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Second round of interviews to identify CATS User Requirements

Distribution:

CATS customer

CATS advisory group

CATS expert group

CATS consortium

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Summary

This memorandum reports on a second round of nine interviews held with members of the CATS advisory and expert groups regarding user requirements for the causal model for air transport safety (CATS), which is being developed. These interviews are a follow-up of a first round of interviews, the results of which are described in [De Jong, 2006].

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1 Introduction

This memorandum reports on nine interviews held with members of the CATS advisory and expert groups regarding user requirements for the causal model for air transport safety (CATS), which is being developed. This is the second round of interviews, intended to make the initial requirements, identified during the first round of interviews [De Jong, 2006] more specific. Topics that are addressed in this second round of interviews are:

- Safety culture has been indicated as highly influential on safety. How can safety culture be characterised? What does it depend on? How to make it tangible in the causal model?
- Which parameters (such as airport layout, airspace characteristics, aircraft types, fleet mix, and language of the pilots) are important to safety and shall be taken into account in the model? and
- Understanding the CATS model is a condition for confidence in its results. How can CATS be made sufficiently understandable to its users?

More specifically, this memorandum outlines:

- The interviewed members of the CATS expert and advisory groups (Section 2);
- The approach followed to identify user requirements by means of interviews (Section 3);
- A summary of the interviews (Section 4);
- Conclusions (Section 5) extracted from the interviews regarding the user requirements;
- The list of questions used in the interviews (Appendix A); and
- The full interview reports (Appendix B).

2 Interviewees

A list of the persons interviewed to obtain user requirements for CATS has been given below, together with these persons' roles within their organisations and with respect to CATS:

Interviewee	Organisation	Role in organisation	Role in CATS
Bart de Vries	KLM	Director Flight Safety & Operational Quality Assurance, F/O 737	Advisor
Arthur Dijkstra		Captain and Safety Researcher – Accident Investigator	Expert
Eric Perrin	Eurocontrol Experimental Centre (EEC)	Co-ordinator EEC Safety Management System, co-ordinator EEC Safety Assessments and deputy EEC Safety Co-ordinator	Expert
Henk van Leeuwen	NIVR	Head Aeronautics Division	Advisor

Jan Busstra	DGTL	Program Leader for Aviation Safety	Advisor
Job Brüggen	LVNL	Safety Manager	Advisor
Jos Wilbrink	IVW	Director of Aerodromes and Air Navigation Services Inspectorate	Advisor
Rudi den Hertog	Fokker Services	Chief Engineer and Deputy Head of Design Organisation	Expert
Frederik Demeyere	IVW	Inspector Aerodromes and Airspace	Expert
Erik Lagerweij	Schiphol Group	Senior Officer Safety & Environment	Advisor
Johan Blom		Consultant Environmental Capacity	Expert

Note that Frederik Demeyere (IVW), and Erik Lagerweij and Johan Blom (Schiphol Group) were not involved in the first round of interviews.

For easy reference, the interviewees and the interviews with them will normally be referenced by means of their organisations' names.

3 Approach to the interviews

A question list has been developed to structure the interviews. The addressed topics are:
- Feedback on results of first round of interviews;
- Safety culture;
- The level of detail that CATS should have; and
- Transparency of CATS for its users.

The full question list has been included in Appendix A.

All interviews have been held in meetings of the interviewees and the interviewers, Hans de Jong and Carolynne Montijn (NLR). The interviewers have made reports of the interviews and have sent these to the interviewees to verify correct understanding and completeness. Appendix B contains the reports of the interviews.

4 Summary of interview results

4.1 Feedback on results of first round of interviews

Most of the interviewees of the first round of interviews have seen the results, as presented in [De Jong, 2006]. Some of the interviewees of the second round of interviews were not involved

in the first round. For those, the results were summarized. All interviewees were asked to provide feedback on the results. This feedback was mainly directed to the following topics:

- Establishment of the ABL (Analysebureau Luchtvaartvoorvallen);
- Complexity of the CATS model and reliability of input data; and
- Air transport as one single process.

As indicated by KLM and DGTL, the ABL (Analysebureau Luchtvaartvoorvallen) is presently being established and the law on reporting of incidents, which also concerns ABL, has been accepted in the meantime since the first round of interviews. ABL has the task to monitor aviation safety. CATS should not double this function. CATS and ABL should interface as complementary functions: CATS evaluates the safety effects of proposed changes to air traffic and ABL monitors the present air traffic by means of occurrences, which may lead to changes to be evaluated by CATS. CATS results may be further validated by monitoring the changed air traffic operation by ABL.

Concern is expressed about the complexity of the CATS model, which would make it difficult to understand by the general public (NIVR) and too complex to be used by decision makers directly (DGTL). However, the CATS model should *support* decision makers (DGTL, Schiphol Group). The CATS model should be pragmatic and simple to gain confidence in it (Schiphol Group). The required input data for the CATS model may not be sufficiently reliable (NIVR) and therefore should be treated carefully when providing quantitative results (Schiphol Group). In case of unreliable input it is preferred to provide no results at all (IVW).

Because air transport is one single process, it is suggested to consider it integrally. CATS should become a sector tool to be used by different sector parties (KLM, LVNL, Schiphol) together, and not aim at the individual user. CATS should help to develop one single language amongst the participants.

One interviewee remarked that he found little of his input in the user requirements (Fokker Services). Some key topics of this input concerned:

- Consider only B737 and A320 in the accident statistics as these aircraft represent a considerable part of the flights and flight hours and since restriction to these aircraft makes translations of findings to other aircraft easier than starting from a large set of aircraft; and
- The approach followed in CATS restricts to accident types that have happened, while due to foreseen changes, new accident types and mechanisms may arise. See the project FAST for foreseen areas of change.

4.2 Safety culture

In the first round of interviews, safety culture was unanimously considered as very influential on safety, needing to be addressed in modelling with high priority [De Jong, 2006]. Safety culture was, therefore, considered in more detail in the second round of interviews, with a focus on the following topics:

- Possible safety culture indicators, their relative importance, and how to concretize them;
- How to express the level of safety culture in CATS?
- For which organisations should the level of safety culture be incorporated in CATS? and
- The mechanisms by which safety culture influences safety.

Seven out of the nine interviewees have treated the topic of safety culture during this round of interviews.

Possible safety culture indicators

A list of possible safety culture indicators was proposed. The table below indicates the number of interviewees assigning a high (H), medium (M) or low (L) importance to each indicator, as well as suggestions to concretize these indicators. The indicators are in order of assigned importance.

Indicator	H	M	L	other	Concretize
Priority of safety in decision making	6	1	0	0	- Word count of “safety” in minutes of meetings. - Is safety an agenda item at CEO level meetings? - Addressing meeting the target of being safe for the operating environment in a structured and adequate manner. - Number of decisions based on safety.
Safety issues reporting system	6	1	0	0	- Existence of a confidential and non-punitive reporting system, together with an analysis, improvement and feedback system. - The number of reports, to be handled with care. - Number of ideas originating from safety reports. - Inclusion of cooperating companies in such a system.

Indicator	H	M	L	other	Concretize
Training	5	1	0	1[1]	- The number of compulsory courses. - Cutback in recurrent training (indicates a low level of safety culture). - Existence of safety specific training for staff, and different levels of training for different levels of staff. - Organization of peer workshops to explain accidents. - Installation of a competence management system.
Proactiveness with respect to safety issues	5[2]	0	0	2[3,4]	- Installation of a risk management system. - Investigating of the safety management system.
Safety procedures	3[5]	3	0	1[6]	- Existence of basic safety procedures. - Through interviews.
Safety department	3	2	2[7]	0	- How are recommendations dealt with? - Are unpopular measures taken? - Level of education of employees of the safety department. - Through the organigram of the organization.

Next to discussing the pre-determined indicators in the table above, the interviewees were given the opportunity to propose other indicators, listed below:

– The implementation of new methodologies to improve safety (e.g. Air France's unique method for accident precursors, KLM's Flight Operation Quality Assurance to consider and

[1] Fokker Services indicates that the importance of training depends on the function of the person. For safety investigators it is important.
[2] IVW indicates proactiveness is important only if there are good communications on safety measures.
[3] DGTL indicates that it is hard to be against proactiveness, it may however be more effective to learn from other organisations than to try to foresee the risks yourself.
[4] Fokker Services respectively indicates that it is difficult to assign a level of importance to proactiveness: It is not always a cost effective means to improve safety and it is important consider operational environment.
[5] DGTL indicates the importance of safety procedures depends on the function for which they are installed.
[6] Fokker Services' procedures are part of the Design Organisation Manual (DOM).
[7] Fokker Services indicates that working safely should be an inherent part of everybody's job, not only for the safety department.

replay in-flight exceedances as learning feedback mechanism, and Fokker Services' "first occurrences" method to manage safety);

- The extent to which the organization adapts itself to changes of the actual environment (e.g. aviation system, airplane operational usage, personnel demographics, infrastructure) in which it operates;
- Open atmosphere;
- Balance of safety versus making profit (partially covered priority of safety in decision making). (E.g., is the airline willing to invest in understanding the aircraft? Are airlines investing in recommended safety enhancements or waiting until the authorities make it mandatory? Is maintenance (personnel, organisation and spare parts) kept at an optimal level?);
- The attitude towards safety of the CEO;
- The financial capabilities for safety (e.g. through the Gross Domestic Product of the country of origin);
- The life principles in the country of origin;
- Number of safety specific meetings;
- At what level of the organization may an employee stop the process? and
- To what extent is top management worried about safety culture?

How to express the level of safety culture?

The interviewees were asked their opinion on the way to express the level of safety culture. The general opinion is that indicating safety culture by a one-dimensional quantity is an oversimplification, but four of the interviewees stated that it should be expressed as a one-dimensional quantity because of the need for simplicity. Two interviewees thought that it should be introduced in multi-dimensional terms in CATS. It is remarked that safety culture can only be introduced when a reasonable scoring method can be developed. One interviewee argued that safety culture should not be included in CATS, as it was in fact a boundary condition for the use of CATS.

For which organisations should the level of safety culture be incorporated in CATS?

The interviewees were shown a list with several kinds of organizations, which they were asked to prioritize according to the need to include the safety culture. Five interviewees have answered this part. The table below shows the number of interviewees assigning which level of importance (high (H), medium (M) or low (L)) to which kind of organizations.

Kind of organization	H	M	L	Other
Airline	5	0	0	0
ANSP	5	0	0	0
Airport	4	0	0	1[8]
Maintenance	4	1	0	0
Manufacturer	3	0	1	1[8]
Inspection	3	1	1	0
Regulator	3	0	2	0

IVW further indicated the following kinds of organizations for which to include the level of safety:

- Crew;
- Ground handling organizations;
- Flight clubs, rental companies; and
- Flight schools.

The mechanisms by which safety culture influences safety

As a last topic on safety culture, the interviewees were asked their opinion on how safety culture influences safety. This topic was discussed with six interviewees. Five of them argued that there was a direct influence of safety culture on safety, because of the role it plays in the way conflicting goals are dealt with, because it is a certain mindset on how people think about safety, and because it starts with open reporting and action upon reporting (safety will increase by itself if it is explained why certain safety measures are taken). One interviewee was not sure about the mechanism of this influence, and thought it would demand quite some research to determine how safety culture affects safety of operations.

4.3 The level of detail that CATS should have

In [De Jong, 2006], questions like “what should be detailed by CATS” and “what data should be used by CATS” were addressed. Following this, in the second round of interviews more detailed input was requested on the level of detail that CATS should have on the following aspects:

- Aircraft;
- Flight operations/airline;
- ANS/CNS;
- Airport;
- Maintenance;

[8] KLM found it difficult to say something about the need to include the level of safety culture for airports and manufacturers.

- Circumstances;
- New developments; and
- Organization.

Four of the nine interviewees have given their opinion on the relevance of data items that could be included in the CATS model. However, not all data items were commented on by the interviewees. In general, the items perceived as less relevant were skipped in commenting. In the following those data items are listed that were selected by at least one interviewee as being relevant for CATS. Those data items that were selected by more than one interviewee are presented in *italics*.

Aircraft

- *State of manufacturer*
- Aircraft make/model
- *Jet versus Turboprop*
- Generation of aircraft (1st – 4th)
- Certification of aircraft
- Long range / regional aircraft
- Year of first flight of the aircraft model
- Average age of the aircraft model's fleet

Fokker Services mentions that it is sufficient to use only A320 and B737 models, the reasons for which are already elaborated in [De Jong, 2006]. The state of the manufacturer is of interest as far as the certification of the aircraft (Western, Eastern certification) and level of maintenance is concerned.

Flight operations/airline

Cultural aspects:

- *Safety culture*
- Cultural aspects
- *Different cultures/language between pilots*
- *Operator country of residence*
- Location with respect to home base

Airline:

- Safety management system
- *Occurrence reporting system*
- *Low cost carrier/traditional flag carrier*

Type of flight:
- *Short haul/long haul flights*
- *Flight phase*
- Navigation means (RNAV, RNP, ILS, VOR/DME, GPS)
- *Aircraft de-icing/anti-icing*
- Type of operation (Passenger, cargo, training, ferry, ...)

Flight crew and supporting systems:
- Flight crew fatigue
- Flight crew physical state (e.g., hypoxia, physical fatigue, intoxication, motion sickness)
- Paperless cockpit, EFB
- Cross cockpit gradient (e.g., junior f/o, experienced captain)
- HMI characteristics
- Flight crew knowledge of systems, procedures
- Safety nets: TCAS, GPWS

ANS/CNS

ATM:
- *Class of airspace / level of service*
- *Traffic density*
- *Airspace/ air traffic complexity*
- Applicable separation criteria
- *Influence of VFR traffic / general aviation*
- *Way of control: radar, visual, procedural, ...*
- Special operation at airport: mixed mode, intersection, take-off, backtracking on runway, ..
- *Workload of controllers*
- NOTAMS applicable?

