	HUMAN Model-based Analysis of Human Errors during Aircraft Cockpit System Design	

D4.6 - Detailed experimental design for cycle 2

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1 Table of Contents

2 Abbreviations and Definitions

Abbreviation	Definition
A/C	Aircraft
AFMS	Advanced flight management system
AHMI	Airborne human machine interface
ATC	Air Traffic Control
CASCaS	Cognitive Architecture for Safety Critical Task Simulation
CDU	Control Display Unit
CFL	Cruise Flight Level
CL	Cognitive lockup
EPM	Error production mechanism
FCU	Flight Command Unit
FMA	Flight Mode Annunciation
FMGC	Flight Management Guidance Computer
GECO	Generic Cockpit (Flight Simulator at DLR)
HLTC	High-level test condition
INT	Interception Altitude
LC	Learned carelessness
LLTC	Low-level test condition
RoT	Rigidity of Thought
RWY	Runway
WYP	Waypoint
TSS	task set switches
TOC	Time occupied
LIP	Level of information processing

3 Introduction

This deliverable provides details on the experimental design (including the experimental scenarios and schedule) and the working hypotheses for the second experimental cycle. The deliverable 2.8 described these aspects on a more generic level.
The deliverable is structured as follows: in section 4, the experimental setup for the error production mechanism *learned carelessness* is described. In section 5, this is done for the error production mechanism *cognitive lockup*, followed by *selective attention* in section 6. In section 7, the overall experimental setup is described.

4 Experimental Setup Learned Carelessness

4.1 Description

The EPM Learned Carelessness belongs to the class of EPMs that in the literature is called "**Rigidity of Thought**". It is characterised by the following statements:

- familiar situations trigger familiar patterns of thought
- the first idea that comes to mind prevents alternatives being considered

We consider two instantiations of the class:

1. Learned Carelessness
2. Mind Set Effect

Learned Carelessness:

Learned Carelessness (LC) is a psychological theory of Frey and Schulz-Hardt (Frey & Schulz-Hardt, 1997) which we use as an explanation of particular pilot errors and as a basis for the implementation of an error producing mechanism in our cognitive architecture CASCaS. We assume that pilots have mental models of how to interact with cockpit systems, like the AHMI/AFMS. The mental model of flight procedures is initially formed based on normative flight procedures acquired through handbooks and in simulator training sessions. Then during repetitive performance the mental model is modified by cognitive learning processes like LC.
The theory states that humans have a tendency to neglect safety precautions if this has immediate advantages, e.g. it saves time because less physical or cognitive resources are necessary. Careless behaviour emerges if safety precautions have been followed several times but would not have been necessary, because no hazards occurred. Then, people tend to omit the safety precautions and the absence of hazardous consequences acts as a negative reinforcer of careless behaviour.

In the context of avionics systems safety precautions may be understood as checking the current state of annunciations (like the vertical view on the AHMI) before performing critical actions (like engaging a modified flight trajectory). LC is characteristic for human nature because we have to implicitly simplify in order to be capable to perform efficiently in a complex environment. Resulting behaviour is highly adapted to routine scenarios but, unfortunately, may lead to errors and hazards in non-routine situations.

Mind Set Effect:
The Mind Set Effect, also often referred to as a problem solving set, describes a person's predisposition to solve a given problem in a specific manner even though there are "better" or more appropriate methods of solving the problem. The most famous example for this effect is the water jar experiment (Luchins & Luchins, 1959), in which subjects were asked, to solve a series of water jar problems. After solving many problems using the same solution, subjects applied this solution also to problems where a simpler solution exists.

4.2 Requirements

For the second cycle experiments we differentiate between Learned Carelessness and the Mind Set Effect with regard to the number of task repetitions that are necessary to provoke the EPM. For Learned Carelessness a significant larger number of repetitions is necessary compared to repetitions needed for the Mind Set Effect (Luchins provoked this effect with just five repetitions). This can be explained by the interference with other tasks: while for the Mind Set Effect the task is not interrupted by other tasks, i.e. the task repetition follows immediately, this is not necessary for Learned Carelessness, i.e. the repetition can follow after other tasks have been performed. In the following we use the class **Rigidity of Thought (RoT)** to refer to both, Learned Carelessness and Mind Set Effect.

In our research, we consider three parameters as the main drivers for RoT:

1. the frequency with which checks are performed,
2. the frequency with which particular values are perceived during these checks
3. the cost of percept actions.

RoT is relevant to explain behaviour of proficient users who have gained some level of experience in the operation of a system. Psychology differentiates between inductive and deductive learning. Inductive learning means acquiring new knowledge, e.g. knowledge about how to operate a system. Deductive learning means reorganizing knowledge that has been acquired before. Reorganizing enables a more efficient use of the knowledge in similar situations. RoT can only be observed during deductive learning. Consequently, the inductive learning phase has to be completed before RoT can occur.

4.3 High Level Test Conditions

The high-level test condition (HLTC) for LC is defined by the following 7 characteristics:

1. *T* is a task which is triggered by an event E.
2. T involves performing a check C of flight parameter P which can either be true or f*alse*:
   - if *true* subtask T_{sub1} has to be performed,
   - if *false* subtask T_{sub2} has to be performed,
3. A sequence of scenarios is flown in which *E* occurs *n* times and *T* (including *C*) has to be performed. The result of *C* in all these task repetitions is always the same (either always *true* or always *false*) which means that always the same subtask (either always T_{sub1} or always T_{sub2}) has to be performed.
4. During the *n*+1 repetition of *T* flight parameter *P* is manipulated in such a way that C delivers a result which is different from the results during the *n* preceding repetitions. Consequently, the other subtask has to be performed this time.
5. Check C requires a certain cost (e.g. performance time).
6. Omitting check C has a certain risk.
7. Check C has to be identifiable in the recorded data (e.g. in the gaze data, voice recordings or physical actions) – empirical indicator

4.4 Low Level Test Conditions

The following table specifies the checks that are possible during an uplink:

Check No.	Parameter to be checked	Condition to be checked	T_{sub1} if condition is true	T_{sub2} if condition is false	Independent Variable
1	Check first WYP of flight plan in horizontal view	First WYP is behind the aircraft	LOAD, GENERATE VIA	CONTINUE	A/C position at uplink
2	Check flight plan at RWY in horizontal view	Flight plan does not end at RWY	REJECT	CONTINUE	Position of last WYP of flightplan
3	Check trajectory in horizontal view	Trajectory contains a circle	GENERATE VIA	GENERATE	A/C position at uplink
4	Check CFL in vertical view	CFL is below INT altitude	REJECT	CONTINUE	Altitude of CFL
5	Check intercept altitude in vertical view	Intercept altitude differs from published intercept altitude in chart	REJECT	CONTINUE	Intercept altitude
6	Check descent profile of the final approach	Vertical profile does not end at RWY	REJECT	CONTINUE	Altitude of last WYP of flightplan

	in vertical view	elevation			

4.5 Elaboration of the Working Hypothesis

In the following sections, the working hypothesis is described in more detail, i.e. the independent variables are identified, operationalised and the working hypothesis is instantiated.

4.5.1 Independent Variables

In order to provoke RoT, we foresee three independent variables:

- CHECK EFFORT: the 6 checks differ in effort (e.g. time needed)
- CHECK HISTORY: every check is performed n times (n task repetitions), this leads to a sequence of check results. We distinguish two patterns:
  - constant pattern: true, true, true, true, true ....
  - random pattern: true, false, false, true, false, ...
- CHECK RISK: every check is associated with a certain risk – consequences for the flight if pilots omit the check (e.g. required extra time for recovery, severity of consequences –minor, major, catastrophic)

4.5.2 Operationalisation of Independent Variables

The following table provides an operationalisation of the independent variables CHECK EFFORT, CHECK HISTORY and CHECK RISK:

Parameter	**Operationalisation**
CHECK EFFORT	Required time for T in cases where C is performed. This time will always be related to risk. If the risk is low, even the shortest check will be subject to "operationalized omission". Regardless of the time, effort can here mean that the check requires rather non-intuitive steptasks, such as switching to an undesired map-mode, no „point-and-shoot" philosophy - which is e.g. when a pilot can accomplish the motor action at or near the same place as the motor action, e.g. motor action on FCU and/or CDU and checking on the FMA would be the contrary to point-and-shoot and needs considerable, error-prone check effort.
CHECK HISTORY	Every check is performed *n* times, this leads to a sequence of check results. When this sequence has a significant higher amount of "true", i.e. all but 1, or a similar "false-true-

	pattern", experimental learning will contribute to a history that leads to LC. Example: Turkey has a very limiting speed restriction in all terminal control areas (e.g. below FL240 within 60NM around an airport). As this speed restriction is so seldom wanted by ATC, and would lead to a very uneconomic descend, all pilots delete this speed restriction which is set as a default value in the FMGC database. If this speed restriction is needed, however, the effort to decelerate and descend with a top-of-descent calculated for a higher descent-speed is quite high, sometimes delay vectors are needed to lose altitude in such a case.
CHECK CRITICALITY	Consequences for the flight if pilots perform T assuming that C is false while actually C is true (e.g. required extra time for recovery, severity of consequences –minor, major, catastrophic)

4.5.3 Working Hypothesis

Based on the three independent variables we define the following working hypothesis:

> **If** CHECK EFFORT for *C* is "high" and
> CHECK RISK for *C* is "low" and
> CHECK HISTORY for *C* is constant,
> **Then** pilots will omit check *C* because of Rigidity of Thought.

4.5.4 Test Condition

For testing the hypothesis, the subjects should implement multiple uplinks in very short scenarios. All uplinks have a similar setup: The subject starts without any trajectory. Then an initial uplink is send by ATC, which the subject has to implement or to reject. If any of the checks fails, the subject must react as specified in section 4.4. As it is currently not possible to instantiate the EFFORT and RISK parameters for the checks, we will have a debriefing at the end of the experiments, where the subjects rate the risk and effort for each check.

For the experiments, we foresee an inter-pilot design, i.e. the subjects are divided in two groups A and B. Group A is the group where we will induce LC, while group B is a control group, i.e. for group A there CHECK HISTORY parameter will be always constant (no fails of the checks), while group A will have a (pseudo) random instantiation of the HISTORY parameter (randomly checks will fail).

The simulation schedule of the scenarios for learned carelessness can be found in the Appendix (section 9.1).

