OCVM. The aim is to ensure a coordinated approach in the mentioned areas with a view to obtain more comparable results and avoid duplication of work in R&D projects and achieve the paradigm shift in European ATM, in particular FP6 projects. Figure 7 shows the CAATS II use case approach.

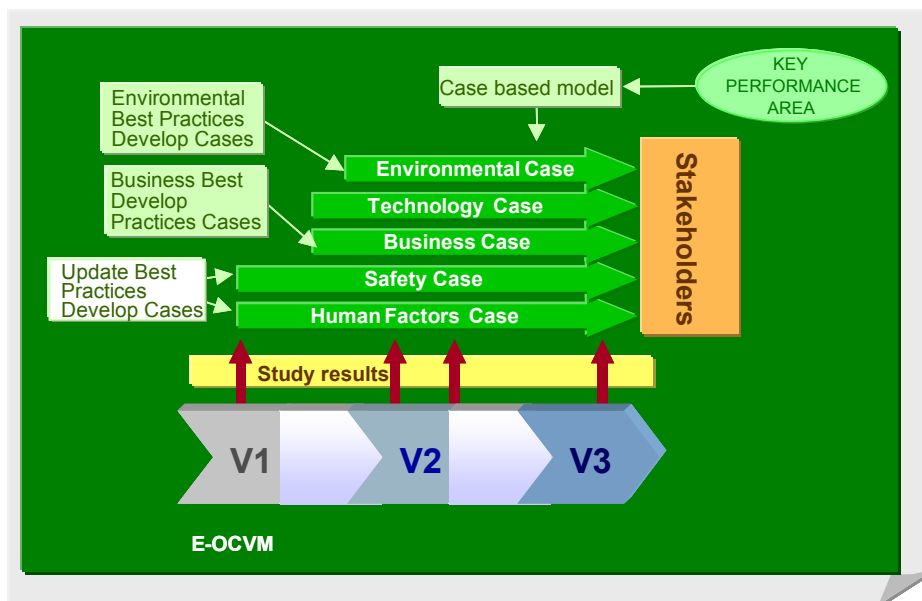


Figure 7 CAATS II Contribution to overall case based view



European Commission
Sixth Framework Programme

Contract: Aero1/2003/502791



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