Organization:
- Single manned operations
- Controller staffing level
- Training standards, method, on the job training
- Age of ANSP

Weather:
- *Weather information*
- ATIS

- *Weather measurements*
- *Weather forecast*
- *Windshear warning system*

CNS:
- Means of communication: VHF, CPDLC, HF, SATCOM, ...
- *Phraseology, ATC clearances*
- *Language (problems)*
- *English proficiency*
- Mixed language between ATC and pilots
- *Navigation means (ILS, VOR/DME, GPS, NDB, Loran, ...)*
- *Surveillance means (Primary/secondary radar, ADS, multi-lateration, ...)*
- *Runway incursion alerting system / stop bar alerts*

Airport
- *Runway layout*
- *Runway/taxi way maintenance*
- Runway/taxi way lighting and signs
- *Bird control*
- *Airport technological capability: runway incursion alert system, stop bars, ...*
- Security
- *Airport traffic mix*
- *Airport capacity*
- *Runway layout: number of runway, crossings, direction*
- *Obstacle clearance*
- *Geographical location (mountains, etc)*
- Towing operations
- *Airport vehicles (operations/drivers)*
- Noise abatement routes
- Emergency services
- Airport characteristic (mainport, regional airport, general aviation)

Maintenance

Two maintenance related comments were received:
- Maintenance is important (KLM); and
- Culture and maturity of the maintenance organisation is important (IVW).

No further details regarding maintenance were explicitly mentioned.

Circumstances

- *Accident occurrence region*
- Accident occurrence date
- Accident occurrence time of day
- *Traffic conditions*
- *Weather conditions*
- *Runway conditions (wet, contaminated, friction, ...)*
- *Special operations (winter operations)*
- Accident occurrence season
- Accident occurrence part of day (day/night)

New developments

- New navigation means (RNP, GPS, et cetera)
- *Head up Display*
- A380, B787
- Wake vortex related issues
- Composite aircraft
- Unmanned Aerial Vehicles
- New aircraft

It has been remarked that the list of new developments from which the above items have been selected is only the top of the iceberg. See for instance the 179 areas of change in the project FAST (see Ref. 2 and 3 in Appendix B.7) for a more complete overview.

Organization

- Organisational climate
- Self correction
- Monetary/Budget Resources
- (Safety) policies
- Accident investigations
- Culture, values, beliefs, attitudes
- Safety department

Most of the interviewees remarked that is was difficult to comment on the level of detail that is required by CATS. It was suggested to deal with this topic in specific mini CATS sessions.

Note that because of the few comments that were received during the interviews, the results of this summary should be treated with care. It will be difficult to draw firm conclusions from it.

4.4 Transparency of CATS for its users

One of the conclusions of [De Jong, 2006] was "Understanding the CATS model is a condition for confidence in its results". It is therefore important to know how CATS can be made sufficiently understandable to its users. Prospective users of CATS indicated that CATS should not be a black box: it should be transparent and understandable. Suggestions for achieving transparency were provided by the interviewees regarding aspects of the CATS model, presentation of the results, validation of the model and confidence building.

Aspects of CATS model that have to be transparent

When evaluating the safety effects of changes in an air transport operation with CATS, the following aspects of the CATS model have to be made explicit and accessible:

- The types of risks and the operational issues that are considered (KLM, IVW);
- The parameters of the model (KLM, NIVR) and how they are weighed (IVW);
- The availability and reliability of the input data. Availability of reliable input data could be a problem; it should be transparent which data is used and how reliable this data is (NIVR, Fokker Services);
- The assumptions that are made. By making assumptions explicit, users can determine whether state-of-the-art assumptions are made, or if assumptions are outdated. This is necessary to obtain confidence in the model and to assess how to use the results (IVW). Making (parameters and) assumptions explicit is considered even more important than the computational method of the model (NIVR);
- Explain in operational terms what risks are behind the changes in safety (LVNL, KLM); and
- Clues for improvement of safety (KLM).

Presentation of the results

Various user groups are interested in the CATS model and its results, e.g. decision makers, operational experts, safety practitioners and the public (e.g. people living in the neighbourhood of an airport). It should be possible to explain the CATS model and results to each of these groups. However, each group requires a different approach and level of detail in the explanation. As stated by Eurocontrol, the CATS model should not be implemented as a tool for direct use by clients. CATS is at least as complicated as similar IRP tool, which is a tool for safety practitioners, and require quite some training. Generalists will not try to understand the entire process/model in detail but will call for their specialists to judge the model and details should be fully accessible to these specialists (DGTL). The interface of CATS needs to be layered: managers and experts want to know different things. Managers want to get the gist and experts want to get to the details (IVW). Give users the possibility to zoom into sub-modules in order for experts to be able to follow CATS up to a reasonable level of detail. Such a zooming function should be optional to use, otherwise less experienced users could be scared off (IVW).

In order to be transparent and understood, the results of CATS should be explained in operational terms/ mechanisms depending on the user (LVNL, EEC). The results should be presented in simple terms in such a way that it instinctively connects to the causal factors of an accident. The longer the explanation, the worse it is. No mathematics or modelling should be entrusted to the CATS experts – in principle everything should be accessible for review. A communicative professional should be given the task to explain the CATS results (LVNL).

An approach to reach transparency is suggested by Schiphol Group: start with a simple model that can already give some insight and that can be developed to a more complicated model later on. Do not make the model very complicated from the beginning. The challenge is to make the model so simple that the users will complain about the simplicity.

Validation

Validation of the CATS model and input data is of utmost importance for confidence in the model and acceptance of the results.

According to DGTL, it is important that the details of the CATS model should be fully accessible to specialists so that it can be peer-reviewed. Positive side effects of this are

- The specialists help further development of the model and its validation by the "peer-review" effect; and
- If people criticize the model, it is possible to bring on a real debate on how it can be improved, rather than ending in a yes-no debate.

Fokker Services mentions another reason for validation of the CATS model: CATS will be of use for accident types for which CATS models have been developed. These models are developed on the basis of historical accident data and extrapolating this linearly from the past to future accident types cannot always (if ever) be done. Validation of the model is therefore extremely important. One important characteristic is that everything is connected in ATM and this may lead to very different phenomena, for which appropriate handling needs to be defined.

Confidence building

It is important to build up confidence in CATS (NIVR). Public relations activities, such as the mini-CATS meeting can support this. The value of such a mini-meeting is illustrated by the fact that Fokker Services now thinks that the CATS model might become of use, whereas before the interviewee was very sceptic about this.

People should at least be convinced of the positive intentions of CATS (DGTL). Perceptions of people should be managed and care should be taken that expectation matches the results (Schiphol Group). These public relations activities should not only involve the users of CATS results but should also involve people who could have ideas on how to improve CATS (IVW).

One way of building confidence is to make clear how one has to pose a question related to the CATS model and to show that something is genuinely done with the question (IVW).

5 Conclusion

Feedback

Most of the interviewees of the first round of interviews have seen the results, as presented in [De Jong, 2006]. One interviewee remarked that he could not find his input in the user requirements. Relevant feedback has been received regarding:

- Establishment of the ABL (Analysebureau Luchtvaartvoorvallen). CATS and ABL should interface as complementary functions; and
- Concern is expressed about the complexity of the CATS model. The CATS model should support decision makers.

Safety culture

The most important indicators for safety culture were considered to be the priority of safety in decision making and the existence of a safety issues reporting system. The priority of safety could be related to the gross national product of the country of origin of the organization, which gives an indication of the financial capabilities for safety, or indicated by the number of safety specific meetings, although it should be investigated what number actually indicates a good safety culture. Another indication is whether an organisation invests in recommended safety enhancements or waits until the authorities make it mandatory.

The existence of a safety issues reporting system should be accompanied by an analysis, feedback and improvement system in order to be efficient, and the number of ideas originating from safety reports could give a concrete indication of the level of safety culture.

Training and proactiveness with respect to safety issues are also considered to be important indicators, but are rather difficult to concretize.

There was no unanimous vision about how to express the level of safety culture in CATS. Although some interviewees agreed that safety culture should be expressed as a one-dimensional quantity within CATS for the sake of simplicity, others indicated that this was over-simplifying the subject, possibly leading to a distorted view on it and thereby erroneous conclusions. Apart

from how to express safety culture, development of a reasonable scoring method is necessary for introduction of safety culture in CATS. Therefore, more in-depth research in the matter should be carried out.
The majority of the interviewees agreed that, if including safety culture in CATS, all the organizations mentioned by the interviewers – i.e., airlines, ANSPs, airports, maintenance, manufacturers, inspection and regulators – should be regarded.

Finally, there were many different views on how safety culture actually influences safety. In fact, knowledge on the subject is missing in general, although there is consensus that there is actually an influence of culture on safety.

To summarize the subject of safety culture, there is a general consensus that it should be included in CATS, and some concrete indicators have been identified. However, it would be very desirable to acquire more knowledge on the subject, especially on how to express it and how it influences safety. Therefore, if safety culture is to be included in a consistent and scientifically sound manner, more in-depth research on the subject is needed, which probably falls outside the scope of the CATS project.

Level of detail of CATS model
Four of the nine interviewees have given their opinion on the relevance of data items that could be included in the CATS model. However, not all data items were commented on by the interviewees. In general, the items perceived as less relevant were skipped in commenting. Most of the interviewees remarked that is was difficult to comment on the level of detail that is required by CATS. It was suggested to deal with this topic in specific mini CATS sessions. Note that because of the few comments that were received during the interviews, the results, as presented in Section 4.3 should be treated with care. It will be difficult to draw firm conclusions from it.

Transparency of CATS model
Prospective users of CATS indicated that CATS should not be a black box: it should be transparent and understandable. Suggestions for achieving transparency were provided by the interviewees regarding aspects of the CATS model, presentation of the results, validation of the model and confidence building.

Aspects of CATS model that have to be transparent
When evaluating the safety effects of changes with CATS, the CATS model has to be made explicit and accessible to the users. Important model aspects related to transparency are the model parameters, the input data (availability and reliability) and model assumptions, relevant also for the confidence of the results.

Presentation of the results

Various user groups are interested in the CATS model and its results, e.g. decision makers, operational experts, safety practitioners and the public. It should be possible to explain the CATS model and results to each of these groups. However, each group requires a different approach and level of detail in the explanation and we should accept that one cannot explain everything to everybody. In order to be transparent and understood, the results of CATS should be explained in operational terms depending on the user.

Validation

Validation of the CATS model and input data is very important for confidence in the model and acceptance of the results. It is important that details of the CATS model are fully accessible to specialists so that it can be peer-reviewed.

Confidence building

It is important to build up confidence in CATS. Public relations activities, such as the mini-CATS meeting can support this. People should at least be convinced of the positive intentions of CATS. Perceptions of people should be managed and care should be taken that expectation matches the results. These public relations activities should not only involve the users of CATS results but should also involve people who could have ideas on how to improve CATS (IVW).

6 References

[De Jong, 2006] H.H. de Jong, Identification of User Requirements for CATS, NLR-Memorandum ATSF-2006-096, September 2006.

Appendix A Question list for second interview regarding CATS User Requirements

Feedback on results of first round

Id	Question
1.	Have you seen the results of the first round of interviews for CATS User Requirements and do you have feedback on it?

Safety culture

From our research we have extracted some indicators for the level of safety culture:

a) Priority of safety in decision making, at all levels of the organisation;

b) Safety issues reporting system: Existence of such a system, possibility for confidential and non-punitive reporting, percentage of incidents that are reported.

c) Training: training on the job, training focussed on safety issues, training in emergency situations.

d) Safety procedures: installation of safety procedures, expectation to follow these procedures, how these procedures are actually followed, regular revision of the procedures.

e) Safety department: existence and quality of a safety department, how is it organised.

f) Proactiveness with respect to safety issues.

Id	Question
2.	Do you have any other suggestions regarding indicators for safety culture?
3.	Could you prioritize the indicators we discussed and identified above?
4.	What suggestions do you have on how the CATS-modellers could measure the indicators correctly?
5.	Do you think the level of safety culture should be expressed in a one-dimensional quantity in CATS, or would you prefer to characterize it through a list of indicators?
6.	For which kind of organisations do you think the level of safety culture needs to be incorporated in CATS? (Please indicate priority H/M/L)
7.	How does safety culture influence safety? By what mechanisms?

The level of detail CATS should have

Aircraft

Id	Question

8.	Please indicate for the aircraft aspects given below: – (Y) if you find it important to zoom into this aspect; – (Q) if you even have questions to CATS in this respect; – (N) if you advise not to zoom in; and – (?) if you find it difficult to choose. Please indicate additional aspects you find important to detail or not.
a)	Aircraft manufacturer
b)	State of manufacturer
c)	Aircraft make/model
d)	Number of engines (2, 3, 4)
e)	Jet versus Turboprop
f)	Generation of aircraft (1st – 4th)
g)	Certification of aircraft

Flight operations/airline

Id	Question
9.	Please indicate (Q/Y/N/?) for the flight operations/airline aspects given below:
a)	Duty times/regulations
b)	Safety culture
c)	Safety management system
d)	Occurrence reporting system
e)	Low cost carrier/traditional flag carrier
f)	Short haul/long haul flights
g)	Flight crew fatigue
h)	Cockpit automation
i)	Workload
j)	Flight crew selection process
k)	Experience of pilot
l)	Crew resource management
m)	Flight crew medical checks
n)	Flight crew mental state (e.g., overconfidence, task saturation, alertness, get-home-itis)
o)	Flight crew physical state (e.g., hypoxia, physical fatigue, intoxication, motion sickness)
p)	Flight phase
q)	Navigation means (RNAV, RNP, ILS, VOR/DME, GPS)
r)	Dispatch/route planning
s)	Aircraft loading

t)	Aircraft de-icing/anti-icing
u)	Paperless cockpit, EFB
v)	Safety nets: TCAS, GPWS
w)	Cultural aspects
x)	Different cultures/language between pilots
y)	Cross cockpit gradient (e.g., junior f/o, experienced captain)
z)	Flight crew scheduling
aa)	HMI characteristics
bb)	Checklist layout
cc)	Flight crew knowledge of systems, procedures
dd)	Type of operation (Passenger, cargo, training, ferry, ...)
ee)	Operator country of residence

Air Navigation Services/Communication Navigation Surveillance

Id	Question
10.	Please indicate (Q/Y/N/?) for the ATM/CNS aspects given below:
a)	Class of airspace/level of services
b)	Traffic density
c)	Airspace/air traffic complexity
d)	Applicable separation criteria
e)	Type of control provided: start-up, ground, tower, departure, area, upper area, stack, approach, ...
f)	Influence of VFR traffic/general aviation
g)	Way of control: radar, visual, procedural, ...
h)	Certification of ANSP
i)	Special operation at airport: mixed mode, intersection take-off, backtracking on run-way, ...
j)	Workload of controllers
k)	Vigilance
l)	NOTAMs applicable?
m)	Single manned operations
n)	Service provision separated from supervision/regulation?
o)	Team resource management
p)	Controller staffing level
q)	Training standards, method, on the job training
r)	ATCO experience
s)	...

t)	...
u)	Weather information
v)	ATIS
w)	Weather measurements
x)	Weather forecast
y)	Windshear warning system
z)	...
aa)	Means of communication: VHF, CPDLC, HF, SATCOM, ...
bb)	Phraseology, ATC clearances
cc)	Language (problems)
dd)	English proficiency
ee)	Loss of communication with ATC
ff)	...
gg)	...
hh)	...
ii)	Navigation means (ILS, VOR/DME, GPS, NDB, Loran, ...)
jj)	...
kk)	...
ll)	...
mm)	Surveillance means (Primary/secondary radar, ADS, multi-lateration, ...)
nn)	Runway incursion alerting system/ stop bar alerts
oo)	...
pp)	...