4.6 Scenarios

Learning from the first cycle of experiments the scenario design for the second cycle was more focused to the EPMs to generate and from the beginning a central part of the preparation phase. During two workshops with pilots and dedicated telephone conferences events have been specified that are likely to trigger a specific EPM. These events were then composed into longer scenarios. According to the hypotheses for each event an experimental scenario and a control scenario have been designed to vary the influence of independent variables like time pressure. As a result of this design process dedicated scenarios for Learned Carelessness (LC) and Cognitive Lockup (CL) have been created and an overall test schedule was designed where the scenarios did not influence each other and that is interesting, not foreseeable and not too exhaustive for the pilot.

4.6.1 Scenarios to generate and test Learned Carelessness (LC)

Following the hypotheses that LC is likely to happen after a number of repetitions it was decided to generate scenarios that only consist of one procedure and are conducted in an artificial environment reducing the complexity of the full featured cockpit to the necessary displays. To generate a constant low level of additional workload a secondary task was added that needs constant attention but is otherwise not related to any other cockpit task. Consequently the experiments to generate LC are not conducted in the GECO but in the Avionic Test bed. For the main task (the ATC uplink procedure) only two screens in front of the pilot (AHMI and PFD) and a mouse pointing input device are used. For the secondary task an additional monitor and mouse are placed slightly to the left.

In all a number of 28 scenarios have been created consisting of 4 different routings into Frankfurt Airport and for each routing one scenario where all 6 test conditions mentioned in chapter 4.4 are false and 6 scenarios with one condition set to “true”. For the training one additional scenario was created where all conditions where true in order to show the possible errors once to the pilot.

Each scenario started somewhere on the route around 180nm away from the arrival airport. After 20 seconds that were needed to set up the scenario controller and start all software programs an ATC uplinks pops up on the AHMI and the pilot handles the uplink. A few seconds after the pilot has engaged the generated trajectory or rejected the uplink the scenario is stopped and the next scenario is started automatically. One LC sessions consist of 30 scenarios lasting about 35 minutes.

Following the hypotheses for LC each pilot in the experimental group conducted 5 sessions where all test conditions were set to “false” to build up LC and encountered errors only during the last 6th session where LC is tested. In the control group all sessions contained some scenarios with one test condition set to “true”. See also the appendix in section 9.1.

4.6.2 Experiment Design

The LC sessions takes place in the Avionic Test bed and start with a training phase where the pilot monitoring instructs the subject pilot how to operate the AHMI and how to implement the ATC uplink. After the training phase when the

experiment leader and the pilot monitoring agree about the training status of the subject pilot the experimental phase starts.
During the experimental phase the session is controlled by a script where the scenario sequence runs automatically. Each scenario finishes either by the successful activation of the generated trajectory or by the rejection of the uplink. During the session an observer notes each check during the implementation of the uplink in table.

4.6.3 Training

Following buttons, functions and procedures are introduced and trained:

- Introduction to the avionic test bed
  - Displays
  - Mouse

- Introduction to the AHMI
  - Horizontal display
    - Pre-selected and Active Flightplan
    - Horizontal profile
    - Moving of the map
    - Zooming (without mouse wheel)
    - Switching between horizontal and vertical view
    - Switching between ARC and ROSE mode

  - Vertical display
    - Vertical profile
    - Function of the CFL
    - Speed profile
    - Function of the INT altitude
    - Function of altitude constraints
    - Explanation of the ROSE/ARC mode and A/C placement

- Instruction and training of procedure of how to handle uplinks
  - Generation of a trajectory
  - Negotiation of a trajectory with ATC
  - Activation of a trajectory after a clearance is received
  - Speak aloud procedure (during training only!)

- Instruction of how to check the flight plan and the trajectory for correctness
  - Demonstration of possible mistakes in the flight plan and trajectory
  - Procedure of reject button

- Explanation and introduction to the secondary task

4.6.4 Instruction for experiment leader

The instructor is required to adhere to the following standards:

- Give an introduction to the AHMI and its functions by demonstrating the uplink procedure. Thereby control the mouse on your own
- Let the subject control the mouse and handle the upcoming uplinks
- Explain along the LC training scenario that contains every mistake in the flight plan and trajectory the required checks
    - Do not establish a certain procedure for the checks
    - Establish speak aloud procedure for the duration of the training

- Make sure that the subject is able to handle an uplink without any help and performs all checks correctly, whereupon the order of how the checks are performed is not important
    - End training session if this condition is given, otherwise give additional instructions and provide further uplinks for training.
- Do not interfere during the simulation runs if possible
- Observe the subject and quote if he has performed each respectively check or not

5 Experimental Setup Cognitive Lockup

5.1 Description

In this section a short review is conducted on the phenomenon cognitive lockup.

5.1.1 Defining cognitive lockup

Moray and Rotenberg (1989) were the first who used the term cognitive lockup for the tendency of system operators to deal with disturbances sequentially. In an experiment where system operators had to detect fires on a ship and deal with a fire accordingly, it appeared that the operators preferred to work on only one fire at a time, which hindered the recognition or management of further fires. They found that any response to fires occurring late in a ‘cascade’ of fires was greatly delayed, even if the later fires were more serious than earlier fires. Kerstholt, Passenier, Houttuin and Schuffel (1996) conducted research to find further support for the cognitive lockup phenomenon. In their experiment participants had to supervise different independent dynamic subsystems on a ship and deal with disturbances whenever they occurred. The system included an option to stabilize a subsystem in which an additional disturbance occurred. Most participants handled the disturbances sequentially: full attention was given to the first disturbances and subsequent disturbances were ignored. So, Kerstholt et al. (1996) also found in their experiment the tendency of operators to concentrate on one disturbance at a time, ignoring the rest of the system. Therefore, we define cognitive lockup as the tendency to deal with disturbances sequentially.

5.1.2 High workload as explanation for cognitive lockup

Cognitive workload refers to the information processing demands imposed by the performance of cognitive tasks (Johnson and Proctor, 2004). In order to predict the cognitive load of a specific task, Neerincx (2003) developed the cognitive task load (CTL) theory. This theory proposed three underlying factors of cognitive task load: (1) time occupied (TOC), (2) number of task set switches (TSS), which is the number of active tasks in execution or planned to do, and (3) level of information processing (LIP). Neerincx (2003) suggested that cognitive lockup would occur when time occupied and the number of task set switches are high. Grootjen, Neerincx and Veltman, (2006) conducted experiments in order to validate the CTL theory. In these real-life experiments participants had to deal with emergencies that appeared on a ship. They found that when all three factors were high people experienced cognitive overload; they did not know what to do.
Meij (2004) investigated whether a lack of cognitive resources could be an explanation for cognitive lockup. He argued that tasks that require a more complex diagnosis process are expected to demand more cognitive resources and thus cause a higher cognitive workload and might cause cognitive lockup. He found, however, that the level of complexity of information processing did not affect the degree of cognitive lockup.

We thus hypothesize that cognitive workload is an underlying factor for cognitive lockup, and that the two factors *time occupied* and *task set switches* play a role in producing cognitive lockup.
In the following, we test this hypothesis.

5.2 Requirements

As a result of the literature, we consider two parameters as drivers for cognitive lockup:

- Task switch sets (TSS)
- Time occupied (TOC)

We assume that the tasks all have a high level of information processing. Even though the level of information processing does not seem to be relevant for the occurrence of cognitive lockup (see Section 5.1.2), it heightens the workload of the pilot. In addition, as in the cognitive model, cognitive lockup is modeled at the moment on the cognitive layer, the level of information processing should lie on the cognitive layer of Rasmussen's (1986) model.

5.3 High-Level Test Conditions

For Cognitive Lockup (formerly referred to as attention capture), we have defined the following high-level test conditions.

1. T_W is a task which is triggered by an event E_W.
2. T_W is a task which increases the task set switches (TSS) significantly. It also has a high level of information processing and increases the time that

the pilot is occupied (TOC) (it thus should not be a task that is finished fast).
3. E_W occurs as early as possible in the scenario to increase the time that is occupied by T_W (TOC_{TW}) as much as possible.
4. *T_S is a task (or a set of tasks) that has a high level of information processing and is triggered by E_s.*
5. *E_S occurs and triggers T_S.*
6. T_{CL} is a task which is triggered by an event E_{CL}. T_{CL} has a high priority and a high level of information processing.
7. E_{CL} occurs as late as possible in the scenario to increase the time completion of T_S.
8. The pilot perceives E_{CL}.
9. The pilot will change after time *t* to task T_{CL}

Hypotheses:
1. If there is T_W, then execution time of Task T_{CL} is either beyond operational efficiency or T_{CL} is not executed at all.
2. The reaction time for E_{CL} is higher when there is a T_W than when there is no T_W

5.4 Elaboration of Working Hypotheses

5.4.1 General comments

In this experiment, we do not aim at proving the mechanism of cognitive lockup in a psychological valid way. As we choose to experiment in an as realistic situation as possible with subject experts (real pilots), a psychological valid experiment is not feasible.
For that reason, we do not plan to vary all independent variables. As described in Section 5.1, Neerincx (2003) hypothesized that being occupied a high percentage of the time and a high number of task set switches leads to cognitive lockup. What we try to aim at is to validate whether these independent variables, if set to the value where cognitive lockup is expected, actually leads to cognitive lockup in realistic scenarios and real-world tasks. We do not claim that these independent variables, set to these conditions, are a necessary condition for cognitive lockup, but that they are possible conditions for cognitive lockup.
In addition, we would like to get a first idea of the probability of having cognitive lockup in the specified situations (how often does it occur etc.).

5.4.2 Independent variables

In order to provoke cognitive lockup, we foresee the following independent variables:
- Task set switches (or the number of tasks that the pilot is executing) (TSS)
- Time the pilot is occupied (TOC).

5.4.3 Operationalization

In Table 5.1, the values for the independent variables for the test conditions are given. As can be seen, the values for both TSS and TOC in the test conditions for cognitive lockup are high, whereas the values for the control conditions are medium.