Airport

Id	Question
11.	Please indicate (Q/Y/N/?) for the airport aspects given below:
a)	Aircraft servicing, aircraft (re)fuelling, catering
b)	Runway layout
c)	Runway/taxi way maintenance
d)	Runway/taxi way lightning and signs
e)	Bird control
f)	Airport technological capability: runway incursion alert system, stop bars, ...
g)	Security
h)	Airport traffic mix
i)	Airport capacity
j)	Runway layout: number of runway, crossings, direction

k)	Obstacle clearance
l)	Geographical location (mountains, etc)
m)	Towing operations
n)	Airport vehicles (operations/drivers)
o)	Certification of airport
p)	Noise abatement routes
q)	Emergency services
r)	Opportunity for crew rest

Maintenance

Id	Question
12.	Please indicate (Q/Y/N/?) for the maintenance aspects given below:
a)	Quality control
b)	Outsourcing
c)	Maintenance process

Circumstances

Id	Question
13.	Please indicate (Q/Y/N/?) for the circumstances of the accident given below:
a)	Accident occurrence region
b)	Accident occurrence date
c)	Accident occurrence time of day
d)	Traffic conditions
e)	Weather conditions
f)	Runway conditions (wet, contaminated, friction, ...)
g)	Special operations (winter operations)
h)	Onboard medical urgency

New developments

Id	Question
14.	Please indicate (Q/Y/N/?) for the new developments given below:
a)	New navigation means (RNP, GPS etc)
b)	Head up Display
c)	A380, B787
d)	Wake vortex related issues
e)	Composite aircraft
f)	Very Light Jets

g)	Unmanned Aerial Vehicles
h)	...
i)	...

Organization

Id	Question
15.	Please indicate (Q/Y/N/?) for the organization aspects given below:
a)	Resource management
b)	Organisational climate
c)	Organisational process
d)	Supervision (violations, inadequate, etc)
e)	Self correction
f)	Staffing/manning
g)	Background checks
h)	Monetary/Budget Resources
i)	Corporate communication
j)	(Safety) policies
k)	Promotion
l)	Accident investigations
m)	Culture, values, beliefs, attitudes

Transparency of CATS for its users

Id	Question
16	Prospective users indicate that CATS should not be a black box: it should be transparent and understandable. How would you advise achieving this? What mathematics or modelling will be entrusted to the CATS experts, what needs to be made explicit and explained?

Appendix B Interview results

Appendix B.1 Bart de Vries and Arthur Dijkstra (KLM) *(reviewed)*

Feedback on results of first round

Id	Question	Answer
1.	Have you seen the results of the first round of interviews for CATS User Requirements and do you have feedback on it?	• *AD and BdV have seen the results.* • *BdV motivates why CATS should not be used as a monitoring/evaluation tool (which was indicated in some of the first round interviews): the ABL (Analysebureau Luchtvaartvoorvallen), presently being established, has the task to monitor aviation safety. CATS should not double this function. CATS and ABL should interface as complementary functions: CATS evaluates the safety effects of proposed changes to air traffic. ABL monitors the present air traffic by means of occurrences, which may lead to changes to be evaluated by CATS. CATS results may be further validated by monitoring the changed air traffic operation by ABL.* • *BdV recommends CATS to do only the tasks all of the users agree with.*

Safety culture

A general remark:

The importance to take safety culture into account depends on what CATS is used for. Safety culture is important when considering an airport in developing countries for instance. However, when Western Europe is the area of attention, safety culture is reasonably uniform. Supervision and managing safety are regulated and implemented by law, and in most organisations there are people like Arthur Dijkstra, looking ahead and developing safety management Therefore, we think it is a less important aspect to address in detail. The effect on safety of airlines with very poor standards is limited these are to some extent excluded by blacklists, and the high quality of air traffic control and other actors largely absorb negative effects.

ry fact that all of us are talking about CATS is safety culture driven.

Possible safety culture indicators, their priorities and how to make them concrete

Id	Indicator	3. Prio (H/M/L)	4. How to make concrete?
a)	Priority of safety in decision making, at all levels of the organisation.	*H – This is a most important aspect of safety culture.*	• *Are the safety impacts of options always taken into account when making choices at a high level?* • *Are the decisions taken by top management driven by safety concerns?* • *For example, an airline could decide to extend its fleet with 20 aircraft, but it should also be concerned with having sufficiently many experienced pilots to fly these safely.* • *AD: A word count of "safety" in minutes of meetings may give an indication* • *The number/proportion of ideas perished due to safety concerns might also be an indication.*
b)	Safety issues reporting system: Existence of such a system, possibility for confidential and non-punitive reporting, percentage of incidents that are reported.	H: *It is important because it gives feedback, but it should be well installed. For instance, if the system is punitive it can have a very negative effect because it could lead to the entire system not to be used.*	• *The mere existence of a reporting system is not enough. If the system is not used well – make actual improvements based on analysis of safety issues reported and provide feedback to reporters and users in general – it has little value.* • *It depends very much on how the operation is managed. It could for instance happen that the training and other aspects are so good that the number of incidents is very low and hence the reporting system rarely needs to be used.*

			• *An indication might be the number of ideas originating from safety issues.*
c)	Training: training on the job, training focussed on safety issues, training in emergency situations.	*BdV: H. Looking back at my training at KLS, I recognize we have been trained in flight safety from day 1. By then I found it sometimes even overdone – now I recognize the value. Training is important for your way of handling safety issues.*	
		AD: I wonder whether training can really influence your safety culture positively. Anyhow, it is hard to influence a culture positively, whereas it is very easy to mess it up.	
d)	Safety procedures: installation of safety procedures, expectation to follow these procedures, how these procedures are actually followed, regular revision of the procedures.	*H* *Having procedures and having the right procedures is very important.*	• *Safety plays a role in all procedures.* • *The number of procedures is not a good indicator, more procedures does not necessarily mean better.* • *Having good procedures is much more important than having lots of them. The 777 is a good example.* • *There is a mismatch between what people think and what happens in practice. In reality*

			there should be space left to be able to deal with non standard situations in an intelligent way.
e)	Safety department: existence and quality of a safety department, how is it organised.	*H* *It is important to have a safety department, but it can also be a trap: the safety department ensures feedback with operations, but is not responsible for safety*	*Important aspects are:* • *The nature of the relation between safety and line management – safety should be a part in running the business and play a role in all decisions.* • *How are recommendations dealt with?* • *Can a safety manager decide by himself what has to be investigated?* • *Level of education of employees of the safety department (GAIN has carried out such research).* • *A big department is not necessarily a better department.*
f)	Proactiveness with respect to safety issues.	*H*	• *Does the organization have a risk management system installed?* • *How many cases and what of cases does this RMS handle?*

Id	Question	3. Prio (H/M/L)	4. How to make concrete?
2.	Do you have any other suggestions regarding indicators for safety culture?		
g)	*The financial capabilities for safety.*	*H*	• *The Gross Domestic Product of the country of origin*
h)	*The life principles of a country.*	*H*	• *We know of someone who had audited in India. There, people did not*

		care about safety, safety procedures and requirements were written down and that was believed to be sufficient, they were not concerned with their own death because they believed in reincarnation. • *What attitude do people have towards the authorities? In Former Ussr during a hungry winter people starved in Moscow whereas outside of town where there were plenty of potatoes. People did not care to go out because they trusted the authorities would take care.*

Good and bad safety culture and how this affects safety

Id	Question	Answer	
5.	Do you think the level of safety culture should be expressed in a one-dimensional quantity in CATS, or would you prefer to characterize it through a list of indicators?	*This will be a difficult task.* *BdV: The input should be a list of items, the output should be a single number.* *AD: expressing safety culture into one single quantity is oversimplifying the issue.*	
6.	For which kind of organisations do you think the level of safety culture needs to be incorporated in CATS? (Please indicate priority H/M/L)	Kind of organization	Prio (H/M/L)
		a) Airline	*H*
		b) ANSP	*H*
		c) Airport	*Difficult*
		d) Manufacturer	*Difficult*
		e) Maintenance	*H*
		f) Inspection	*Don't*
		g) Regulator	*Don't*
		h) ...	
		i) ...	
7.	How does safety culture influence safety? By what	• *It plays a role in trade-off decisions (job pressure versus safety). The example of choosing between de-*	

mechanisms?	*icing and leaving on time is given.* • *Knowledge of what is important and what is not important, plays a role in the trade-offs that are made – hence knowledge and insight is also important.* • *Together these aspects determine how conflicting goals are dealt with.*

The level of detail CATS should have

Aircraft

Id	Question	
8.	Please indicate for the aircraft aspects given below: – (Y) if you find it important to zoom into this aspect; – (Q) if you even have questions to CATS in this respect; – (N) if you advise not to zoom in; and – (?) if you find it difficult to choose. Please indicate additional aspects you find important to detail or not.	
a)	Aircraft manufacturer	*N*
b)	State of manufacturer	*Eastern-western/ certification standard*
c)	Aircraft make/model	*Includes in fact a), b), d)-g)*
d)	Number of engines (2, 3, 4)	
e)	Jet versus Turboprop	*Y – The mix is important because of the differences in speed*
f)	Generation of aircraft (1st – 4th)	*Y – For future changes, the mix is very important.*
g)	Certification of aircraft	

Flight operations/airline

Id	Question	
9.	Please indicate (Q/Y/N/?) for the flight operations/airline aspects given below:	
a)	Duty times/regulations	*Very difficult*
b)	Safety culture	*Very difficult*
c)	Safety management system	
d)	Occurrence reporting system	
e)	Low cost carrier/traditional flag carrier	*Y*
f)	Short haul/long haul flights	*Y – the world looks very different after 16 hours of flying*

g)	Flight crew fatigue	
h)	Cockpit automation	
i)	Workload	
j)	Flight crew selection process	
k)	Experience of pilot	
l)	Crew resource management	
m)	Flight crew medical checks	*N*
n)	Flight crew mental state (e.g., overconfidence, task saturation, alertness, get-home-itis)	*Not measurable*
o)	Flight crew physical state (e.g., hypoxia, physical fatigue, intoxication, motion sickness)	*Not measurable*
p)	Flight phase	*Y*
q)	Navigation means (RNAV, RNP, ILS, VOR/DME, GPS)	*Y*
r)	Dispatch/route planning	
s)	Aircraft loading	
t)	Aircraft de-icing/anti-icing	*Y*
u)	Paperless cockpit, EFB	*Is not important at the moment, yet. A careful Y.*
v)	Safety nets: TCAS, GPWS	
w)	Cultural aspects	
x)	Different cultures/language between pilots	*Y - because of internationalization (see e.g. Helios report).*
y)	Cross cockpit gradient (e.g., junior f/o, experienced captain)	
z)	Flight crew scheduling	
aa)	HMI characteristics	
bb)	Checklist layout	
cc)	Flight crew knowledge of systems, procedures	
dd)	Type of operation (Passenger, cargo, training, ferry, ...)	*Y*
ee)	Operator country of residence	*Y*

A general remark is that the items should be clustered.

Air Navigation Services/Communication Navigation Surveillance

Id	Question

10.	Please indicate (Q/Y/N/?) for the ATM/CNS aspects given below:	
a)	Class of airspace/level of services	*Y*
b)	Traffic density	*Y*
c)	Airspace/air traffic complexity	*Y*
d)	Applicable separation criteria	*N*
e)	Type of control provided: start-up, ground, tower, departure, area, upper area, stack, approach, ...	*Related to a)*
f)	Influence of VFR traffic/general aviation	*Y*
g)	Way of control: radar, visual, procedural, ...	*Y*
h)	Certification of ANSP	*N*
i)	Special operation at airport: mixed mode, intersection take-off, backtracking on runway, ...	*Y*
j)	Workload of controllers	*Y – related to traffic density and number of controllers*
k)	Vigilance	*N*
l)	NOTAMs applicable?	*N*
m)	Single manned operations	*Y*
n)	Service provision separated from supervision/regulation?	*N*
o)	Team resource management	*N*
p)	Controller staffing level	*Y - the ratio traffic density versus controller staffing level is important*
q)	Training standards, method, on the job training	
r)	ATCO experience	
s)	...	
t)	...	
u)	Weather information	
v)	ATIS	
w)	Weather measurements	*Y*
x)	Weather forecast	*A careful Y*
y)	Windshear warning system	*N*
z)	...	
aa)	Means of communication: VHF, CPDLC, HF, SATCOM, ...	*Y*
bb)	Phraseology, ATC clearances	
cc)	Language (problems)	*Y*

dd)	English proficiency	*Y – is similar to cc)*
ee)	Loss of communication with ATC	
ff)	*Mixed languages between ATC and pilots. E.g. the French controllers speak French amongst themselves, and switch to English when talking to pilots.*	*Y*
gg)	...	
hh)	...	
ii)	Navigation means (ILS, VOR/DME, GPS, NDB, Loran, ...)	*Y - The use of NDB and Loran should be forbidden...*
jj)	...	
kk)	...	
ll)	...	
mm)	Surveillance means (Primary/secondary radar, ADS, multi-lateration, ...)	*Y*
nn)	Runway incursion alerting system/ stop bar alerts	*Y*

Airport

Id	Question	
11.	Please indicate (Q/Y/N/?) for the airport aspects given below:	
a)	Aircraft servicing, aircraft (re)fuelling, catering	
b)	Runway layout	*YY – Not only complexity matters, the worst runway incursions occur on simple fields*
c)	Runway/taxi way maintenance	*YY*
d)	Runway/taxi way lightning and signs	*Related to 10 nn)*
e)	Bird control	*Y – relates strongly to the number of bird hits.*
f)	Airport technological capability: runway incursion alert system, stop bars, ...	*Y*
g)	Security	*Y*
h)	Airport traffic mix	*Y (is the same as 8a)*
i)	Airport capacity	*Y but the question is how busy it is.*
j)	Runway layout: number of runway, crossings, direction	*Is the same as b)*
k)	Obstacle clearance	*Y*
l)	Geographical location (mountains, etc)	*Y*

m)	Towing operations	*Y*
n)	Airport vehicles (operations/drivers)	*Y*
o)	Certification of airport	*N*
p)	Noise abatement routes	*Y*
q)	Emergency services	*N – it is too late, you have already crashed*
r)	Opportunity for crew rest	*N*

Maintenance

Id	Question	
12.	Please indicate (Q/Y/N/?) for the maintenance aspects given below:	
a)	Quality control	*Too vague*
b)	Outsourcing	*Y – What do you do yourself and what is outsourced is impor-tant*
c)	Maintenance process	
d)	...Maintenance as a whole	*Y*

The above mentioned aspects for maintenance are too vague – please work this out further: it is an important function deserving to be addressed better

Maintenance

Id	Question
	Please indicate (Q/Y/N/?) for the maintenance aspects given below:

Answers by Arthur Dijkstra

e)	Inspection intervals	Y
f)	Maintenance scheduling	Y
g)	Training	N
h)	Human factors training	Y
i)	Turn around times	Y
j)	Elements in the MEL	Y
k)	Master MEL	N
l)	Place where major repairs are carried out	*N*
m)	Type of maintenance that is outsourced	Y
n)	Technical support (portable computer)	*N*

o)	Support through manuals (paper, cd's, interactive)	N
p)	Service bulletins	N
q)	Airworthiness directives	N

Circumstances

Id	Question	
13.	Please indicate (Q/Y/N/?) for the circumstances of the accident given below:	
a)	Accident occurrence region	*Y*
b)	Accident occurrence date	*Y*
c)	Accident occurrence time of day	*Y*
d)	Traffic conditions	*Y*
e)	Weather conditions	*Y cluster with f) and g)*
f)	Runway conditions (wet, contaminated, friction, ...)	*Y*
g)	Special operations (winter operations)	*Y*
h)	Onboard medical urgency	*N*

New developments

Id	Question	
14.	Please indicate (Q/Y/N/?) for the new developments given below:	
a)	New navigation means (RNP, GPS etc)	*Y*
b)	Head up Display	*Y*
c)	A380, B787	
d)	Wake vortex related issues	
e)	Composite aircraft	*AD: ?* *BdV: Y – interesting*
f)	Very Light Jets	*AD: N* *BdV: ?*
g)	Unmanned Aerial Vehicles	*N*

Organization

Id	Question	
15.	Please indicate (Q/Y/N/?) for the organization aspects given below:	
a)	Resource management	*Financial state could be a sensible indicator*
b)	Organisational climate	
c)	Organisational process	
d)	Supervision (violations, inadequate, etc)	

e)	Self correction	
f)	Staffing/manning	
g)	Background checks	
h)	Monetary/Budget Resources	*Y*
i)	Corporate communication	
j)	(Safety) policies	
k)	Promotion	
l)	Accident investigations	
m)	Culture, values, beliefs, attitudes	
n)	*Safety department*	*Y*

In general, the above aspects are too vague

Transparency of CATS for its users

Id	Question
16.	Prospective users indicate that CATS should not be a black: it should be transparent and understandable. How would you advise achieving this? What mathematics or modelling will be entrusted to the CATS experts, what needs to be made explicit and explained?

evaluating the safety effects of changes with CATS:

- *Indicate what parameters have played a role in the evaluation and what risks have been considered;*
- *Explain which risks are behind the changes in safety; and*
- *Give clues for aspects that could improve safety.*

All these aspects should be explained in operational terms, understandable for the users.

Appendix B.2 Eric Perrin (Eurocontrol Experimental Centre)

Feedback on results of first round

Id	Question	Answer
1.	Have you seen the results of the first round of interviews for CATS User Requirements and do you have feedback on it?	*No I have not.*

Safety culture

Id	Indicator	3. Prio (H/M/L)	4. How to make concrete?
a)	Priority of safety in decision making, at all levels of the organisation.	*H*	*Is safety an agenda item at CEO level meetings?*
b)	Safety issues reporting system: Existence of such a system, possibility for confidential and non-punitive reporting, percentage of incidents that are reported.	*H*	
c)	Training: training on the job, training focussed on safety issues, training in emergency situations.	*H*	• *Do you have safety specific training for staff?* • *Do you have different levels of safety specific training for different levels of staff? E.g. level 1 for all staff, level 3 for safety practitioners.* • *Do you organize peer workshops explaining accidents?* • *Do you have a competence management system installed?*
d)	Safety procedures: installation of	*H*	*I do not know whether and how the*

	safety procedures, expectation to follow these procedures, how these procedures are actually followed, regular revision of the procedures.		*following of procedures could be measured objectively and easily. However, in a just culture, interviews could give an answer.*
e)	Safety department: existence and quality of a safety department, how is it organised.	*H*	*Check the organigram of the organization.*
f)	Proactiveness with respect to safety issues.	*H*	*This is part of the Safety Management System. Investigating the SMS should give an answer.*

Id	Question	3. Prio (H/M/L)	4. How to make concrete?
2.	Do you have any other suggestions regarding indicators for safety culture?		*Look at the work done by Rachael Gordon at EEC on the subject. This work focusses on the operational side and did for example not include maintenance or management.* *(Rachael Gordon has sent us two links to documents on safety culture[9]).*

Good and bad safety culture and how this affects safety

Id	Question	Answer
5.	Do you think the level of safety culture should be expressed in a one-dimensional quantity in CATS, or would you prefer to characterize it through a list of indicators?	*Yes, safety culture could crudely be expressed in a one-dimensional quantity. However, I am not sure whether this can or should be connected to a risk model. The biggest question would be how to improve the level of safety culture towards a higher level.* *At the moment, EEC is at the level of enablers/disablers of safety culture. The next step to classifying safety cul-*

[9] http://www.eurocontrol.int/safety/gallery/content/public/SafetyDomainSept06.pdf
http://www.eurocontrol.int/eec/gallery/content/public/documents/EEC_notes/2006/EEC_note_2006_11.pdf

		ture would be to attach a weighing factor to these indicators, but this is a rather big step.	
6.	For which kind of organisations do you think the level of safety culture needs to be incorporated in CATS? (Please indicate priority H/M/L)	Kind of organization	Prio (H/M/L)
		a) Airline	*H*
		b) ANSP	*H*
		c) Airport	*H (to some extent)*
		d) Manufacturer	*L*
		e) Maintenance	*M*
		f) Inspection	*M*
		g) Regulator	*L*
		h) ...	
		i) ...	
7.	How does safety culture influence safety? By what mechanisms?	*I don't think that it will be possible, within the next 2 or 3 years, to determine how safety culture maturity affects safety of operations.*	

Miscellaneous remarks concerning safety culture:
Eric Perrin noticed that safety culture and safety management systems are closely related and that, ultimately, the SMS should not only include bureaucratic processes, but also practice and people, and hence safety culture.

The level of detail CATS should have
No answers for this section.

Transparency of CATS for its users

Id	Question
16.	Prospective users indicate that CATS should not be a black box: it should be transparent and understandable. How would you advise achieving this? What mathematics or modelling will be entrusted to the CATS experts, what needs to be made explicit and explained?
	The CATS model should not be implemented as a tool for direct use by clients; this would be safety contra-productive. The similar tool IRP is a tool for safety practitio-

ners, and already demands quite some training for these users. CATS is at least as complicated and should therefore be used by CATS experts.

In order to be transparent and understood, explain results of CATS in operational terms/ mechanisms depending on the user (e.g. more explanations for CEO, safety experts need less). This user dependency is one reason why CATS cannot only be a tool. Suppose for instance that V+CATS is used to study the safety effects of changing vertical separation in the Heathrow TMA. It would help to explain the risk by referring to for instance an increase/decrease of the expected number of level bursts.

Appendix B.3 Henk van Leeuwen (NIVR)

Feedback on results of first round

Id	Question	Answer
1.	Have you seen the results of the first round of interviews for CATS User Requirements and do you have feedback on it?	• *It is still not clear which is group is targeted with CATS; the model might even be too complicated to understand for insiders, not to mention the general public.* • *<HdJ: The first round of interviews regarding CATS User Requirements has largely clarified the target user group as the main organisations in Dutch aviation: DGTL, IVW, KLM, LVNL, Schiphol and perhaps also Fokker Services.>* • *Still, CATS is mainly politically motivated, and a major problem for CATS is the shortage of trustworthy data. How to get reliable answers from unreliable input?* • *According to the FAA, the project is courageous and very ambitious. Experts generally indicate that CATS is on the right track. It will however cost years (say ten) to develop a reliable and usable model, and it is doubtful whether the political motivation will be that patient. Hence a challenge is to make the support for the development of CATS sustainable.*

Safety culture

- *HvL has illustrated the importance of safety culture by means of several accidents in the first interview to obtain User Requirements for CATS.*
- *HvL indicates it is very difficult to characterize safety culture by means of a few reliable parameters.*
- *It is therefore decided that the best use of the time available for the interview is made by going into the next topics – the level of detail that CATS should have and Transparency of CATS for its users.*

The level of detail CATS should have

Aircraft

Id	Question	
8.	Please indicate for the aircraft aspects given below: – (Y) if you find it important to zoom into this aspect; – (Q) if you even have questions to CATS in this respect; – (N) if you advise not to zoom in; and – (?) if you find it difficult to choose. Please indicate additional aspects you find important to detail or not.	
a)	Aircraft manufacturer	*N – The manufacturer's State is what you need, see b)*
b)	State of manufacturer	*Y*
c)	Aircraft make/model	*N – The manufacturer's State is what you need, see b)*
d)	Number of engines (2, 3, 4)	*N*
e)	Jet versus Turboprop	*Y – Due to their use, turboprops may take off and land many times a day while jets on the average make longer flights, see also h). Due to this usage, turboprops are also more sensitive to weather conditions.*
f)	Generation of aircraft (1st – 4th)	*? – Without "generation" being clearly defined, this aspect cannot be answered.* *<HdJ: From the Definitions of Civil Aviation Safety Data 1980 – 2001 by IVW, I have identified the following (not exhaustive) indications:* *Aircraft generation - a distinction among aircraft types based on certification year and applied technology.* *• Generation 1 - aircraft design and technology pre-1965. This includes the DC-8, Fokker F27, and Boeing 707.* *• Generation 2 - aircraft design and technology from the late 60's and 70's. This includes: Airbus A300, Boeing 737-100/200, DC-9 and DC-10.* *• Generation 3 - aircraft design and technology from after 1980. This includes: Fokker F100, Airbus A340/330, and Boeing 757/767/777. These aircraft are equipped with modern technology.* *The referenced document is available from www.ivw.nl>*
g)	Certification of aircraft	*N – As such this does not make sense, every aircraft is certified. What is relevant is included in b).*
h)	*Long range/regional aircraft*	*Y – Regional aircraft take off and land much more often and these phases give the largest risk.*

i)	*Year of first flight of the aircraft model*	*Y – This is much more specific than the generation*
j)	*Average age of the aircraft model's fleet*	*This could be an alternative for i).*

Flight operations/airline

Id	Question	
9.	Please indicate (Q/Y/N/?) for the flight operations/airline aspects given below:	
a)	Duty times/regulations	*N – This is regulated, the question is whether it is actually done and enforced.*[1]
b)	Safety culture	*Y – Peer pressure is a relevant aspect.*
c)	Safety management system	
d)	Occurrence reporting system	*Y*
e)	Low cost carrier/traditional flag carrier	*N – This says nothing about safety. Most people expect low cost carriers to be less good regarding safety, but airlines like EasyJet have very new fleets, as they fly a lot and want to minimize service interruptions*
f)	Short haul/long haul flights	*Y – See 8.h)*
g)	Flight crew fatigue	*N – This should be regulated*[1]
h)	Cockpit automation	*N – Not a distinguishing aspect as such. It is important how the crew deals with it*
i)	Workload	
j)	Flight crew selection process	*N – Training is important and this relates to safety culture.*
k)	Experience of pilot	*? – Perhaps relevant*
l)	Crew resource management	*N*
m)	Flight crew medical checks	*N – Regulated aspect.*
n)	Flight crew mental state (e.g., overconfidence, task saturation, alertness, get-home-itis)	*N – Relates to experience and safety culture.*
o)	Flight crew physical state (e.g., hypoxia, physical fatigue, intoxication, motion sickness)	*N – Useless as such.*

p)	Flight phase	*Y – This is always registered for accidents.*
q)	Navigation means (RNAV, RNP, ILS, VOR/DME, GPS)	*N – In this part of the world not a risk factor. Usage of available sources is important though. See the footnote[1] again.*
r)	Dispatch/route planning	
s)	Aircraft loading	*N – Relates to safety culture/SMS. Is important as cause for occurrences.*
t)	Aircraft de-icing/anti-icing	*There are many accidents where this should have been done. Weather conditions are important*
u)	Paperless cockpit, EFB	*N*
v)	Safety nets: TCAS, GPWS	*Y – Not only availability counts, but also usage. See footnote[1] again.*
w)	Cultural aspects	*Relates to safety culture*
x)	Different cultures/language between pilots	*It is relevant how pilots team together.*
y)	Cross cockpit gradient (e.g., junior f/o, experienced captain)	*Is related to the previous aspect, x)*
z)	Flight crew scheduling	*N*
aa)	HMI characteristics	*N – It is a relevant aspect, but seems impossible to handle?*
bb)	Checklist layout	*N*
cc)	Flight crew knowledge of systems, procedures	*Y – This is an important aspect, but it seems difficult to measure. Relates to safety culture.*
dd)	Type of operation (Passenger, cargo, training, ferry, ...)	*N*
ee)	Operator country of residence	*Y*
ff)	Complaints to and from home base	*N – Useless as such.*
gg)	*Location with respect to home base*	*Y*

[1]HvL: For all regulations and technical systems there are basic 3 questions to ask:
- *Does the regulation exist/ is the system available;*
- *Is the regulation applied / does the system work; and*