	TestConditions1		TestConditions2		TestConditions3		TestConditions4	
	Control	CL	Control	CL	Control	CL	Control	CL
TSS	Medium	High	Medium	High	Medium	High	Medium	high
TOC	Medium	High	Medium	High	Medium	High	Medium	high

Table 5.1: The values for the independent variables for the test conditions

5.4.4 Dependent variable cognitive lockup

This variable is measured and analyzed in two different ways:

- Cognitive lockup is measured as the percentage of scenarios in which participants switch to T_{CL} too late. Being too late is measured by not being able to execute T_{CL} normatively, and thus making an error in the normative behaviour.
- Cognitive lockup is also measured as the relative action time to switch to T_{CL}

This distinction in the analysis has been made to make the analysis more sensitive to cognitive lockup. In the first definition cognitive lockup is only found when participants do not switch 'on time' to T_{CL}, which can be seen in the normative behaviour and will lead to safety-critical situations. In the second definition cognitive lockup is found when participants significantly delay their switch to T_{CL}. The second analysis is therefore more sensitive to finding cognitive lockup than the first analysis.

5.4.4.1 Working hypotheses

According to the two different ways of defining/measuring cognitive lockup, we have the following two working hypotheses:

Working hypothesis 1:

If the
TSS is '*high'*
TOC is '*high'*
Then
The switch to task T_{CL} is not done on time.

This hypothesis is qualitatively evaluated by domain experts, who will evaluate per situation of the pilot whether the pilot has reacted correctly or not.

Working hypothesis 2

If the

TSS is '*high*'
TOC is '*high*'

Then

The reaction time t for T_{CL} is higher than in situations where TSS and TOC is lower

This hypothesis is qualitatively evaluated by determining the reaction time of the pilots in the test condition and compared to the same situation without the TSS and TOC having the value '*high*'.

5.5 Test conditions

The low level test conditions are described using Table 5.2.

Parameter	Description	Instantiation	Variables	Values
E_W	Event that triggers T_W			
T_W	Task that includes a high TSS, has a high LIP and a high TOC			
E_s	*Event that triggers T_S*			
T_S	*Task (set) that has a high LIP*		TOC LIP TSS	
E_{CL}	Event that triggers T_{CL}			
T_{CL}	Task that has a high priority		TOC LIP TSS	
T	Reaction time for T_{CL}			

Table 5.2: Parameter definition of the low level test conditions.

5.5.1 Test conditions 1

5.5.1.1 Textual description

The scenario starts before the beginning of the approach phase. The context is an airport with 2 runways (e.g. 14 and 28).

An anti-skid failure occurs and the pilot is informed about the constraints on the runway length. The current runway is not too short. Later, an autopilot failure occurs. In addition there is a thunderstorm close to and later in the missed approach sector of runway 14.
During the approach, ATC sends an UPLINK for a RWY change. The new runway does not have the thunderstorm close-by. The pilot needs to do the implementation of the runway change, including the new approach briefing. It is expected that the pilot's reaction time to the runway change is later (than in the control scenario), and that he might forget to check the length of the new runway to keep the constraints because of the anti-skid failure (even though the runway is not too short).

5.5.1.2 Test conditions

In Table 5.3, the first low-level test conditions are specified.

Parameter	Description	Instantiation	Variables	Value
E_W	Event that triggers T_W	Autopilot failure		
T_W	Task	To fly in selected mode	TSS	High
			TOC	High
			LIP	High
E_s	Event that triggers T_S	none		
T_S	Task (set) that has a high LIP	approach monitoring monitor thunder storm anti-skid failure	TSS LIP TOC	Medium High Medium
E_{CL}	Event that triggers T_{CL}	ATC uplink		
T_{CL}	Task	Check/implement runway change - Approach briefing	priority T_{CL}	High

T_{CL}^{+}	Task that measures if CL leads to a 'real' error	monitor constraints anti-skid failure	Priority T_{CL}^{+}	High
T	Reaction time for T_{CL}			

Table 5.3: Low-level test conditions 1

The difference between the control scenario and the scenario in which we expect cognitive lockup is the occurrence of E_W, followed by T_W.
For T_{CL}, working hypothesis 2 is being evaluated, as the reaction time to E_{CL} can directly be compared to the reaction time to E_{CL} without a task T_W. In addition, it is possible to evaluate working hypothesis 1, as it is also possible to recognize in the normative behaviour at what point in time it is too late (and thus an error) to react to E_{CL}.
For T_{CL}^{+}, it is not possible to evaluate working hypothesis 2, as no comparison can be made to a reaction time to handle this task. Only working hypothesis 1 will be evaluated for T_{CL}^{+}, as for this task, it can clearly be seen if the task is not executed (the anti-skid failure constraints are not taken into account when accepting the new runway, and the pilot realizes too late that he cannot land on the accepted runway).
When evaluating working hypothesis 1 for T_{CL}^{+}, task T_{CL} can be seen as being part of the task set T_S. As T_{CL} is not a task with a very high TSS and TOC, the overall TSS and TOC can still be seen as being medium.

5.5.1.3 Measuring Cognitive Lockup

5.5.1.3.1 T_{CL}

For T_{CL}, the second working hypothesis is applicable. That means that we expect that T_{CL} will be executed later than without TW. For that reason, the reaction time needs to be measured. For that, we need to measure the following:

- the moment that the pilot sees the uplink. This needs to be measured for two reasons:
  - for cognitive lockup, we need to be sure that the pilot sees the event, and knows that there is a task that he should execute. Cognitive lockup occurs if the pilot does not change to the task, even though he knows that the task could be executed at that moment.
  - this would be the starting point for the reaction time for the event. The reaction time would then be calculated by the moment of the first action of the task minus the moment in time when he saw the uplink
- the first action of the runway change, e.g. checking the profiles, pressing the generate button etc.
-

5.5.1.3.2 T_{CL}^{+}

For T_{CL}^{+}, the first working hypothesis is applicable. That means that we expect that the pilot does not execute a task that a domain expert would deem necessary in a particular situation, and deviates from acceptable behaviour. For that, we need to measure the following:

- When the anti-skid failure occurs, it is necessary to know whether the pilot realizes the new constraints on the runway.
- Whether the pilot rejects or accepts the runway change. He should not accept the uplink, as the new runway is too short
- Whether the pilot briefs the PM about the runway

5.5.1.4 Control condition 1

The control condition looks the same as the test condition 1. However, there will be no autopilot failure. The data that needs to be recorded and evaluated is the same as for the test condition, for both T_{CL} and T_{CL+}.

5.5.2 Test conditions 2

5.5.2.1 Textual description

The scenario starts before the beginning of the approach phase. The context is an airport with 2 runways (e.g. 14 and 28).

An autopilot failure occurs before the approach phase begins. Approach briefing is completed.

ATC sends an UPLINK for a RWY change. This is done very late in the approach phase, which leads to a high time pressure. The approach briefing needs to be done again. The new approach has an approach altitude that is higher than the old one (e.g. instead of 4000 ft, the new approach starts at 5000 ft). Because we are in selected mode, the autopilot does not automatically change the value. The pilot needs to select the new altitude himself. It is expected that the pilot will do this too late (or after having left the glide slope) as he is busy with the approach briefing.

5.5.2.2 Test conditions

In Table 5.4, the second low-level test conditions are specified.

Tasks:

- Fly in selected mode
- Approach
- Runway change

Parameter	Description	Instantiation	Variables	Value

E_W	Event that triggers T_W	ATC uplink late in the approach phase		
T_W	Task	Runway change in the last phase of the approach	TSS	High
			TOC	High
			LIP	high
E_s	Event that triggers T_S	None		
T_S	Task (set) that has a high LIP	approach monitoring selected flying	TSS LIP TOC	Medium High Medium
E_{CL}	Event that triggers T_{CL}	ATC uplink		
T_{CL}	Task	Handle ATC uplink	priority T_{CL}	high
T_{CL}^+	Task that measures if CL leads to a 'real' error	monitor general constraints of new trajectory	Priority T_{CL}^+	high
T	Reaction time for T_{CL}			

Table 5.4: Low-level test conditions 2

The difference between the control scenario and the scenario in which we expect cognitive lockup is the timing of the occurrence of E_W, followed by T_W.
In the control scenario, the uplink with the runway change is triggered earlier in the approach phase, leading to a less high time pressure.

5.5.2.3 Measuring Cognitive Lockup

5.5.2.3.1 T_{CL}

For T_{CL}, we expect that T_{CL} is executed later in the test scenario than in the control scenario. This means that the following data should be collected:

- The scenario time at which for the first time, the altitude is changed according to the new trajectory.
- The difference between the glide slope value that the lane should follow at that moment and the actual deviance from the glide slope

5.5.2.3.2 T_{CL+}

For T_{CL+}, it might be the case that the pilot is too late in monitoring the altitude constraints and manually changing the altitude. This is not really expected, but still it might be possible. In this case, the videos are needed, and a domain expert (or several) could determine whether an actual error has occurred.

5.5.2.4 Control conditions 2

The only difference between the control condition and the test condition is the timing of the runway change. The triggering of a runway change late in the approach adds a lot of workload, compared to the runway change earlier during the approach. This is mostly the case as the time pressure is varied. In the control condition, the runway change is uplinked early in the approach phase, which will also lead to a change in altitude, but it is expected that the pilot will monitor this altitude change correctly and timely.

5.5.3 Test conditions 3

5.5.3.1 Textual description

The scenario starts before the beginning of the approach phase. The pilot receives several ATC uplinks with radar vectors. ATC sends an UPLINK for a RWY change, which leads to an interception of the profile from above. We expect that the pilot is busy with the runway change and does not monitor the speed and height constraints.

5.5.3.2 Test conditions

In Table 5.5, the third low-level test conditions are specified.

Parameter	Description	Instantiation	Variables	Value
E_W	Event that triggers T_W	ATC uplink/runway change		
T_W	Task	Monitoring Intercept profile from above/Runway change and shortening of time	TSS	High
			TOC	High
			LIP	high
E_s	Event that triggers T_S	None		

T_S	Task (set) that has a high LIP	Approach monitoring	TSS LIP TOC	Medium High Medium
E_{CL}	Event that triggers T_{CL}	ATC uplink		
T_{CL}	Task	approach briefing/monitoring constraints speed and height	priority T_{CL}	high
t	Reaction time for T_{CL}			

Table 5.5: Low-level test conditions 3

The difference between the control scenario and the scenario in which we expect cognitive lockup is the occurrence of E_W, followed by T_W.
It is possible to evaluate working hypothesis 1, as it is also possible to recognize in the normative behaviour at what point in time it is too late (and thus an error) to react to E_{CL}.