- *Is the regulation actually followed/ how is the system used?*

Air Navigation Services/Communication Navigation Surveillance

Id	Question	
10.	Please indicate (Q/Y/N/?) for the ATM/CNS aspects given below:	
a)	Class of airspace/level of services	*Y*
b)	Traffic density	*Y – This is related to the class of airspace, a).*
c)	Airspace/air traffic complexity	*Sufficiently covered by the above aspects.*
d)	Applicable separation criteria	*Y*
e)	Type of control provided: start-up, ground, tower, departure, area, upper area, stack, approach, ...	*N – The phase of flight is important, 9.p)*
f)	Influence of VFR traffic/general aviation	*Y*
g)	Way of control: radar, visual, procedural, ...	*Y*
h)	Certification of ANSP	*N – Not useful; this is poorly settled yet.*
i)	Special operation at airport: mixed mode, intersection take-off, backtracking on runway, ...	*?*
j)	Workload of controllers	*Y – How long have they been active?*
k)	Vigilance	*N*
l)	NOTAMs applicable?	*Y – Are they available and are they used, see again the footnote on the previous page.*
m)	Single manned operations	*N*
n)	Service provision separated from supervision/regulation?	*N*
o)	Team resource management	*N*
p)	Controller staffing level	*N*
q)	Training standards, method, on the job training	*Y*
r)	ATCO experience	*N*
s)	*Age of ANSP*	*Y – But this does not say too much in Western Europe.*
t)	...	
u)	Weather information	*Y – Availability is important, but*

		whether the information is really taken into account is even more important.
v)	ATIS	*?*
w)	Weather measurements	*N – Is included in u).*
x)	Weather forecast	*N – Is included in u).*
y)	Windshear warning system	*Y – In this region not so important but elsewhere it is. See again footnote[1] – is it available and actually used?*
z)	...	
aa)	Means of communication: VHF, CPDLC, HF, SATCOM, ...	*N – Sensitivity to disturbance is a relevant aspect.*
bb)	Phraseology, ATC clearances	*Y – It is remarkable we are still working with spoken language.*
cc)	Language (problems)	
dd)	English proficiency	
ee)	Loss of communication with ATC	
ff)	...	
gg)	...	
hh)	...	
ii)	Navigation means (ILS, VOR/DME, GPS, NDB, Loran, ...)	***YError! Bookmark not defined.***
jj)	...	
kk)	...	
ll)	...	
mm)	Surveillance means (Primary/secondary radar, ADS, multi-lateration, ...)	***YError! Bookmark not defined.***
nn)	Runway incursion alerting system/ stop bar alerts	***YError! Bookmark not defined.***

Airport

Id	Question	
11.	Please indicate (Q/Y/N/?) for the airport aspects given below:	
a)	Aircraft servicing, aircraft (re)fuelling, catering	
b)	Runway layout	*Y – But how? You won't be able to include it in the model.*

c)	Runway/taxi way maintenance	*N – It is ok in Northwest Europe.*
d)	Runway/taxi way lightning and signs	*N – It is ok in Northwest Europe.*
e)	Bird control	*Y – Very important, especially in the Netherlands.*
f)	Airport technological capability: runway incursion alert system, stop bars, ...	*Considered this before, in 10.nn).*
g)	Security	*N*
h)	Airport traffic mix	*N – The relevant aspects are included in s).*
i)	Airport capacity	*N – The relevant aspects are included in s).*
j)	Runway layout: number of runway, crossings, direction	*Y – But this is the same as b).*
k)	Obstacle clearance	*Y*
l)	Geographical location (mountains, etc)	*Y – Not an issue here, but important at other places.*
m)	Towing operations	*N*
n)	Airport vehicles (operations/drivers)	*Y – Ground transport.*
o)	Certification of airport	*N*
p)	Noise abatement routes	*N – Unless these routes are so much adjusted that they get outside the set of "normal" routes.*
q)	Emergency services	*Y**Error! Bookmark not defined.***
r)	Opportunity for crew rest	*N*
s)	*Airport characteristic (mainport, regional airport, general aviation)*	*Y*

Maintenance

Id	Question
12.	Please indicate (Q/Y/N/?) for the maintenance aspects given below:

HvL: Maintenance is regulated to a large extent – the real question is whether the regulations are indeed followed.

a)	Inspection intervals	
b)	Maintenance scheduling	
c)	Training	
d)	Human factors training	
e)	Turn around times	
f)	Elements in the MEL	*Is there a MEL and is there adhered to?*
g)	Master MEL	
h)	Place where major repairs are carried out	*N – Have major repairs been carried out? This generally is impossible to check.*
i)	Type of maintenance that is outsourced	*N – In principle this should not matter.*
j)	Technical support (portable computer)	*N*
k)	Support through manuals (paper, cd's, interactive)	*Is the material available and is it used?*
l)	Service bulletins	*Is the material available and is it used?*
m)	Airworthiness directives	*Is the material available and is it used? Here application is mandatory.*

Circumstances

Id	Question	
13.	Please indicate (Q/Y/N/?) for the circumstances of the accident given below:	
a)	Accident occurrence region	*Y*
b)	Accident occurrence date	*N – Season is important, see i).*
c)	Accident occurrence time of day	*N – Day/night is important, see j).*
d)	Traffic conditions	*This one has been covered before, see for instance 10.b).*
e)	Weather conditions	*Y*
f)	Runway conditions (wet, contaminated, friction, ...)	*Y*
g)	Special operations (winter operations)	*Y – Related to season, see i).*
h)	Onboard medical urgency	*N*
i)	*Accident occurrence season*	*Y*
j)	*Accident occurrence part of day (day/night)*	*Y*

New developments

Id	Question
14.	Please indicate (Q/Y/N/?) for the new developments given below:

a)	New navigation means (RNP, GPS etc)	*N*
b)	Head up Display	*Y – Especially when visibility is low.*
c)	A380, B787	*N*
d)	Wake vortex related issues	*Y – In relation to separation.*
e)	Composite aircraft	*N*
f)	Very Light Jets	*N – Not important yet, but the number of VLJs will grow exponentially, and this will become a headache. Airports will have troubles to handle these, and the pilots ("flying dentists") often do not have the experience of a professional.*
g)	Unmanned Aerial Vehicles	*Not yet relevant, but interesting.*

Organization

Id	Question	
15.	Please indicate (Q/Y/N/?) for the organization aspects given below:	
a)	Resource management	
b)	Organisational climate	*Y*
c)	Organisational process	
d)	Supervision (violations, inadequate, etc)	
e)	Self correction	*Related to safety culture.*
f)	Staffing/manning	
g)	Background checks	
h)	Monetary/Budget Resources	
i)	Corporate communication	*Least important (such functions are often specialized in keeping off difficult questions.)*
j)	(Safety) policies	*Y – Related to safety culture.*
k)	Promotion	
l)	Accident investigations	
m)	Culture, values, beliefs, attitudes	
n)		
o)	*If earning money is the primary target, this may at odds with a good safety culture.*	

Transparency of CATS for its users

Id	Question
16.	Prospective users indicate that CATS should not be a black box: it should be transparent and understandable. How would you advise achieving this? What mathematics or modelling will be entrusted to the CATS experts, what needs to be made explicit and explained?
	• *As I said in question 1), the biggest problem with making CATS reliable is to find reliable data.* • *Make the parameters and assumptions explicit and accessible; this is even more important than the computational method (garbage in, garbage out).* • *It is important to build up confidence in CATS.*

- *HvL: It is important to keep in mind that accidents are usually the result of a chain of events, instead of single events, which, on themselves, are not enough to cause an accident.*
- *HvL illustrates this with the recent accident with the Helios 737.*

Appendix B.4 Jan Busstra (DGTL) *(reviewed)*

Feedback on results of first round

Id	Question	Answer
1.	Have you seen the results of the first round of interviews for CATS User Requirements and do you have feedback on it?	• *I have taken a look and noticed that most other interviewees have given more detailed answers than I have.* • *Regarding the possible use of CATS as a monitoring tool (about which different opinions existed in the first round of interviews) JB remarks that at the time the first interviews, the law on reporting of incidents, which also concerns Analysebureau Luchtvaartvoorvallen (ABL), was not accepted yet. It has been accepted in the mean time, so the allocation of functions between CATS (safety risk analysis of foreseen changes to the aviation system) and ABL (monitoring the state of the present aviation system) as indicated by for instance Bart de Vries sounds reasonable to me.* *Regarding the positioning of CATS: it is a too complex model to be used directly by decision makers, it should rather be used in the preliminary process by scientists, providing support (parameters) for decision making.*

Safety culture

Possible safety culture indicators, their priorities and how to make them concrete

Id	Indicator	3. Prio (H/M/L)	4. How to make concrete?
a)	<u>Priority of safety in decision making</u>, at all levels of the organisation.	*H*	• *In our organization decision making is strongly influenced by safety – it is always questions what the safety risks are.* • *The priority of safety is concretized in such a way that not only employees, but especially management and top management feel personally responsible for securing safety.* • *This role should be made explicit in the safety management system (or quality management).* • *It has recently been investigated (in "Veiligheidsonderzoek Nederland") how*

			roles and responsibilities inside the transport and water management department (VenW) have been laid down and how they work in practice. • *A good practice demands a good description.*
b)	Safety issues reporting system: Existence of such a system, possibility for confidential and non-punitive reporting, percentage of incidents that are reported.	*H*	• *This is a crucial element – without input there is no output.* • *A reporting system is not going to work if reporters feel they risk punishment for reporting. To this end there is a good new law, offering reasonable protection, to some extent also against criminal prosecution. The law on non-punitive reporting is going to be accepted by the end of November 2006. The law was adopted by the First Chamber around 31 October 2006 and has been published.* • *The law needs to be trusted to become effective: bad experiences from the past often have a long term effect on the willingness to use the reporting system again. Also, it needs to become clear when the public prosecutor acts and when he does not act.* • *Therefore the law is only the tip of the iceberg: the actual work – reporting and handling reports (investigating, acting and feeding back) needs to be done by the sector. Therefore, the mere existence of such a law is not yet an indicator for a good reporting system.*
c)	Training: training on the job, training focussed on safety issues, training in emergency situations.	*H*	• *It is important because people learn to recognize risk, which is essential for the reporting system to be used.* • *Training is important for risk awareness. Adequate training helps both "generalists" working at some distance of the operations and people zooming into certain aspects and*

			who might get a "tunnel vision" to be alert regarding negative safety effects.
d)	Safety procedures: installation of safety procedures, expectation to follow these procedures, how these procedures are actually followed, regular revision of the procedures.	*H/M*	• *H for routine jobs close to the operations.* • *M for more policy oriented functions, where safety awareness and culture is more important. The procedure to analyze safety consequences of changes is rather a part of the SMS.*
e)	Safety department: existence and quality of a safety department, how is it organised.	*L*	• *The existence of a safety department could also we considered as an indicator for work to be done.* • *Not having a safety department does not mean that the CEO does not find safety important.* • *The ultimate goal of an organization should be that the safety department becomes unnecessary, and that safety is an integral part of the entire organization. Internalisation of safety!*
f)	Proactiveness with respect to safety issues.	*Difficult*	• *It is hard to be against proactiveness and the sense to analyse and act before accidents happen and not afterwards.* • *On the other hand, if a reporting system is installed it might be more useful to see the parallels between what others have done and what you are about to do, than to foresee the risks yourself.*

Id	Question	3. Prio (H/M/L)	4. How to make concrete?
2.	Do you have any other suggestions regarding indicators for		

	safety culture?		
g)	*The above indicators are very focussed on objectivity. However, I think however that culture and perception are very important, although they are hard to fill in and to measure.*		• *Measure the importance of safety against other interests (e.g. work pressure), in employees' opinion as well as in the appraising managers' opinion.*

Good and bad safety culture and how this affects safety

Id	Question	Answer	
5.	Do you think the level of safety culture should be expressed in a one-dimensional quantity in CATS, or would you prefer to characterize it through a list of indicators?	• *I think it is necessary to characterize it in multi-dimensional terms, as it is a multi-dimensional quantity – there are always better and worse aspects.* • *The motivational aspect is crucial. An airline in the press with a bad mark regarding safety will do everything to criticize the results rather than improve its safety management system. Therefore one should rather express the results of a safety culture measurement in a neutral way by indicating the aspects compared to other organisations so that the organisation can pick out the weaker aspects for improvement.*	
6.	For which kind of organisations do you think the level of safety culture needs to be incorporated in CATS? (Please indicate priority H/M/L)	Kind of organization	Prio (H/M/L)
		a) Airline	*H*
		b) ANSP	*H*
		c) Airport	*H*
		d) Manufacturer	*H*
		e) Maintenance	*H*
		f) Inspection	*H*
		g) Regulator	*H*
		h) …	
		i) …	
		The chain is as strong as the weakest link.	
7.	How does safety culture influence safety? By what	• *Safety culture relates to the values and standards of the individuals. When these individuals do not value*	

mechanisms?	*human life, correcting is extremely difficult.* • *Safety culture also relates to the extent to which the values and standards of an individual are confirmed by others, especially by management.* • *I am convinced that safety eventually is worthwhile economically.*

The level of detail CATS should have

No answers for this section.

Transparency of CATS for its users

Id	Question
16.	Prospective users indicate that CATS should not be a black box: it should be transparent and understandable. How would you advise achieving this? What mathematics or modelling will be entrusted to the CATS experts, what needs to be made explicit and explained?

	• *There are two items to take into account:*
	  o *Accept that you cannot explain everything to everybody.*
	  o *Generalists will not try to understand the entire process/model in detail but will call for their specialists to judge the model; and*
	  o *Make the details fully accessible to these specialists.*
	• *There are positive side–effects:*
	  o *The specialists help further development of the model and its validation by the "peer-review" effect; and*
	  o *If people criticize the model, it is possible to bring on a real debate on how it can be improved, rather than ending in a yes-no debate.*
	• *Where CATS employs Bayesian Believe Networks, the model is rather intersubjective than objective.*
	• *The most important is to convince people of the positive intentions of the model.*

Appendix B.5 Job Brüggen (LVNL)

Feedback on results of first round

Id	Question	Answer
1.	Have you seen the results of the first round of interviews for CATS User Requirements and do you have feedback on it?	*No*

Safety culture

Possible safety culture indicators, their priorities and how to make them concrete

Id	Indicator	3. Prio (H/M/L)	4 How to make concrete?
a)	Priority of safety in decision making, at all levels of the organisation.	*H*	• *What considerations with respect to safety have been taken in the decision making?* • *Number of decisions in which safety is explicitly mentioned*
b)	Safety issues reporting system: Existence of such a system, possibility for confidential and non-punitive reporting, percentage of incidents that are reported.	*M*	*Note: a reporting system alone is not sufficient: it does not express to which extent an organization is committed to safety, only to what extent an organization is willing to involve employees in safety issues. Moreover, confidential reporting should be allowed but it is not an indicator for a good safety culture.* • *Existence of a reporting, analysis and improvement system, together with a feedback loop.*

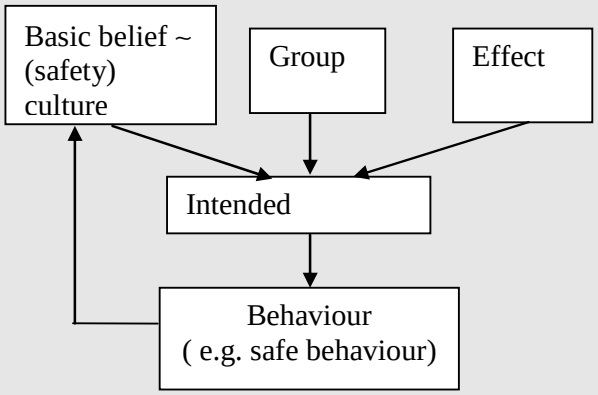
			• *It is impossible to get to know what percentage of incidents is reported.*
c)	Training: training on the job, training focussed on safety issues, training in emergency situations.	*H*	• *Number of trainings that are compulsory and to which consequences are attached.* *Note: training is very important as long as there consequences attached to whether or not fulfilling successfully the training.*
d)	Safety procedures: installation of safety procedures, expectation to follow these procedures, how these procedures are actually followed, regular revision of the procedures.	*M*	• *I do not know. Installing too many procedures is not good either.*
e)	Safety department: existence and quality of a safety department, how is it organised.	*M*	*Note: It is important for the existence of a safety culture. It is not sure, however, whether it is important for the safety itself.*
f)	Proactiveness with respect to safety issues.	*H*	*Note: It is important for the proactiveness to be visible.*

Id	Question	3. Prio (H/M/L)	4. How to make concrete?
2.	Do you have any other suggestions regarding indicators for safety culture?		
g)	*Number of specific meetings on safety.*		*How is the attention that is given orally to safety applied in practice?*
h)	*The extent to which the organization is open to unknown hazards*		*Is there attention for incidents elsewhere and their implications for the*

	("think the unthinkable")		*organization?*
i)	*Number of internal safety reports (very similar to b))*		*Number of telephone calls, e-mails etc. about safety.*
j)	*At what level of the organization is an employee allowed to stop the process?*		
k)	*To what extent does top management worry about safety culture, and does it make safety culture apparent and measurable?*		

Good and bad safety culture and how this affects safety

Id	Question	Answer	
5.	Do you think the level of safety culture should be expressed in a one-dimensional quantity in CATS, or would you prefer to characterize it through a list of indicators?	*It should be expressed as a one-dimensional quantity, otherwise it becomes too complicated.*	
6.	For which kind of organisations do you think the level of safety culture needs to be incorporated in CATS? (Please indicate priority H/M/L)	Kind of organization	Prio (H/M/L)
		a) Airline	*H*
		b) ANSP	*H*
		c) Airport	*H*
		d) Manufacturer	*H*
		e) Maintenance	*H*
		f) Inspection	*H*
		g) Regulator	*H*
		h) ...	
7.	How does safety culture influence safety? By what mechanisms?	• *There is a strong and reciprocal relationship between safety culture and safety.*	



- *(Safety) culture is resistant hard to changes. It is, however, the result of a certain behaviour, which in contrast can be changed rather easily.*

The level of detail CATS should have

These questions were not treated with the interviewee.

Transparency of CATS for its users

Id	Question
16.	Prospective users indicate that CATS should not be a black box: it should be transparent and understandable. How would you advise achieving this? What mathematics or modelling will be entrusted to the CATS experts, what needs to be made explicit and explained?

- *To be understandable and transparent, the results of CATS should not be expressed in terms of the mathematic models, but in operational terms.*
- *The results should be presented in simple terms in such a way that it instinctively connects to the causal factors. For instance, when a procedure should not be conduct with low visibility, just say that this is because at low visibility pilots cannot see each other, and therefore can not avoid each other.*
- *The longer the explanation, the worse it is.*
- *No mathematics or modelling should be entrusted to the CATS experts. A communicative professional should be given the task to explain the CATS results.*

Appendix B.6 Jos Wilbrink (IVW)

Feedback on results of first round

Id	Question	Answer
1.	Have you seen the results of the first round of interviews for CATS User Requirements and do you have feedback on it?	*Yes I have read it and have seen no strange things.*

Safety culture

Possible safety culture indicators, their priorities and how to make them concrete

Id	Indicator	3. Prio (H/M/L)	4 How to make concrete?
a)	Priority of safety in decision making, at all levels of the organisation.	*H* *(Safety is stated as priority #1 in the Common Requirements for ANS certification.)*	• *Has a target level of safety been defined? This is needed to determine whether the level of safety is sufficient. If there is no target level of safety, safety can easily become of less priority.*
b)	Safety issues reporting system: Existence of such a system, possibility for confidential and non-punitive reporting, percentage of incidents that are reported.	*H – It is important to report in order to learn, not in order to punish. A punitive reporting system poses a danger to safety. The Prosecution Counsel is a danger in the Netherlands, less in Europe.*	• *It is hard to concretize for outsiders* • *The number of reports could be an indicator, but should be handled with care, as the number of reports can also change when some issues are under special attention or when definitions change.* • *The best way to determine the functioning of a reporting system is through interviews.*
c)	Training: training on the	*M*	• *Cutbacks in recurrent training*

	job, training focussed on safety issues, training in emergency situations.		*show a low level of safety culture.*
d)	Safety procedures: installation of safety procedures, expectation to follow these procedures, how these procedures are actually followed, regular revision of the procedures.	*M – It is good to have safety procedures, but they also should be complied with.*	• *Existence of the basic safety loop is a good indicator for safety culture. The safety manager should supervise this process and advise the higher management; problems should be solved in the line.*
e)	Safety department: existence and quality of a safety department, how is it organised.	*H*	• *Is related to the previous item. What is the effect of the safety manager: are his advises thrown away or are they genuinely taken into account? Are unpopular measures taken if necessary?*
f)	Proactiveness with respect to safety issues.	*H if good communication on safety measures;* *M if not.*	• *Proactively addressing safety issues needs to be done in managing safety and it says something about the safety culture.* • *Proactiveness needs to be communicated about.* • *An open atmosphere/culture is an aspect IVW assesses in determining the supervision regime.*

Id	Question	3. Prio (H/M/L)	4. How to make concrete?
2.	Do you have any other suggestions regarding indicators for safety culture?		
g)	*Open atmosphere*	*H*	• *Do people dare to talk about the problems?*
h)	*External communication on safety*	*M*	• *If there is good external communi-*

	issues	*cation this means there is an open culture, however the contrary does not hold: for instance, Schiphol invests a lot in safety, but is reserved with external communication on these issues because of the hypersensitivity of air transport on media attention (when alcohol controls are announced for taxi or truck drivers, the public opinion is enthusiastic, but if one would announce alcohol controls on pilots people would get really worried).*
i)	*Turnover of staff in the safety department.* *M*	

Good and bad safety culture and how this affects safety

Id	Question	Answer
5.	Do you think the level of safety culture should be expressed in a one-dimensional quantity in CATS, or would you prefer to characterize it through a list of indicators?	• *I do not think a number would be suitable as it suggests absoluteness, which does not fit an issue as culture. I would rather use a colour code (e.g. traffic lights).* • *Give a qualitative measure based on a combination of indicators. Sometimes you know immediately that safety culture is poor – when the priority of safety is low.* • *It is, however, a difficult subject; confidence should be gained in the indicators.*

		Kind of organization	Prio (H/M/L)
6.	For which kind of organisations do you think the level of safety culture needs to be incorporated in CATS?	a) Airline	
		b) ANSP	
		c) Airport	
		d) Manufacturer	
		e) Maintenance	
	(Please indicate priority	f) Inspection	

	H/M/L)	g) Regulator	
		h) *Crew (in South America the captain is the big boss, he has a lot more authority than the first officer; hence, joint KLM-Varig crews would be complicated)*	
		i) *Other users (ground handling organization, pushbacks give a lot problems at the moment)*	
		j) *In smaller air traffic: flight clubs, rental companies*	
		k) *Flight schools*	
		l) *Communication between all the organizations is very important so the interfaces between them should also be considered.* *Examples of challenging communication:* • *Communication between LVNL and towing drivers; and* • *Inspection explaining to airlines why another instrument is needed in a very full cockpit.*	
		I will not prioritize between the different kinds of organizations; I think they all are of high priority. Regulator and inspection are less directly involved in the operation, but they have an important task in keeping the others alert.	
7.	How does safety culture influence safety? By what mechanisms?	*Directly. Safety culture is a certain mindset.* *People need to learn this in their education and training: first check three times and then fly.*	

The level of detail CATS should have

Remarks of Jos Wilbrink concerning the level of detail CATS should have:

- *Regarding for instance the number of engines of an aircraft, or the state of the manufacturer, I can say what my intuition is about the influence of these parameters, but it might not be true. (People for instance feel that later generation aircraft are safer. This might however not be due to the aircraft, but to the best crews flying the newest aircraft.) Instead of indicating intuitions, these things should be decided based on research.*
- *Be careful with rejecting apparently unimportant details, this could change significantly the outcome.*
- *Include all these parameters but do not weigh them yet; by doing so, the model is flexible and ready for further development once more data and insight is at the disposition of the modellers.*

The questions regarding the level of detail CATS have not been dealt with in this interview; see the interview with Frederik Demeyere for IVW input to these.

Transparency of CATS for its users

Id	Question
16.	Prospective users indicate that CATS should not be a black box: it should be transparent and understandable. How would you advise achieving this? What mathematics or modelling will be entrusted to the CATS experts, what needs to be made explicit and explained?
	• *CATS should indicate when assumptions involve uncertainties and when extrapolations are made.* • *It is preferable that CATS in the beginning yields no results rather than incorrect ones.* • *Whatever the results are, indicate:* o *How they were obtained;* o *What issues were considered; and* o *How the parameters were weighed.* *By doing so, the users can determine whether state-of-the-art assumptions were made, or if assumptions were outdated. This is necessary to obtain confidence in the model and to assess how to use the results. I do not have clearly in mind how this should be presented: graphically, or with text…* • *If one has a question to pose, it should be clear where it has to be posed, and that something is genuinely done with it.*

- *Make a PR-show to present and explain CATS. Such a show should be kept low-profile, otherwise people will not take part in the process of thinking about how to improve CATS.*
- *Give the possibility to zoom into sub-modules in order for experts to be able to follow CATS up to a reasonable level of detail. Such a zooming function should be optional to use, otherwise less experienced users could be scared off.*

Appendix B.7 Rudi den Hertog (Fokker Services) *(reviewed)*

Feedback on results of first round

Id	Question	Answer
1.	Have you seen the results of the first round of interviews for CATS User Requirements and do you have feedback on it?	*Yes I did, and I noticed that I could not find much of my input in the user requirements.* *For the rest, I do not really have feedback to give, which does not mean there is none.*

Safety culture

Possible safety culture indicators, their priorities and how to make them concrete

Id	Indicator	3. Prio (H/M/L)	4. How to make concrete?
a)	Priority of safety in decision making, at all levels of the organisation.	*M*	• *Priority number one always: does the aircraft meet its design safety goals. Sometimes, we get in the grey area in between design and operational environment, especially when this environment is less than optimal,* • *In several such cases we have modified the aircraft, rather than insisting on changing the operational environment.* • *See Ref. 1 "If I were a rich man" for a paper discusses money versus safety; the appendix quotes the abstract.* • *Fokker Services has a safety board that meets on a regular basis; decisions are based on technical, lead time & cost considerations with a target of being safe for the operating environment, which is essential for the type certificate holder.*

b)	Safety issues reporting system: Existence of such a system, possibility for confidential and non-punitive reporting, percentage of incidents that are reported.	*H*	• *The existence of a confidential and especially a non-punitive reporting system is essential.* • *At Fokker Services, reporting safety issues is mandatory: this includes companies that cooperate with us.*
c)	Training: training on the job, training focussed on safety issues, training in emergency situations.	*Variable*	*The importance of training depends on the function of the person: for safety investigators it is important.*
d)	Safety procedures: installation of safety procedures, expectation to follow these procedures, how these procedures are actually followed, regular revision of the procedures.	*?*	• *Fokker Services has a Design Organisation Approval [DOA] and a Design Organisation Manual [DOM]* • *In general, it is our experience that our own CVE's (Compliance Verification Engineers) are slightly more stringent than in the pre-DOA system without CVE's.*
e)	Safety department: existence and quality of a safety department, how is it organised.	*L*	• *I do not believe the existence of a safety department is essential for being safe; working safely should be an inherent part of everybody's job, not only of the safety department.*
f)	Proactiveness with respect to safety issues.	*Difficult*	• *Difficult to say because in the end it is always a question of money. Implementing safety measures as a result of incidents/accidents is already difficult. SFAR 88 on fuel tank safety is an example – it costs a fortune and the safety improvement is very small.* • *For instance, the Boeing 737 has no envelope protection unlike the 777 and Airbuses, the latter have it even hardwired. Nonetheless the 737 is a safe aircraft. Fokker has implemented*

		envelope protection on their planes; it was taken into account that many Fokkers fly for non-Western airlines, which may be less stringent regarding training and safety.