5.5.3.3 Measuring Cognitive Lockup

5.5.3.3.1 T_{CL}

For T_{CL}, we expect that T_{CL} is executed later in the test scenario than in the control scenario. This means that the following data should be collected:

- The reaction time for the approach briefing

5.5.4 Test conditions 4

5.5.4.1 Textual description

In this scenario, in cruise flight level, the pilot receives an uplink with a trajectory that is not complete. Only the next waypoint is given. A little later, the pilot receives an ATC message that he is cleared for the rest of the flight, but needs to input the waypoints itself into the AHMI. When he is almost finished with this, a fuel pump malfunction occurs. We expect that the pilot reacts too late (or later than usually) to the message.

5.5.4.2 Test conditions

In Table 5.6, the fourth low-level test conditions are specified.

Parameter	Description	Instantiation	Variables	Value
E_W	Event that triggers T_W	ATC message		
T_W	Task	Insert waypoints into AHMI	TSS	High
			TOC	High
			LIP	high
E_s	Event that triggers T_S	none		
T_S	Task (set) that has a high LIP	Monitor flight	TSS	Low
			LIP	Medium
			TOC	Low
E_{CL}	Event that triggers T_{CL}	System message		
T_{CL}	Task	Handle fuel pump malfunction	priority T_{CL}	high
T	Reaction time for T_{CL}			

Table 5.6: Low-level test conditions 4

The difference between the control scenario and the test scenario in which we expect cognitive lockup is the occurrence of E_W, followed by T_W. This means that in the control scenario, the pilot does not need to insert the trajectory into the AHMI.
For T_{CL}, working hypothesis 2 is being evaluated, as the reaction time t to E_{CL} can directly be compared to the reaction time to E_{CL} without a task T_W.

5.5.4.3 Measuring Cognitive Lockup

5.5.4.3.1 T_{CL}

For T_{CL}, we expect that T_{CL} is executed later in the test scenario than in the control scenario. This means that the following data should be collected:

- The reaction time for the fuel pump malfunction

5.6 Scenarios

During two workshops with pilots from different airlines events were identified that are likely to lead to a cognitive lockup by the pilot. After exhaustive discussions and test sessions in the simulator four experimental and three corresponding control scenarios have been designed. Two of the four experimental scenarios share one control scenario while the other two have dedicated control scenarios. The flight situations were cognitive lockup could occur are combinations of usually system degradation and another difficult flight situation that need a certain action to be resolved. Depending on the current workload it is more or less likely that the pilot will show a behaviour that might indicate a possible cognitive lockup. While scenario 2 and 3 have their own dedicated control scenario, scenario 1 and 4 share one which makes a total of 7 scenarios each lasting about 20 minutes.
In the following each situation that has been identified to be likely to show this behaviour forms one scenario.

5.6.1 Scenario 1

The flight starts in normal conditions with all systems working. The pilot is informed about a failure of the anti skid system and about the new required landing distance. This new required landing distance has to be kept in mind during the following runway change and approach briefing. An additional AP2 failure requires the pilot to fly the aircraft in selected mode and makes it more likely that he forgets to check the runway length either during the runway change or during the approach briefing.

5.6.1.1 Test Scenario 1

CL Scenario	Simulation Time	Destination Airport	Final RWY	Initial Position				Weather		
				Position	Altitude	Heading	Speed	Thunder-storm	Visibility	Wind
Scenario 1	UTC	LSZH	RWY 28	N48.150 E9.460	19000 ft	180°	240 kt	N47.608 E8.108 Radius 5 nm	4096 m	No Wind

Route		BIKBI	RUSOT	LAPAG	VEDOK	ROMIR	ZUE	ZH703	FAP1	RW28
Timing	10 sec after scenario start		10 sec before RUSOT		8 nm before VEDOK		150 sec before ZUE			
Action	Initial uplink		SYS MSG: Anti skid failure, LDR 2100m		SYS MSG: autopilot 2 failure, revert to selected mode		Uplink: RWY change			

5.6.1.2 Control Scenario 1 & 4

CL Scenario	Simulation Time	Destination Airport	Final RWY	Initial Position				Weather		
				Position	Altitude	Heading	Speed	Thunder-storm	Visibility	Wind
Control Scenario 1&4	UTC	LSZH	RWY 28	N48.357 E9.365	19000 ft	164°	240 kt	N47.608 E8.108 Radius 5 nm	4096 m	No Wind

Route		MINGA	BIKBI	RUSOT	LAPAG	VEDOK	ROMIR	ZUE	ZH701	TRA	CI14	FI14	RW14
Timing	10 sec after scenario start		140 sec before BIKBI	10 sec before RUSOT				150 sec before ZUE					
Action	Initial uplink		SYS MSG: Master caution: fuel pump malfunction, descend FL100 or below	SYS MSG: Anti skid failure, LDR 2100m				Uplink: RWY change					

5.6.2 Scenario 2

The flight starts in normal conditions with all systems working. An AP2 failure after the top of descent leaves the aircraft in hold mode for speed and heading and in altitude acquire mode for the intercept altitude of the current arrival runway. A subsequent runway change requires levelling off at a higher altitude. Depending on the timing of the events it is more or less likely that the pilot follows horizontal route in selected mode but oversees the higher intercept altitude.

5.6.2.1 Test Scenario 2

CL Scenario	Simulation Time	Destination Airport	Final RWY	Initial Position				Weather		
				Position	Altitude	Heading	Speed	Thunder-storm	Visibility	Wind
Scenario 2	UTC	LSZH	RWY 28	N48.116 E9.169	18000 ft	186°	240 kt	N47.600 E8.150 Radius 5 nm	4096 m	No Wind

Route		HEUSE	TINOX	SONOM	ZH701	ZUE	ZH703	FAP1	RW28
Timing	10 sec after scenario start			5 nm before SONOM	100 sec before ZH701				

Action	Initial uplink			SYS MSG: autopilot 2 failure, revert to selected mode	Uplink: RWY change				

5.6.2.2 Control Scenario 2

CL Scenario	**Simulation Time**	**Destination Airport**	**Final RWY**	**Initial Position**				**Weather**		
				Position	**Altitude**	**Heading**	**Speed**	**Thunder-storm**	**Visibility**	**Wind**
Control Scenario 2	UTC	LSZH	RWY 28	N48.416 E9.200	23000 ft	186°	240 kt	-	4096 m	No Wind

Route		HEUSE	TINOX	SONOM	ZH701	ZUE	ZH703	FAP1	RW28
Timing	10 sec after scenario start		4 nm before TINOX	8 nm before SONOM					
Action	Initial uplink		SYS MSG: autopilot 2 failure, revert to selected mode	Uplink: RWY change					

5.6.3 Scenario 3

The flight starts in cruise flight with a wrong weight typed into the FMS resulting in a miscalculation of the descent profile. The flight is radar vectored to an intermediate flight level where the descent to the intercept altitude starts. Depending on the additional workload caused by a runway change the pilot will likely forget to monitor the vertical profile and ends up in a position too high for a normal approach.

5.6.3.1 Test Scenario 3

CL Scenario	**Simulation Time**	**Destination Airport**	**Final RWY**	**Initial Position**				**Weather**		
				Position	**Altitude**	**Heading**	**Speed**	**Thunder-storm**	**Visibility**	**Wind**
Scenario 3	UTC	LSZH	RWY 28	N47.729 E10.000	17000 ft	270°	240 kt	-	4096 m	No Wind

Route		RAVED	[ETOXU]	[NEGRA]	[MATIV]	AMIKI	ZH703	FAP1	RW28
Timing	10 sec after scenario start	3 nm before RAVED	South of N47.6583	South of N47.6	West of E9.333333	6.5 nm before AMIKI			
Action	Initial uplink	ATC MSG: Radar vectors: turn left heading 200, descend FL120	ATC MSG: Radar vectors: turn right heading 230, reduce speed 220kt	ATC MSG: Radar vectors: turn right heading 270, descend FL100	ATC MSG: Proceed direct MATIV and continue on route	Uplink: RWY change			

5.6.3.2 Control Scenario 3

CL Scenario	Simulation Time	Destination Airport	Final RWY	Initial Position				Weather		
				Position	Altitude	Heading	Speed	Thunder-storm	Visibility	Wind
Control Scenario 3	UTC	LSZH	RWY 28	N47.729 E10.000	17000 ft	270°	240 kt	-	4096 m	No Wind

Route		RAVED	[ETOXU]	[NEGRA]	[MATIV]	AMIKI	ZH703	FAP1	RW28
Timing	10 sec after scenario start	3 nm before RAVED	South of N47.6583	South of N47.6	West of E9.333333				
Action	Initial uplink	ATC MSG: Radar vectors: turn left heading 200, descend FL120	ATC MSG: Radar vectors: turn right heading 230, reduce speed 220kt	ATC MSG: Radar vectors: turn right heading 270, descend FL100	ATC MSG: Proceed direct MATIV and continue on route				

5.6.4 Scenario 4

The flight starts in normal conditions with all systems working. An uplink instructs the pilot to input his own approach geometry into the FMS. While doing so he is informed about a system degradation requiring to descent to a lower flight level. Depending on the additional workload caused by editing the flight plan the immediate action will be delayed to after finishing the flight plan or will be totally forgotten during a subsequent shortcut uplink that causes the airplane to climb again.

5.6.4.1 Test Scenario 4

CL Scenario	Simulation Time	Destination Airport	Final RWY	Initial Position				Weather		
				Position	Altitude	Heading	Speed	Thunder-	Visibility	Wind

								storm		
Scenario 4	UTC	LSZH	RWY 28	N51.000 E9.666	15000 ft	180°	240 kt	-	Clear	No Wind

Route				GED	FUL	[MTR]	DF021	REDGO	RW25R
Timing	10 sec after scenario start	40 sec after scenario start	While inserting WYP DF016 send SYS MSG manually			10 nm before MTR			
Action	ATC MSG: Proceed to GED via FUL, expect further clearance	ATC MSG: Cleared for the GED 25 RNAV transition and for the ILS 25R, no ALT CSTR	Manual SYS MSG: Master caution: fuel pump malfunction, descend FL100 or below			Uplink: RWY change			

5.6.4.2 Control Scenario 4

See control scenario 1 & 4.

5.7 Experiment Design

The scenarios to generate cognitive lockup are all flown in the Generic Cockpit Simulator GECO. Although they were designed to be as independent as possible it was not possible to order them totally randomly. Thus there were only two different scenario sequences as described in chapter 7.3.

The scenarios are started by the experiment leader from the GECO control station and run automatically driven by the scenario controller except for the AP2 failure, which needed manual input. Observations during the experiment regarding the subject pilot actions are taken by the pilot monitoring and regarding the overall simulation by the experiment leader. After the landing the simulation is totally stopped and the scenario specific questionnaire is handed out to the subject pilot.

5.7.1 Training

The training for the cognitive lockup scenarios takes place in the GECO and is conducted by the pilot monitoring. It starts with a general overview of the GECO's systems and their location and the flight characteristics of the aircraft are demonstrated. The flight control law, the information that can be shown on the displays, the different modes of the autopilot, and the function of the radio management panel will be explained in detail. Following list specifies the respective systems and indications:

- Flight controls
  - Side stick rate control
  - Flaps
  - Speed brakes, ground spoilers

  - Autobrake
  - Gear

- Displays
  - Primary flight display
  - Flight mode annunciator indications
  - Navigation display
  - VOR/NDB/ILS/DME indications
  - Engine display
  - Engine indication
  - Flaps, speed brakes and gear position
  - System display

- Autopilot
  - Functions of autopilot 1 & 2
  - Autoflight system modes
  - Autothrottle
  - Autoland
  - Autocall system

- Radio management panel

- KCCU – AHMI

- GECO's speeds and performance

- Flight path monitoring and adherence

- Messages
  - System messages
    - System malfunctions
    - Procedures for autopilot 2 failure (flying in selected mode)
  - ATC messages
    - Radar vectors

- Weather
  - Procedures for thunderstorms
  - ATIS information

The following completion standard for the training applies:

- The pilot knows how to fly the simulator and knows the different levels of automation
- The pilot understands the different autopilot functions and is able to use the selected mode to follow an FMS trajectory
- The pilot is able to follow radar vectors given by ATC via datalink and switch back FMS mode

5.7.2 Instructions for experiment leader (pilot monitoring)

The pilot monitoring is required to adhere to the following general rules:

- Do not tell the subject if he has made a mistake
- Do not help the subject to a great extend in handling general cockpit duties
- Do not suggest a solution to a problem unless explicitly asked
- Do not remind the subject of tasks to do or tasks that have been forgotten
- Perform standard call outs
- Support the subjects decision to accept a RWY change
- Support the subject in handling the AHMI if necessary
- Make sure that the subject closes open uplink or message windows after the information of the windows have been processed
- Avoid any Smalltalk as far as possible

5.7.3 Debriefing

After each scenario, the pilot is asked to fill in a questionnaire evaluate his task load during the scenario. For an example of the questionnaire, see 9.3 Task load questionnaire in the Appendix.

During the debriefing at the end of the second day general remarks of the subject regarding the simulation and the target system are discussed and quoted and any open questions are answered.

6 Experimental Setup Selective Attention

6.1 Description

Humans are constantly faced with a large amount of information, especially in a environment like a cockpit. It is essential that the pilot has certain situation awareness on the current state of the instruments. Display designers try to control the attention of the pilot by using flashing elements that should attract the attention of the pilot to certain changes. The effect that is used here is bottom-up attention. In theory, bottom-up visual attention is defined as automatic shifts of attention due to static or dynamic discontinuities. Static discontinuities are differences in colour, shape or brightness, e.g. a red circle in a set of green circles, or a circle in a set of rectangles. In contrast to this, dynamic discontinuities are changes over time, e.g. a flashing or moving object. In the following, we will refer to the occurrence of a dynamic discontinuity as *event*. If such an event occurs in the visual field, this can result in a shift of visual attention. This effect is e.g. used for the flight mode annunciations of the Primary

Flight Display in a modern glass cockpit, where all mode changes are highlighted by flashing FMA (or a flashing box around the FMA) for about 10 seconds. A mode change is an important event that a pilot has to be aware of. Recent studies showed that bottom-up visual attention is not always working. One reason is that top-down visual attention can prevent a shift of attention, e.g. when a pilot is very focused on acquiring certain information on another display. A second reason could be that the event is outside the visual field at all, e.g. because the pilot is looking down for a longer time. The third reason is that the event is missed because of interference with other discontinuities. Nikolic, Orr and Sarter (2004) called this display context: If the event occurs on a display where the neighbourhood is very colourful or dynamic, the probability of recognizing the event is reduced.

6.2 Requirements

- Mode changes, with different special extend to focus of subject.
- Call out of FMA change required.

6.3 High Level Test Conditions

(1) Scenario in which pilots have to perform a task T1.
(2) Visual Event E (e.g. flashing display element) occur which requires performing a second task (T2).
(3) The display context in which E occurs is dynamic.

Hypothesis: Pilots will not notice event E because of the dynamic graphical neighbourhood of E, or because it's outside his visual field.

Dependent Variables:
- Time to detection of event
- Detection rate

Fixed Variables:
- Duration of flashing

Independent Variables:
- Colours of environment
- Dynamicity of elements
- Distance between flashing element and current focus

6.4 Low Level Test Conditions

1) FMA

Parameter	Description	Instantiation
T1	Main Task	Task on display different from PFD
E	Event that occurs	Mode Annunciations on the PFD (manual + automatic changes)

T2	Task to be performed if E occours	Verbalise actual Mode

2) Uplink

Parameter	Description	Instantiation
T1	Main Task	Monitoring or other task not on AHMI
E	Event that occurs	Uplink pops up
T2	Task to be performed if E occurs	Implement uplink

6.5 Elaboration of the Working Hypothesis

Not all mode changes will be focused by the pilots within 10s after change, not all mode changes will be focused by the pilots within 20s after change. Not all uplinks will be detected within 10s after pop-up by the pilots.

6.5.1 Independent Variables:

- Distance between Event and current focus
- Colours of environment
- Dynamicity of elements

6.5.2 Operationalisation of Independent Variables:

Parameter	Operationalisation
DISTANCE	This is the distance between the Event E and the current focus of the subject F. Could be influenced by explicitly controlling the current task for the time when E is awaited, e.g. during a decent one could omit an ATC message at the AHMI to influence the attention of the pilot to this (low priority task). Operationalised as NEAR (<=40°) and FAR (> 40°)
ENVIRONMENT_COLOURS	The colours of the environment can be either monochrome (black or white) or coloured (number of different colours > 2)

DYNAMICITY	An element can be classified if it is continuously changing (position, value), with a frequency >= 1 Hz (i.e. 1 change per second), e.g. the artificial horizon is moving, or the altimeter is continuously updated. There should be at least one dynamic element in a distance of maximum 15° to the event

6.5.3 Working Hypothesis

If (ENVIRONMENT_COLOURS=mono AND DYNAMICITY=NONE AND DISTANCE=NEAR)
DETECTION_RATE ~ 95%
IF (ENVIRONMENT_COLOURS=mono AND DYNAMICITY=NONE AND DISTANCE=FAR)
DETECTION_RATE ~ 80%
If (ENVIRONMENT_COLOURS=mono AND DYNAMICITY=TRUE AND DISTANCE=NEAR)
DETECTION_RATE ~ 90%
IF (ENVIRONMENT_COLOURS=mono AND DYNAMICITY=TRUE AND DISTANCE=FAR)
DETECTION_RATE ~ 70%
If (ENVIRONMENT_COLOURS=colour AND DYNAMICITY=NONE AND DISTANCE=NEAR)
DETECTION_RATE ~ 95%
IF (ENVIRONMENT_COLOURS=colour AND DYNAMICITY=NONE AND DISTANCE=FAR)
DETECTION_RATE ~ 80%
If (ENVIRONMENT_COLOURS=colour AND DYNAMICITY=TRUE AND DISTANCE=NEAR)
DETECTION_RATE ~ 80%
IF (ENVIRONMENT_COLOURS=colour AND DYNAMICITY=TRUE AND DISTANCE=FAR)
DETECTION_RATE ~ 60%
See also Nicolic, Orr and Sarter (2004).

6.6 Simulation Scenario (OFF/TNO)

No dedicated scenario for this EPM will be designed in order to test these hypotheses. For all (cognitive lockup) scenarios, the pilot is asked to announce the mode changes. These announcements are used to determine whether selective attention has occurred. The experiments are used to further gain knowledge about the parameters for selective attention and the data is used to determine whether the theory described above can be validated. Needed data is the gaze position and the mode changes. We will measure, if the pilot has called out the mode change, within 10 or 20 seconds after the mode change appeared.

7 Overall Experimental Setup

All in all at least 16 pilots will take part in the experiments at the DLR. Each pilot will be confronted with the same scenarios in the GECO where only the order will vary. Depending on the group the pilot will conduct different LC sessions. The experimental group will conduct 5 sessions with scenarios where all test conditions set to "false" and only one session with scenarios where one test condition is set to "true" in order to test if LC has been build up. The control group will have scenarios with test conditions set to "true" in all sessions.

7.1 Invitation

The subjects are invited via email to participate in the simulation. The invitation can be found in the Appendix.
After a subject receives a confirmation of participation, he is provided with information regarding the schedule of the two days and information about accommodation and remuneration. He receives as well a description of the AHMI for an autonomous initial study of the system.

7.2 Briefing

The briefing forms the beginning of the simulation cycle for each subject. It starts with an introduction to the project and the simulator. Afterwards the AHMI as the target system is described again in detail. It is assured that the subject has understood the basic principle of the system, in particular the data link only communication function and the necessary steps to generate, negotiate and activate a trajectory out of a flight plan.
The briefing continues with a description of the taken measurements. Here the focus is on why and what kind of performance data are measured in the avionic test bed and the GECO. The presentation ends with an overview of the schedule for the two days.