Id	Question	3. Prio (H/M/L)	4. How to make concrete?
2.	Do you have any other suggestions regarding indicators for safety culture?		
g)	*The implementation of novel methodologies to improve safety: this demonstrates the will of an organization to be safe and that they have been thinking about how to achieve this.*	*H*	• *For instance, Fokker Services has implemented a "first occurrences" method to manage safety. First occurrences are investigated systematically and followed up by appropriate action. Theses cases are only closed when understood and handled completely.* • *KLM has FOQA (Flight Operation Quality Assurance), considering several kinds of in-flight exceedances captured by Flight Data Monitoring: replaying such a flight with the crew involved provides essential learning feedback.* • *Air France is unique in having a method for accident precursors.*
h)	*The extent to which the organization adapts itself to the actual environment in which it operates:*		• *Boeing has figured out that in accidents, where systems were involved or could have prevented the accident and did not, that in 70% of the cases the original design assumptions were inadequate for the situation existing at the time of the accident due to changes in:* – *The aviation system;*

			– *Airplane operational usage;* – *Personnel demographics; and* – *Evolving infrastructure or other considerations.* • *To enable adequate support for the aircraft - after 2001 more than 150 Fokker 50 and 100 aircraft went from one operator to another - Fokker Services launched its award winning FUTURE program. Here we joined forces with our suppliers. This signalled the operators that support will be there well into the future.*
i)	*The relative priority of money and safety (also mentioned under a))*		• *RdH mentions that there are some airlines unwilling to invest in understanding the aircraft itself. Some people know very well that the F100 needs to be maintained differently than a 737. However, since it is often the smallest aircraft in the fleet, the airline is often not willing to invest in specific knowledge and expertise for this aircraft. There are "good" airlines, but it requires investment.* • *Today, airlines will resist investing in recommended safety enhancements and simply wait until it is mandated by the authorities.* • *In 2005, there were 63 cancellations in one week related to Fokker aircraft at one particular airline due to less than optimal maintenance: spare parts missing, lack of organisation, demoralized people.*

Good and bad safety culture and how this affects safety

Id	Question	Answer	
5.	Do you think the level of safety culture should be expressed in a one-dimensional quantity in CATS, or would you prefer to characterize it through a list of indicators?	*I find it difficult to answer this question, but I do not believe safety culture is a one-dimensional quantity, see also the final remarks concerning safety culture and CATS below.*	
6.	For which kind of organi-sations do you think the level of safety culture needs to be incorporated in CATS? (Please indicate priority H/M/L)	Kind of organization	Prio (H/M/L)
		a) Airline	?
		b) ANSP	
		c) Airport	
		d) Manufacturer	
		e) Maintenance	
		f) Inspection	
		g) Regulator	*They want to see safety culture, the rest are stakeholders.*
		h) ...	
		i) ...	
7.	How does safety culture influence safety? By what mechanisms?	*Safety culture certainly influences safety. Safety culture starts with open reporting and action upon reporting: if the reason for the occurrence of an accident is clear and if it is clear that something is done about this, safety will increase by itself.*	

Final remarks by Rudi den Hertog concerning safety culture and CATS:

- *Safety Culture can only be included in the CATS model when a reasonable scoring method can be developed, see my Jan 11, 2007 E-mail to Patrick Hudson.*
- *Try to understand FAST, especially the synthesis of the top 20 areas of change. Reference 2 presents a preliminary hazard analysis of a concept of operation for 2011 using FAST (see the notes at slide 14 for three non-nominal scenarios) and Reference 3 for an overview of Future Areas of Change.*

The level of detail CATS should have

Aircraft

Id	Question	
8.	Please indicate for the aircraft aspects given below: – (Y) if you find it important to zoom into this aspect; – (Q) if you even have questions to CATS in this respect; – (N) if you advise not to zoom in; and – (?) if you find it difficult to choose. Please indicate additional aspects you find important to detail or not.	
a)	Aircraft manufacturer	
b)	State of manufacturer	
c)	Aircraft make/model	
d)	Number of engines (2, 3, 4)	
e)	Jet versus Turboprop	
f)	Generation of aircraft (1st – 4th)	
g)	Certification of aircraft	
h)		*As indicated and argued in the first interview: zoom into A320 en B737; this will provide good statistics.*

Flight operations/airline

Id	Question	
9.	Please indicate (Q/Y/N/?) for the flight operations/airline aspects given below:	
a)	Duty times/regulations	
b)	Safety culture	
c)	Safety management system	
d)	Occurrence reporting system	
e)	Low cost carrier/traditional flag carrier	
f)	Short haul/long haul flights	
g)	Flight crew fatigue	
h)	Cockpit automation	
i)	Workload	
j)	Flight crew selection process	
k)	Experience of pilot	
l)	Crew resource management	
m)	Flight crew medical checks	
n)	Flight crew mental state (e.g., overconfidence, task saturation, alertness, get-home-itis)	
o)	Flight crew physical state (e.g., hypoxia, physical fatigue, intoxication, motion sickness)	
p)	Flight phase	
q)	Navigation means (RNAV, RNP, ILS, VOR/DME, GPS)	
r)	Dispatch/route planning	
s)	Aircraft loading	
t)	Aircraft de-icing/anti-icing	
u)	Paperless cockpit, EFB	
v)	Safety nets: TCAS, GPWS	
w)	Cultural aspects	
x)	Different cultures/language between pilots	
y)	Cross cockpit gradient (e.g., junior f/o, experienced captain)	*This is an issue.*
z)	Flight crew scheduling	
aa)	HMI characteristics	
bb)	Checklist layout	
cc)	Flight crew knowledge of systems, procedures	
dd)	Type of operation (Passenger, cargo, training, ferry, ...)	
ee)	Operator country of residence	
ff)	Complaints to and from home base	

RdH notes that the above aspects are mixed together and should be ordered:

- *The ICAO ADREP Manual probably provides a good way.*
- *Involve the SHELL model (S: manuals, procedures; H: equipment and software; E: environment; L: liveware).*

Air Navigation Services/Communication Navigation Surveillance

Id	Question	
10.	Please indicate (Q/Y/N/?) for the ATM/CNS aspects given below:	
a)	Class of airspace/level of services	
b)	Traffic density	
c)	Airspace/air traffic complexity	
d)	Applicable separation criteria	
e)	Type of control provided: start-up, ground, tower, departure, area, upper area, stack, approach, ...	
f)	Influence of VFR traffic/general aviation	
g)	Way of control: radar, visual, procedural, ...	
h)	Certification of ANSP	
i)	Special operation at airport: mixed mode, intersection take-off, backtracking on runway, ...	
j)	Workload of controllers	
k)	Vigilance	
l)	NOTAMs applicable?	
m)	Single manned operations	
n)	Service provision separated from supervision/regulation?	
o)	Team resource management	
p)	Controller staffing level	
q)	Training standards, method, on the job training	
r)	ATCO experience	
s)	...	
t)	...	
u)	Weather information	
v)	ATIS	
w)	Weather measurements	
x)	Weather forecast	
y)	Windshear warning system	

z)	...	
aa)	Means of communication: VHF, CPDLC, HF, SATCOM, ...	
bb)	Phraseology, ATC clearances	
cc)	Language (problems)	
dd)	English proficiency	
ee)	Loss of communication with ATC	
ff)	...	
gg)	...	
hh)	...	
ii)	Navigation means (ILS, VOR/DME, GPS, NDB, Loran, ...)	
jj)	...	
kk)	...	
ll)	...	
mm)	Surveillance means (Primary/secondary radar, ADS, multi-lateration, ...)	
nn)	Runway incursion alerting system/ stop bar alerts	

Airport

Id	Question	
11.	Please indicate (Q/Y/N/?) for the airport aspects given below:	
a)	Aircraft servicing, aircraft (re)fuelling, catering	
b)	Runway layout	
c)	Runway/taxi way maintenance	
d)	Runway/taxi way lightning and signs	
e)	Bird control	
f)	Airport technological capability: runway incursion alert system, stop bars, ...	
g)	Security	
h)	Airport traffic mix	
i)	Airport capacity	
j)	Runway layout: number of runway, crossings, direction	
k)	Obstacle clearance	
l)	Geographical location (mountains, etc)	
m)	Towing operations	
n)	Airport vehicles (operations/drivers)	
o)	Certification of airport	
p)	Noise abatement routes	

q)	Emergency services	
r)	Opportunity for crew rest	

Maintenance

Id	Question	
12.	Please indicate (Q/Y/N/?) for the maintenance aspects given below:	
a)	Inspection intervals	
b)	Maintenance scheduling	
c)	Training	
d)	Human factors training	
e)	Turn around times	
f)	Elements in the MEL	
g)	Master MEL	
h)	Place where major repairs are carried out	
i)	Type of maintenance that is outsourced	
j)	Technical support (portable computer)	
k)	Support through manuals (paper, cd's, interactive)	
l)	Service bulletins	
m)	Airworthiness directives	

Circumstances

Id	Question	
13.	Please indicate (Q/Y/N/?) for the circumstances of the accident given below:	
a)	Accident occurrence region	
b)	Accident occurrence date	
c)	Accident occurrence time of day	
d)	Traffic conditions	
e)	Weather conditions	
f)	Runway conditions (wet, contaminated, friction, ...)	
g)	Special operations (winter operations)	
h)	Onboard medical urgency	
i)		*These quantities are all included in accident reports.*

RdH indicates that most of the above aspects are automatically included since these are in the accident data.

New developments

Id	Question	
14.	Please indicate (Q/Y/N/?) for the new developments given below:	
a)	New navigation means (RNP, GPS etc)	
b)	Head up Display	
c)	A380, B787	
d)	Wake vortex related issues	
e)	Composite aircraft	
f)	Very Light Jets	
g)	Unmanned Aerial Vehicles	*The above just the top of the ice berg, please look into the 179 Areas of change from FAST for a more complete overview.*

Organization

Id	Question	
15.	Please indicate (Q/Y/N/?) for the organization aspects given below:	
a)	Resource management	
b)	Organisational climate	
c)	Organisational process	
d)	Supervision (violations, inadequate, etc)	
e)	Self correction	
f)	Staffing/manning	
g)	Background checks	
h)	Monetary/Budget Resources	
i)	Corporate communication	
j)	(Safety) policies	
k)	Promotion	
l)	Accident investigations	
m)	Culture, values, beliefs, attitudes	

Transparency of CATS for its users

Id	Question

16. Prospective users indicate that CATS should not be a black box: it should be transparent and understandable.
How would you advise achieving this? What mathematics or modelling will be entrusted to the CATS experts, what needs to be made explicit and explained?

- *Rudi den Hertog has seen the model (in the mini-CATS meeting) en now thinks it might become of use, whereas before he was very sceptic about this. However, the usability of the model depends crucially on the appropriateness of the input data.*
- *Also, CATS will only be of use for accident types for which CATS models have been developed. These models are developed on the basis of historical accident data. Although this is often automatically and erroneously done, the future can not always (if ever) be extrapolated linearly from the past; therefore the validation of the model is extremely important.*
- *There are ideas on dealing with future types of accidents in the FAST project. One important characteristic is that everything is connected in ATM and this may lead to very different phenomena, for which appropriate handling needs to be defined.*
- *CATS is full of assumptions, and it yields what is fed into it – garbage in, garbage out. The input data must be reliable and understandable. Many more sessions like the mini-CATS meeting are necessary to validate input data.*
- *Do not make CATS even more complex than it already is. Keep it as is, make trial runs, and see whether the results make sense. What happens to the database accidents when CPDLC is introduced, or RNP1 and have experts assess the results to validate CATS.*

References

1. *If I were a rich man ... , ... my accident record wouldn't be so bad! On the influence of economic constraints on jet aircraft accident statistics, H.C. Visser (Fokker Services) Aviation Safety, pp. 365-383, H. Soekkha(Ed.), ©VSP1997*
2. *Preliminary Hazard Analysis of EUROCONTROL Concept of Operations 2011 using FAST method, presented by Alexander Krastev, Safety R & D seminar, 25 – 27 October 2006, Barcelona*
3. *FAST Generic Presentation, June 2006*
4. *Email from Rudi den Hertog to Patrick Hudson, 11 January 2007*

Appendix: Abstract of "If I were a rich man... ,"

Aviation Safety, pp. 365-383, H.Soekkha(Ed.), ©VSP1997

If I were a rich man ... , ... my accident record wouldn't be so bad!
On the influence of economic constraints on jet aircraft accident statistics

H.C. Visser, Fokker Services, P.O. Box 75047, 1117 ZN Schiphol-Oost, The Netherlands

Abstract - Understanding jet aircraft accident statistics has always been hampered by low average yearly accident numbers and unavailability of detailed utilization data. Hence, throughout the years only very few parameters have been identified that are a factor in (differences in) accident rates. As such have been recognized: original in-service entry date of the type and geographic region of operation. To attain a better understanding of the latter factor, an exercise has been undertaken to statistically investigate the differences in accident rates of the B737, DC9 and F28 aircraft. A major element in the approach has been to use the accident rates of the B737 and the DC9 and then apply the F28 utilization distribution for determination of how the hypothetical B737 and DC9 accident rates would have been if they would have been operated by the same mix of operators as the F28. The strength of the economy of the country of the operator appeared to be the overruling influence factor, explaining for most of the differences in accident rates. This finding indicates that addressing the traditional 'human factor' will not succeed in bringing down accident rates worldwide if the economic environment in which individual airlines operate (the 'prosperity factor') is left untouched.

Appendix B.8 Frederik Demeyere (IVW) *(reviewed)*

Feedback on results of first round

Id	Question	Answer
1.	Have you seen the results of the first round of interviews for CATS User Requirements and do you have feedback on it?	*FD was not involved in the first round of interviews regarding CATS User Requirements, but he has seen the results of the first round of interviews. His general view on CATS is that it should be a tool to determine where the biggest risks of an operation are.*

Safety culture

In FD's master thesis a model has been developed to adapt the way of inspection to the inspected organisation. This relates the organisation's safety culture and depends on:
- *Openness of communication towards inspection;*
- *How points for improvement are handled; and*
- *How the organization's self picture relates to the picture the inspection has.*

"Trust" is crucial in inspection. It is a subjective topic. Trust is based on results in the past and trends.