7.3 Schedule

All sessions of LC scenarios and the CL scenarios together with the required briefing and training sessions and the necessary breaks take place in the simulation facilities of the DLR in Braunschweig during two successive days. During these two days the experimental design follows certain requirements:

- A briefing and a debriefing at the beginning and the end
- A training of all needed systems and procedures prior to the experimental session or scenario
- Enough breaks and time to relax the eyes in order not to measure effects like fatigue and to get high quality gaze measurement data
- A diverse schedule of LC sessions and CL scenarios to keep the pilot interested and busy

- A varying order of the CL scenarios to avoid sequencing effects being undiscovered
- An order of the CL scenarios that don't affect the performance of the pilot in a certain situation. (Experimental and control scenario should not follow each other)
- Incorporation of control groups of different size for each EPM.
    - LC (experimental/control group): 12 experimental, 4 control.
    - CL (scenario sequencing): 8 experimental, 8 control

Below is the resulting schedule that incorporates all these requirements:

Day 1			
Time	**What**		**Where**
	Group A	**Control Group B**	
09:00	Briefing		
09:30	LC Training A	LC Training B	Test bed
10:15	*- Coffee -*		
10:30	LC Build up Session 1A	LC Build up Session 1B	Test bed
11:15	LC Build up Session 2A	LC Build up Session 2B	Test bed
12:00	*- Lunch -*		
13:00	CL Training (GECO Training)		GECO
14:30	CL Scenario 1	CL Scenario 1	GECO
15:15	CL Scenario 2	CL Control Scenario 2	GECO
16:00	*- Coffee -*		
16:15	LC Build up Session 3A	LC Build up Session 3B	Test bed
17:00	End		

Day 2			
Time	**What**		**Where**
	Group A	**Control Group B**	
09:00	CL Scenario 3	CL Control Scenario 3	GECO

09:45	CL Control Scenario 2	CL Scenario 2	GECO
10:30	*- Coffee -*		
10:45	LC Build up Session 4A	LC Build up Session 4B	Test bed
11:30	LC Build up Session 5A	LC Build up Session 5B	Test bed
12:15	*- Lunch -*		
13:15	LC Test Session A	LC Test Session B	Test bed
13:45	CL Training (Editing of Route)		Test bed
14:30	CL Control Scenario 3	CL Scenario 3	GECO
15:15	*- Coffee -*		
15:30	CL Scenario 4	CL Scenario 4	GECO
16:15	CL Control Scenario 1&4	CL Control Scenario 1&4	GECO
17:00	End		

7.4 Debriefing

At the end of both experiment days, the pilots are asked to fill in a questionnaire that asks the pilots to evaluate the importance of checks in general and the task load of tasks in general.
For the questionnaire, please see the Appendix (9.4).

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9 Appendix

9.1 Learned Carelessness Simulation Schedule

Run	Total Time [min:sec]	Scenario	Group A						Scenario	Control Group B					
			Checks							Checks					
			1	2	3	4	5	6		1	2	3	4	5	6
Training															
1	05:00	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
2	10:00	NE C0	True	True	True	True	True	True	NE C0	True	True	True	True	True	True
3	14:00	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
4	16:00	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
5	18:00	NE C0	False	False	False	False	False	False	NE C2	False	True	False	False	False	False
6	20:00	SE C0	False	False	False	False	False	False	SE C3	False	False	False	False	False	False
7	22:00	SW C0	False	False	False	False	False	False	SW C0	False	False	True	False	False	False
8	24:00	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
9	26:00	SE C0	False	False	False	False	False	False	SE C1	True	False	False	False	False	False
10	28:00	SW C0	False	False	False	False	False	False	SW C6	False	False	False	False	False	True
11	30:00	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
12	32:00	NE C0	False	False	False	False	False	False	NE C5	False	False	False	False	True	False
13	34:00	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
14	36:00	NW C0	False	False	False	False	False	False	NW C4	False	False	False	True	False	False
15	38:00	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
16	40:00	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
Build up Session 1															
1	01:10	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
2	02:20	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
3	03:30	SE C0	False	False	False	False	False	False	SE C6	False	False	False	False	False	True
4	04:40	SW C0	False	False	False	False	False	False	SW C2	False	True	False	False	False	False
5	05:50	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
6	07:00	SE C0	False	False	False	False	False	False	SE C1	True	False	False	False	False	False
7	08:10	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
8	09:20	NW C0	False	False	False	False	False	False	NW C5	False	False	False	False	True	False
9	10:30	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
10	11:40	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
11	12:50	NW C0	False	False	False	False	False	False	NW C4	False	False	False	True	False	False
12	14:00	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
13	15:10	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
14	16:20	NW C0	False	False	False	False	False	False	NW C3	False	False	True	False	False	False
15	17:30	NE C0	False	False	False	False	False	False	NE C1	True	False	False	False	False	False
16	18:40	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
17	19:50	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
18	21:00	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False

19	22:10	SE C0	False	False	False	False	False	False	SE C4	False	False	False	True	False	False
20	23:20	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
21	24:30	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
22	25:40	SE C0	False	False	False	False	False	False	SE C5	False	False	False	False	True	False
23	26:50	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
24	28:00	NW C0	False	False	False	False	False	False	NW C2	False	True	False	False	False	False
25	29:10	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
26	30:20	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
27	31:30	NW C0	False	False	False	False	False	False	NW C6	False	False	False	False	False	True
28	32:40	NE C0	False	False	False	False	False	False	NE C3	False	False	True	False	False	False
29	33:50	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
30	35:00	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False

Build up Session 2

31	01:10	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
32	02:20	NW C0	False	False	False	False	False	False	NW C5	False	False	False	False	True	False
33	03:30	NE C0	False	False	False	False	False	False	NE C1	True	False	False	False	False	False
34	04:40	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
35	05:50	SW C0	False	False	False	False	False	False	SW C2	False	True	False	False	False	False
36	07:00	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
37	08:10	SE C0	False	False	False	False	False	False	SE C4	False	False	False	True	False	False
38	09:20	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
39	10:30	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
40	11:40	SE C0	False	False	False	False	False	False	SE C6	False	False	False	False	False	True
41	12:50	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
42	14:00	NW C0	False	False	False	False	False	False	NW C3	False	False	True	False	False	False
43	15:10	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
44	16:20	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
45	17:30	NW C0	False	False	False	False	False	False	NW C1	True	False	False	False	False	False
46	18:40	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
47	19:50	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
48	21:00	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
49	22:10	NE C0	False	False	False	False	False	False	NE C5	False	False	False	False	True	False
50	23:20	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
51	24:30	SW C0	False	False	False	False	False	False	SW C2	False	True	False	False	False	False
52	25:40	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
53	26:50	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
54	28:00	SW C0	False	False	False	False	False	False	SW C4	False	False	False	True	False	False
55	29:10	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
56	30:20	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
57	31:30	SW C0	False	False	False	False	False	False	SW C6	False	False	False	False	False	True
58	32:40	NW C0	False	False	False	False	False	False	NW C3	False	False	True	False	False	False
59	33:50	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
60	35:00	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False

Build up Session 3

61	01:10	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
62	02:20	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
63	03:30	NW C0	False	False	False	False	False	False	NW C6	False	False	False	False	False	True

64	04:40	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
65	05:50	SE C0	False	False	False	False	False	False	SE C2	False	True	False	False	False	False
66	07:00	SW C0	False	False	False	False	False	False	SW C1	True	False	False	False	False	False
67	08:10	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
68	09:20	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
69	10:30	SW C0	False	False	False	False	False	False	SW C5	False	False	False	False	True	False
70	11:40	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
71	12:50	SE C0	False	False	False	False	False	False	SE C4	False	False	False	True	False	False
72	14:00	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
73	15:10	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
74	16:20	NE C0	False	False	False	False	False	False	NE C1	True	False	False	False	False	False
75	17:30	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
76	18:40	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
77	19:50	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
78	21:00	SE C0	False	False	False	False	False	False	SE C3	False	False	True	False	False	False
79	22:10	NW C0	False	False	False	False	False	False	NW C6	False	False	False	False	False	True
80	23:20	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
81	24:30	SE C0	False	False	False	False	False	False	SE C4	False	False	False	True	False	False
82	25:40	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
83	26:50	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
84	28:00	SE C0	False	False	False	False	False	False	SE C5	False	False	False	False	True	False
85	29:10	SW C0	False	False	False	False	False	False	SW C2	False	True	False	False	False	False
86	30:20	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
87	31:30	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
88	32:40	SW C0	False	False	False	False	False	False	SW C3	False	False	True	False	False	False
89	33:50	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
90	35:00	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False

Build up Session 4

91	01:10	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
92	02:20	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
93	03:30	SE C0	False	False	False	False	False	False	SE C4	False	False	False	True	False	False
94	04:40	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
95	05:50	NE C0	False	False	False	False	False	False	NE C3	False	False	True	False	False	False
96	07:00	SE C0	False	False	False	False	False	False	SE C6	False	False	False	False	False	True
97	08:10	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
98	09:20	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
99	10:30	SE C0	False	False	False	False	False	False	SE C2	False	True	False	False	False	False
100	11:40	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
101	12:50	NW C0	False	False	False	False	False	False	NW C5	False	False	False	False	True	False
102	14:00	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
103	15:10	SW C0	False	False	False	False	False	False	SW C1	True	False	False	False	False	False
104	16:20	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
105	17:30	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
106	18:40	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
107	19:50	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
108	21:00	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
109	22:10	SE C0	False	False	False	False	False	False	SE C5	False	False	False	False	True	False
110	23:20	NW C0	False	False	False	False	False	False	NW C2	False	True	False	False	False	False
111	24:30	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
112	25:40	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
113	26:50	SW C0	False	False	False	False	False	False	SW C4	False	False	False	True	False	False
114	28:00	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False

115	29:10	SE C0	False	False	False	False	False	False	SE C1	True	False	False	False	False	False
116	30:20	SW C0	False	False	False	False	False	False	SW C3	False	False	True	False	False	False
117	31:30	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
118	32:40	SE C0	False	False	False	False	False	False	SE C6	False	False	False	False	False	True
119	33:50	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
120	35:00	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False

Build up Session 5

121	01:10	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
122	02:20	NW C0	False	False	False	False	False	False	NW C6	False	False	False	False	False	True
123	03:30	NE C0	False	False	False	False	False	False	NE C4	False	False	False	True	False	False
124	04:40	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
125	05:50	NW C0	False	False	False	False	False	False	NW C1	True	False	False	False	False	False
126	07:00	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
127	08:10	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
128	09:20	SW C0	False	False	False	False	False	False	SW C5	False	False	False	False	True	False
129	10:30	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
130	11:40	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
131	12:50	SW C0	False	False	False	False	False	False	SW C3	False	False	True	False	False	False
132	14:00	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
133	15:10	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
134	16:20	SW C0	False	False	False	False	False	False	SW C2	False	True	False	False	False	False
135	17:30	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
136	18:40	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
137	19:50	SW C0	False	False	False	False	False	False	SW C1	True	False	False	False	False	False
138	21:00	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
139	22:10	NE C0	False	False	False	False	False	False	NE C6	False	False	False	False	False	True
140	23:20	SE C0	False	False	False	False	False	False	SE C4	False	False	False	True	False	False
141	24:30	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
142	25:40	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
143	26:50	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
144	28:00	SW C0	False	False	False	False	False	False	SW C2	False	True	False	False	False	False
145	29:10	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
146	30:20	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
147	31:30	SW C0	False	False	False	False	False	False	SW C3	False	False	True	False	False	False
148	32:40	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
149	33:50	SE C0	False	False	False	False	False	False	SE C5	False	False	False	False	True	False
150	35:00	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False

Test Session

151	01:10	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
152	02:20	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
153	03:30	SE C1	True	False	False	False	False	False	SE C1	True	False	False	False	False	False
154	04:40	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
155	05:50	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
156	07:00	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
157	08:10	SW C6	False	False	False	False	False	True	SW C6	False	False	False	False	False	True
158	09:20	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
159	10:30	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
160	11:40	SW C5	False	False	False	False	True	False	SW C5	False	False	False	False	True	False
161	12:50	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
162	14:00	NE C2	False	True	False	False	False	False	NE C2	False	True	False	False	False	False

163	15:10	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False
164	16:20	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
165	17:30	NE C4	False	False	False	True	False	False	NE C4	False	False	False	True	False	False
166	18:40	SE C0	False	False	False	False	False	False	SE C0	False	False	False	False	False	False
167	19:50	NW C0	False	False	False	False	False	False	NW C0	False	False	False	False	False	False
168	21:00	NE C0	False	False	False	False	False	False	NE C0	False	False	False	False	False	False
169	22:10	SE C3	False	False	True	False	False	False	SE C3	False	False	True	False	False	False
170	23:20	SW C0	False	False	False	False	False	False	SW C0	False	False	False	False	False	False

9.2 Invitation (in German)

Mail #1 vom 09.07.2010

Liebe Piloten,

ich freue mich Ihnen heute mitteilen zu können, dass die abschließende, zweite Runde der Versuche für das EU-Projekt HUMAN im August startet!
Hierzu möchte ich Sie herzlich einladen, bei uns in Braunschweig im Simulator an Experimenten teilzunehmen.

Worum geht es bei HUMAN?
Das EU-Projekt HUMAN verfolgt als Hauptziel die Entwicklung eines kognitiven Models, das in der Lage ist, die Interaktion des Piloten mit Systemen vorherzusagen. Hierzu gehören auch und gerade neue Systeme, die sich noch in frühen Reifestadien befinden und mitunter noch fehleranfällig sind.

Wer macht bei HUMAN mit?
Federführend wirkt das Oldenburger Informatik Institut OFFIS als Koordinator mit. Weiterhin sind das niederländische Forschungsunternehmen TNO, die Université catholique de Louvain-La-Neuve, Airbus Frankreich und Alenia Aeronautics am Projekt beteiligt – und das DLR Institut für Flugführung.

Was ist Aufgabe des DLR hierbei?
Wir liefern den Partnern im Konsortium empirische Flugsimulationsdaten.

Welche Eigenschaften müssen Sie mitbringen?
Da während der Versuchsszenarien die Blickbewegung des Piloten gemessen wird, sind wir leider dazu angehalten, ausschließlich Piloten einzuladen, die NICHT Brillen- oder Kontaktlinsenträger sind.

Welche Vor-Kenntnisse sind gefordert?
Eigentlich gar keine…
Dennoch erhalten Sie von uns per Mail (rechtzeitig…) ein Handbuch, in dem Sie grundlegende Bedienschritte mit dem sog. A-HMI (Airborne Human Machine Interface) schon vorab kennenlernen. Das A-HMI ist die Schnittstelle zum Advanced Flight Management System (AFMS), einem interaktiven Navigationsdisplay – beides sind Prototypen des DLR-Instituts für Flugführung.

Welche Aufgabe haben Sie, als Versuchsperson beim DLR?
Sie lernen in einem gründlichen Briefing das A-HMI kennen, welches Sie in Simulator-Szenarien erproben werden:
Sie fliegen dann sowohl part task Simulationen im Avionik Test Bed als auch Szenarien im fixed base Flugsimulator GECO. Diese werden dann nach Abschluss aller Versuche im Herbst zur Überprüfung des kognitiven Models genutzt.
Die Szenarien sind vom DLR gemeinsam mit den HUMAN Partnern generiert worden.
Die Crew wird im GECO durch einen weiteren Piloten komplementiert, den wir stellen.

Wann finden die Versuche statt?

Wir bieten Ihnen EINEN zweitägigen Termin an. Insgesamt brauchen wir 16 Piloten – first come, first serve ☐☐
Sie haben – Ihr Interesse vorausgesetzt – die Möglichkeit, sich in untenstehende Tabelle einzutragen.
Auch gern mit Kommentaren, bzw. unter Vorbehalt.
Wer mag, kann die Mail auch gern weiterleiten. Merci.

Was gibt es dafür?
Sie bekommen **800 Euro** für die Teilnahme an den Versuchen. Das schließt die gewissenhafte Lektüre des o.g. A-HMI Handbuchs natürlich mit ein!
Zusätzlich werden Reise- und Übernachtungskosten bis zu 500 Euro maximal erstattet.
Wie schon in unseren vorigen Kampagnen mit Messung der Blickbewegung bieten wir Ihnen gerne an, eine DVD mit kompletten Blickbewegungsfilmen ausgewählter Szenarien zu erhalten.

Monat	Woche	Tag	Datum	Versuchsperson
August	32	MO	09./10.08.	
		DI		
		MI	11./12.08	
		DO		
	33	MO	16./17.08.	
		DI		
		MI	18./19.08.	
		DO		
	34	MO	23./24.08.	
		DI		
		MI	25./26.08.	
		DO		
	35	MO	30./31.08.	
		DI		
September		MI	01./02.09.	
		DO		
	36	MO	06./07.09.	
		DI		
		MI	08./09.09.	
		DO		
	37	MO	13./14.09.	
		DI		
		MI	15./16.09.	
		DO		
	38	MO	20./21.09.	
		DI		
		MI	22./23.09.	
		DO		
	39	MO	27./28.09.	
		DI		

		MI DO	29./30.09.	

Gern steh ich auch zur Verfügung, wenn es um mögliche Rückfragen Ihrerseits geht.

In jedem Fall freu ich mich auf Ihre Rückmeldung -
noch mehr natürlich auf ein Wiedersehen in Braunschweig!

Mit besten Grüßen
Marcus Biella

PS:
Allen, die Interesse an den Versuchen haben, kann ich an dieser Stelle bereits die nächsten Schritte ankündigen:

- Sie bekommen ein template, in welchem Sie Ihre Kontaktdaten eintragen. Diese ausgefüllte template wird dann unserer Verwaltung gesendet und Sie bekommen exklusiv für die Arbeit im Rahmen von HUMAN einen Vertrag mit dem DLR.
- Nach erfolgter Feinabstimmung bzgl. des Termins buchen wir für Sie ein Hotelzimmer.
- Nach den Versuchen reichen Sie beim DLR Hotel-, Reisekosten und Ihre Honorarforderung als Rechnung ein.

Deutsches Zentrum für Luft- und Raumfahrt e.V.
in the Helmholtz-Association
German Aerospace Center
Institute of Flight Guidance
Human Factors Department

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Mail #2 vom 13.07.2010

Liebe Versuchspersonen,

danke nochmals für die Bereitschaft, an unseren Versuchen teilzunehmen!

Heute sende ich einen vorläufigen (!) Plan für die beiden Versuchstage:
daraus geht unmittelbar hervor, dass wir zwei nicht so ganz kurze Tage vor uns haben.

Ich biete Ihnen an, im http://www.hotel-landhaus-seela.de/ für Sie Einzelzimmer einschl. Frühstück zu buchen.
Sie müssen vor Ort die Rechnung bezahlen, bekommen es aber in Ihrer Reisekostenabrechnung mit dem DLR natürlich dann erstattet.
Bitte teilen Sie mir daher mit, ob Sie von diesem Angebot Gebrauch machen möchten, und – ganz wichtig - **wann Sie an- bzw. abreisen wollen**.

Die Versuche finden im DLR-Institut für Flugführung, Braunschweig, Gebäude 117 statt.
Ihr Name wird vor Beginn der Versuche bei der Pförtnerei hinterlegt sein.
Dort wird man Ihnen – falls nötig – auch die grobe Himmelsrichtung zeigen, wo es langgeht.
Ebenfalls hinterlegt sind dort die Koordinaten Ihrer Ansprechpartner. Das wird in der Regel Helge.Lenz@dlr.de sein.

Im Laufe der Versuche bekommen Sie von uns im generischen Experimental Cockpit (GECO) einen Co-Piloten gestellt.

Ich möchte noch einmal ausdrücklich darauf hinzuweisen,
dass wegen der Erfassung der Blickbewegung **KEINE Brillen- und Kontaktlinsenträger** zugelassen sind.

Sie bekommen als nächstes in einer gesonderten Mail:
- ein Template, aus dem Sie ein Angebot für uns basteln
- eine Erklärung zum Abschluss eines Beratervertrags mit dem DLR e.V.

Sobald wie möglich erhalten Sie dann auch die angedrohten Unterlagen, um sich mit dem A-HMI vertraut zu machen.

Simulation Schedule

Day 1

Time	What	Where
09:00	Briefing	
09:30	A-HMI Training Pt. 1	Avionic Test bed

10:30	*- Coffee -*	
10:45	Scenario	Avionic Test bed
11:30	Scenario	Avionic Test bed
12:15	A-HMI Training Pt. 2	Avionic Test bed
12:30	*- Lunch -*	DLR Kantine, … Sie sind eingeladen
13:30	GECO / A-HMI-Training	GECO
14:30	Scenario	GECO
15:15	Scenario	GECO
16:00	*- Coffee -*	
16:15		Avionic Test bed
17:00	End	

Day 2

Time	What	Where
09:00	Scenario	GECO
09:45	Scenario	GECO
10:30	*- Coffee -*	
10:45	Scenario	Avionic Test bed
11:30	Scenario	Avionic Test bed
12:15	Scenario	Avionic Test bed
12:30	*- Lunch -*	DLR Kantine, … Sie sind eingeladen
13:30	A-HMI Training Pt. 3	Avionic Test bed
14:15	Scenario	GECO
15:00	Scenario	GECO

15:45	*- Coffee -*	
16:00	Scenario	GECO
16:45	Debriefing	
17:00	End	

Mit besten Grüßen aus Braunschweig-Waggum
Marcus Biella

Mail #3 vom 13.07.2010

Liebe Versuchspersonen,

Sie erhalten nun – wie angekündigt - :

- ein Template, aus dem Sie ein Angebot für uns basteln:
  Bitte die gelb schraffierten Passagen um Ihre persönlichen Daten ergänzen
- eine Erklärung zum Abschluss eines Beratervertrags mit dem DLR e.V.
  Bitte ausfüllen und unterschreiben

Durch diese Unterlagen wird sichergestellt, dass Sie Ihre Rechung a.s.a.p. beglichen bekommen.