<u>The questions regarding Safety culture have not been dealt with in this interview; see the interview with Jos Wilbrink for IVW input to these.</u>

The level of detail CATS should have

Aircraft

Id	Question	
8.	Please indicate for the <u>aircraft</u> aspects given below: – (Y) if you find it important to zoom into this aspect; – (Q) if you even have questions to CATS in this respect; – (N) if you advise not to zoom in; and – (?) if you find it difficult to choose. Please indicate additional aspects you find important to detail or not.	
a)	Aircraft manufacturer	
b)	State of manufacturer	*? Relatively many Russian made aircraft crash, but is this due to Russian manufacturer or due to*

		Russian maintenance? *Y - It is important where maintenance is done.*
c)	Aircraft make/model	
d)	Number of engines (2, 3, 4)	*? Do not know whether this is necessary*
e)	Jet versus Turboprop	
f)	Generation of aircraft (1st – 4th)	*? Less is known about new generation aircraft. There are more accidents with older aircraft, but due to that also more improvement measures.*
g)	Certification of aircraft	*Y – It is important where is this done*

Flight operations/airline

Id	Question	
9.	Please indicate (Q/Y/N/?) for the flight operations/airline aspects given below:	
a)	Duty times/regulations	
b)	Safety culture	*Y – Important but complicated to deal with*
c)	Safety management system	*Y – Maturity of the SMS is important*
d)	Occurrence reporting system	*Y – This is the backbone of the SMS*
e)	Low cost carrier/traditional flag carrier	*The financial situation of the carrier is important, for instance in relation to maintenance.*
f)	Short haul/long haul flights	
g)	Flight crew fatigue	*Y – important aspect, see Transavia investigation*
h)	Cockpit automation	
i)	Workload	*Y - Related to g) as part of the general condition of the crew, and many other aspects.*
j)	Flight crew selection process	
k)	Experience of pilot	
l)	Crew resource management	
m)	Flight crew medical checks	
n)	Flight crew mental state (e.g., overconfidence, task saturation, alertness, get-home-itis)	
o)	Flight crew physical state (e.g., hypoxia, physical fatigue, intoxication, motion sickness)	
p)	Flight phase	*Y – but this is already taken into account*

q)	Navigation means (RNAV, RNP, ILS, VOR/DME, GPS)	*On airports, this is important*
r)	Dispatch/route planning	
s)	Aircraft loading	
t)	Aircraft de-icing/anti-icing	*YY – depending on destination*
u)	Paperless cockpit, EFB	
v)	Safety nets: TCAS, GPWS	*?*
w)	Cultural aspects	*Important where maintenance is done*
x)	Different cultures/language between pilots	*Y – The interface between pilots and ATC is more important (recall runway incursion in Paris)*
y)	Cross cockpit gradient (e.g., junior f/o, experienced captain)	
z)	Flight crew scheduling	
aa)	HMI characteristics	*Y – recent topic, opportunities for improvement. What can people still handle?*
bb)	Checklist layout	
cc)	Flight crew knowledge of systems, procedures	
dd)	Type of operation (Passenger, cargo, training, ferry, …)	
ee)	Operator country of residence	*Especially important via maintenance.*
ff)	Complaints to and from home base	

Air Navigation Services/Communication Navigation Surveillance

Id	Question	
10.	Please indicate (Q/Y/N/?) for the ATM/CNS aspects given below:	
a)	Class of airspace/level of services	*Y – There are often problems at transitions between classes. Especially a problem for General Aviation, less for commercial aircraft.*
b)	Traffic density	
c)	Airspace/air traffic complexity	*Y – Complexity is an important topic, both for airspace and airport. It is related to workload.*
d)	Applicable separation criteria	

e)	Type of control provided: start-up, ground, tower, departure, area, upper area, stack, approach, …	
f)	Influence of VFR traffic/general aviation	
g)	Way of control: radar, visual, procedural, …	
h)	Certification of ANSP	*Related to culture. In Western Europe this should be okay.*
i)	Special operation at airport: mixed mode, intersection take-off, backtracking on runway, …	
j)	Workload of controllers	*Y*
k)	Vigilance	
l)	NOTAMs applicable?	
m)	Single manned operations	
n)	Service provision separated from supervision/regulation?	
o)	Team resource management	
p)	Controller staffing level	
q)	Training standards, method, on the job training	
r)	ATCO experience	
s)	…	
t)	…	
u)	Weather information	*This is important but weather information provision is reasonably mature in Western Europe.*
v)	ATIS	
w)	Weather measurements	
x)	Weather forecast	
y)	Windshear warning system	
z)	…	
aa)	Means of communication: VHF, CPDLC, HF, SATCOM, …	
bb)	Phraseology, ATC clearances	*Quality of the English of pilots and ATC is important, as well as read back and hear back issues, call sign confusion and general confusion of tongues. Workload plays a role in these issues.*
cc)	Language (problems)	
dd)	English proficiency	
ee)	Loss of communication with ATC	
ff)	…	

gg)	…	
hh)	…	
ii)	Navigation means (ILS, VOR/DME, GPS, NDB, Loran, …)	
jj)	…	
kk)	…	
ll)	…	
mm)	Surveillance means (Primary/secondary radar, ADS, multi-lateration, …)	
nn)	Runway incursion alerting system/ stop bar alerts	

Airport

Id	Question	
11.	Please indicate (Q/Y/N/?) for the airport aspects given below:	
a)	Aircraft servicing, aircraft (re)fuelling, catering	
b)	Runway layout	*Y – in combination with work-load ATC and pilot*
c)	Runway/taxi way maintenance	*Y – complexity of airport is important*
d)	Runway/taxi way lightning and signs	
e)	Bird control	
f)	Airport technological capability: runway incursion alert system, stop bars, …	*Y – related to complexity and maturity*
g)	Security	*N – not relevant*
h)	Airport traffic mix	*Related to complexity and traf-fic load – workload.*
i)	Airport capacity	
j)	Runway layout: number of runway, crossings, di-rection	
k)	Obstacle clearance	
l)	Geographical location (mountains, etc)	*Is visibility often poor?*
m)	Towing operations	*Again related to complexity*
n)	Airport vehicles (operations/drivers)	
o)	Certification of airport	
p)	Noise abatement routes	
q)	Emergency services	
r)	Opportunity for crew rest	

Complexity is a central indicator. This aspect has to be specified by means of underlying aspects.

Maintenance

Id	Question		
12.	Please indicate (Q/Y/N/?) for the maintenance aspects given below:		
a)	Inspection intervals		*Culture and maturity of the maintenance organization is important*
b)	Maintenance scheduling		
c)	Training		
d)	Human factors training		
e)	Turn around times	*Also related to pilot workload*	
f)	Elements in the MEL		
g)	Master MEL		
h)	Place where major repairs are carried out		
i)	Type of maintenance that is outsourced		
j)	Technical support (portable computer)		
k)	Support through manuals (paper, cd's, interactive)		
l)	Service bulletins		
m)	Airworthiness directives		

Circumstances

Id	Question	
13.	Please indicate (Q/Y/N/?) for the circumstances of the accident given below:	
a)	Accident occurrence region	*Y – motivated before*
b)	Accident occurrence date	
c)	Accident occurrence time of day	*? – Possibly. Fatigue and working at un-natural hours (at night) may be important*
d)	Traffic conditions	
e)	Weather conditions	*Y – Poor visibility, fog*
f)	Runway conditions (wet, contami-nated, friction, …)	*Y*
g)	Special operations (winter operations)	
h)	Onboard medical urgency	*N – rarely cause for accidents; there are standard procedures.*

New developments

Id	Question	
14.	Please indicate (Q/Y/N/?) for the new developments given below:	
a)	New navigation means (RNP, GPS etc)	
b)	Head up Display	
c)	A380, B787	*Y*
d)	Wake vortex related issues	*Interesting for 380*
e)	Composite aircraft	
f)	Very Light Jets	
g)	Unmanned Aerial Vehicles	*Use CATS for*
h)	*New aircraft*	*Could be an example to apply CATS to.*

Organization

Id	Question	
15.	Please indicate (Q/Y/N/?) for the organization aspects given below:	
a)	Resource management	
b)	Organisational climate	*N – goes too far*
c)	Organisational process	
d)	Supervision (violations, inadequate, etc)	
e)	Self correction	
f)	Staffing/manning	
g)	Background checks	
h)	Monetary/Budget Resources	*? – Possibly relevant for airline*
i)	Corporate communication	
j)	(Safety) policies	
k)	Promotion	
l)	Accident investigations	*Y – occurrence investigation crucial*
m)	Culture, values, beliefs, attitudes	*Y – discussed before*

Transparency of CATS for its users

Id	Question
16.	Prospective users indicate that CATS should not be a black box: it should be transparent and understandable. How would you advise achieving this? What mathematics or modelling will be entrusted to the CATS experts, what needs to be made explicit and explained?
	• *The interface of CATS needs to be layered: managers and experts want to know different things: managers want to get the gist; experts want to get to the details.*

- *It is an implicit assumption that CATS will be a software package.*
- *User friendliness of CATS is crucial.*
- *Developers will be needed for the analysis of large changes.*
- *Reliability of CATS is an assumption, necessary for trust and usage.*

Appendix B.9 Erik Lagerweij and Johan Blom (Schiphol Group)

Feedback on results of first round

Id	Question	Answer
1.	Have you seen the results of the first round of interviews for CATS User Requirements and do you have feedback on it?	*The respondents did not participate to the first round.* *The conclusions of the first round were discussed with them, they had the following comments:* • *The primary goal of CATS should be to be a tool to support decision making regarding important changes in air transport. CATS is a supporting means as common sense will always be involved as well.* • *CATS should not be used as a monitoring tool.* • *CATS is still very theoretical, and the interviewees do no trust it yet. It should be much simpler and more pragmatic to gain confidence.* • *JB: be careful with quantifying something that is not reliable.* • *EL: start with a simple model that can already give some insight and that can be developed to a more complicated model later on. Do not make the model very complicated from the beginning. The challenge is to make the model so simple that the users will complain about the simplicity.* • *There is a discrepancy between the sector and DGTL regarding CATS: the sector wants a simple and pragmatic tool, whereas DGTL wants to score internationally and hence wishes a state of the art tool.* • *The interviewees understand that the input can be complex, but they stress that the output should be easy to understand.* • *In the early stages of CATS, it would not be a bad idea to have it as a demo on CD ROM to familiarize future users.* • *Of the three sector partners, LVNL is most advanced in system thinking, with their VEMERs. Schiphol is eager to get on the same level in system thinking.* • *CATS should also serve to support decision making regarding short term changes, as more mistakes are made with these. Long term changes usually are usually carefully examined before decisions are made.* • *Because air transport is one single process, consider it integrally. CATS should become a sector tool to be used by different sector*

	parties (KLM, LVNL, Schiphol) together, and not aim at the individual user. CATS should help to develop one single language amongst the participants. CATS should first be used by the different sector parties separately, and lessons should be learned from trial runs, but it should be taken care that it is developed as an integral tool for the sector; otherwise the coupling could lead to problems. • *If CATS is developed as a tool for the entire sector, the interviewees foresee a problem with the confidentiality of the data needed, and with the non-uniformity of definitions. VPS will work on this item.*

Safety culture

Possible safety culture indicators, their priorities and how to make them concrete

Id	Indicator	3. Prio (H/M/L)	4. How to make concrete?
a)	Priority of safety in decision making, at all levels of the organisation.	*H*	• *How often is safety mentioned in internal reports?* • *Can safety be found back in the decision making?* *(Schiphol is in a transition from concrete and construction to an organization taking part in developing aviation safety.)*
b)	Safety issues reporting system: Existence of such a system, possibility for confidential and non-punitive reporting, percentage of incidents that are reported.	*H (very important)*	
c)	Training: training on the job, training focussed on safety issues, training in emergency situations.	*H*	

d)	Safety procedures: installation of safety procedures, expectation to follow these procedures, how these procedures are actually followed, regular revision of the procedures.	*H*	*Note: This relates to training; the importance of safety procedures depends on the target group: highly trained people need fewer procedures.*
e)	Safety department: existence and quality of a safety department, how is it organised.	*M*	*Double feelings with respect to this:* • *Safety issues are not solved by a safety department. Safety should be in the genes of the members of the entire organization.* • *However, a safety department is actually important for independent investigation of accidents, for instance.*
f)	Proactiveness with respect to safety issues.	*H*	

Id	Question	3. Prio (H/M/L)	4. How to make concrete?
2.	Do you have any other suggestions regarding indicators for safety culture?		
g)	*How have you been educated, where do you come from, what are your norms and values?* *This defines your values and attitudes towards safety.*		

h)	*The attitude towards safety of the CEO*	• *Does he come from a safety conscious environment? or* • *Is he more concerned with grabbing every occasion to make profit?*
i)	*Balance safety against making profit.*	

Good and bad safety culture and how this affects safety

Id	Question	Answer	
5.	Do you think the level of safety culture should be expressed in a one-dimensional quantity in CATS, or would you prefer to characterize it through a list of indicators?	• *It should be the other way around: Safety culture should not be included in CATS, it has to be a boundary condition for the use of CATS.* • *The level of safety culture will rise from incident data, if not, it is not relevant.* • *Use CATS to indicate the grey areas, and not for instance to include the origin of 1000 carriers. Rather focus on the home carrier that takes care of 80% of the flights or, if the other 20% of the carriers lead to 80% of the accidents, take those into account. The involvement of accident data should clarify this.*	
6.	For which kind of organisations do you think the level of safety culture needs to be incorporated in CATS? (Please indicate priority H/M/L)	Kind of organization	Prio (H/M/L)
		a) Airline	
		b) ANSP	
		c) Airport	
		d) Manufacturer	
		e) Maintenance	
		f) Inspection	
		g) Regulator	
		h) ...	
		i) ...	
7.	How does safety culture influence safety? By what mechanisms?		

General remarks on safety culture:

- *If CATS is kept simple, it will be reliable and will therefore be used by the sector, which promotes safety culture.*
- *Safety is related to quality. It is important for a reliable and smooth operation. Safety therefore should be an integral part of management.*

The level of detail CATS should have

General remarks on the level of detail CATS should have:

- *Begin simple with what is available.*
- *In choosing aspects to detail further, it is important to look at what is flying around in the Netherlands.*
- *Look historically where the safety leaks are. Select one or two cases and work these out in detail. Better one or two cases well done, than ten cases done in a shallow way.*
- *Ask experts about the important details, we are not in the position to prioritize them.*
- *Do not in advance choose what aspects to zoom into. To choose what aspects to zoom into, a hierarchical top-down approach should be used: investigate what high level aspects play an important role in accidents and incidents, zoom into the details of that aspect, et cetera. It therefore is the role of the CATS modellers to find what aspects should be zoomed into.*
- *You want to be proactive, but to this end one should be reactive and analyse the past to make choices for the future. Use the facts to choose what should be taken into account and what not.*

Transparency of CATS for its users

Id	Question
8.	Prospective users indicate that CATS should not be a black box: it should be transparent and understandable. How would you advise achieving this? What mathematics or modelling will be entrusted to the CATS experts, what needs to be made explicit and explained?
	This question was to a large extent answered in question 1: CATS should be easy to understand and pragmatic; not only the modellers should be able to understand it, but also the sector, and the people living in the environment of the airport, since decisions that affect them are supported by CATS. Perceptions of people in the neighbourhood should be managed – take care that expectation are matched with comprehensible results. JB participates in CROS – initiatives such as CATS are followed.

Miscellaneous remarks:

- *The User Requirements are identified very late – the CATS modelling people are already like a steam train on speed. Independent of the evaluation of CATS, the process will go on. We try to steer the project in the right direction – the target is that people will use CATS.*
- *It is important to hear back what is done with the input!*