Wir freuen uns, wenn Sie diese beiden Unterlagen dann an uns zurücksenden, am Besten so schnell wie möglich:
Unsere Administration wäre dann begeistert ☐

Sicherlich am einfachsten per Einscannen und als Attachment versenden.
Wer mag, darf aber auch faxen oder per snail mail senden.

Danke!

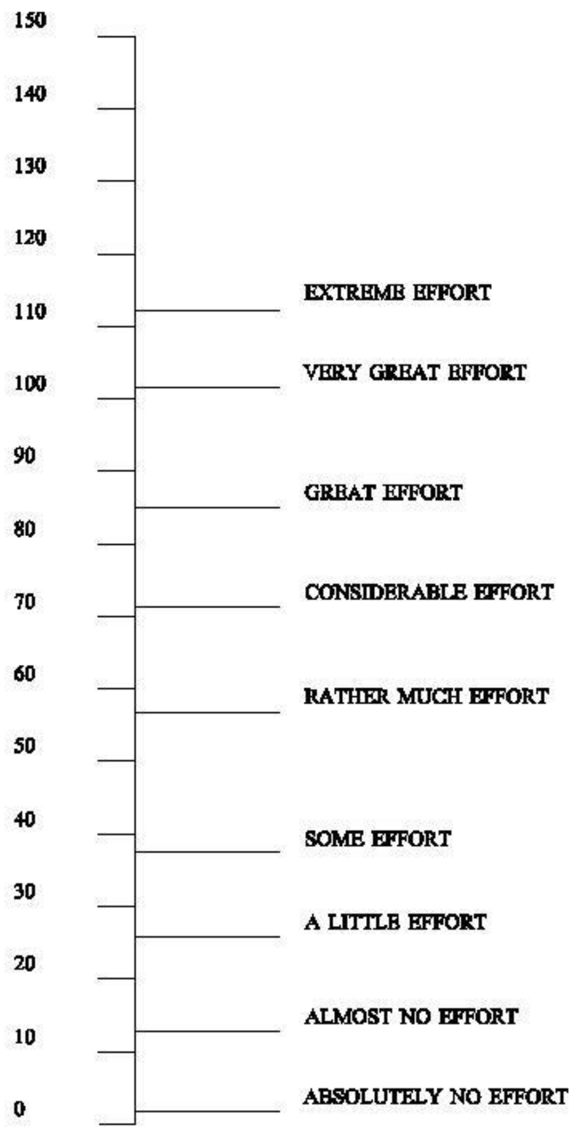
Zu Ihrer Information: aus diesen beiden Unterlagen generieren wir eine sog. Bedarfsmeldung bei unserem Einkauf.
Dann wird genehmigt, dass Sie kommen dürfen (reine Formsache …).
Sie bekommen dann auch Post von unserer Verwaltung aus Köln. Da ist dann auch schon die Adresse angegeben, wohin Sie Ihre Rechnung nach den abgeleisteten Versuchen schicken dürfen.

Sollte es diesbezüglich noch Fragen Ihrerseits geben: dann unbedingt bei mir melden oder einen der Kollegen während der laufenden Versuche fragen.

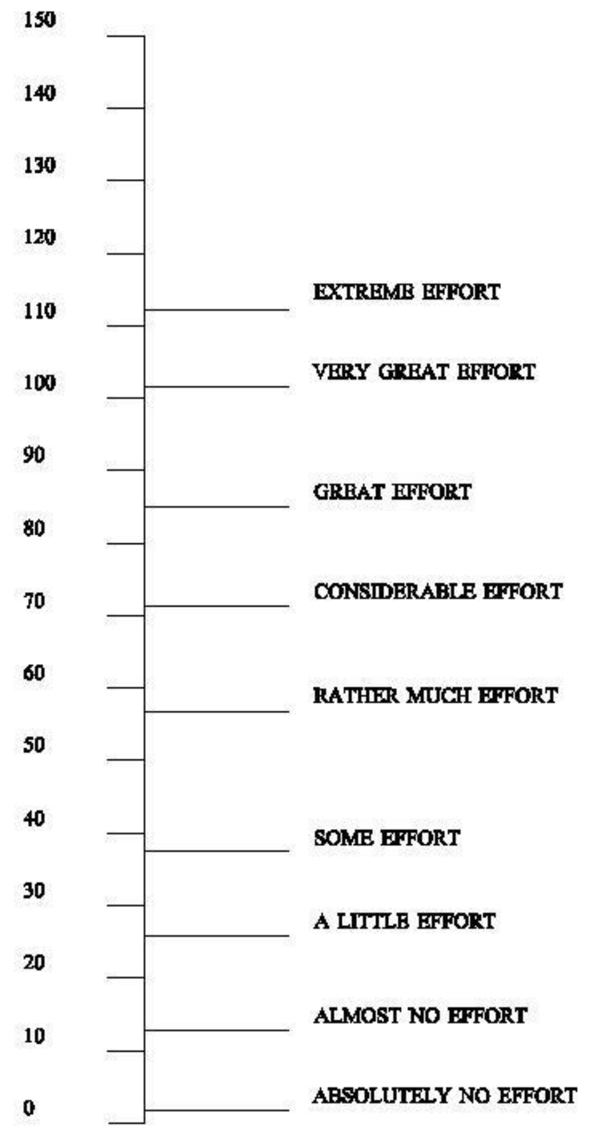
Mit besten Grüßen
Marcus Biella

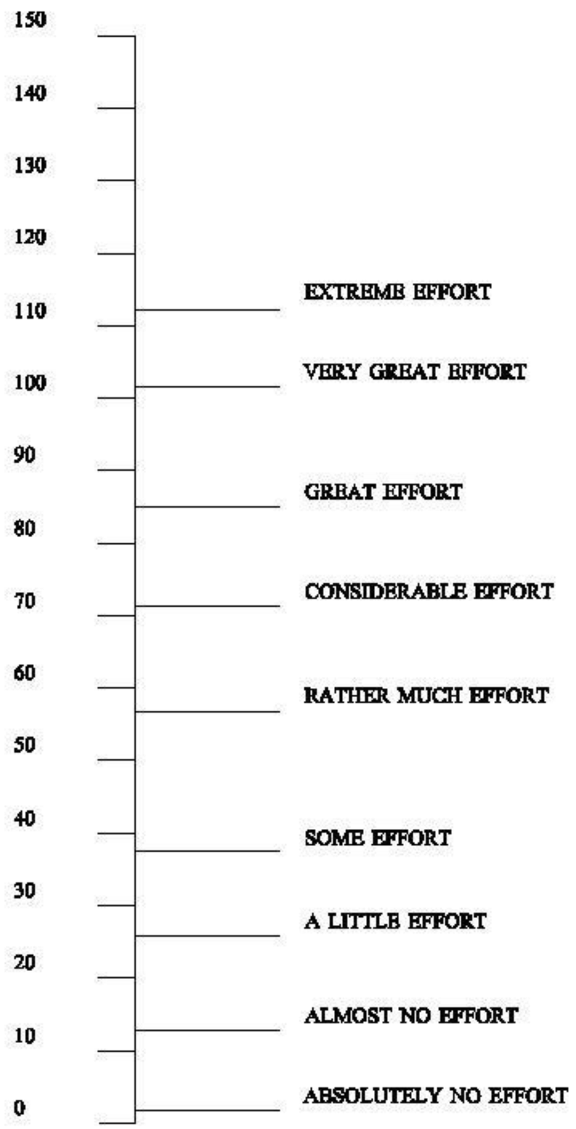
9.3 Task load questionnaire

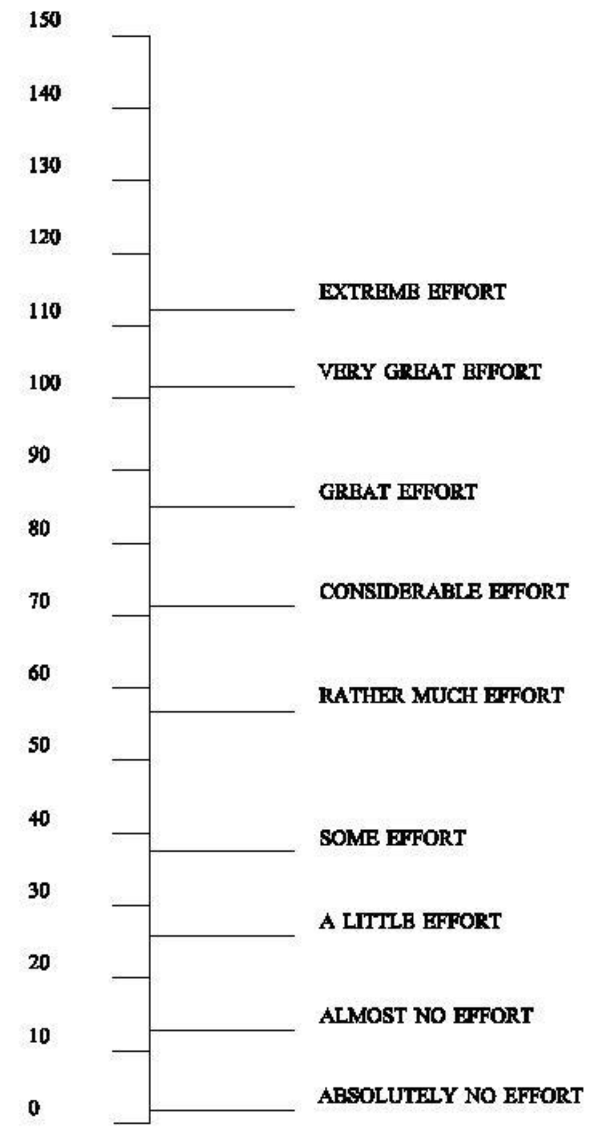
The questionnaire below is filled in by the pilots after each cognitive lockup scenario.

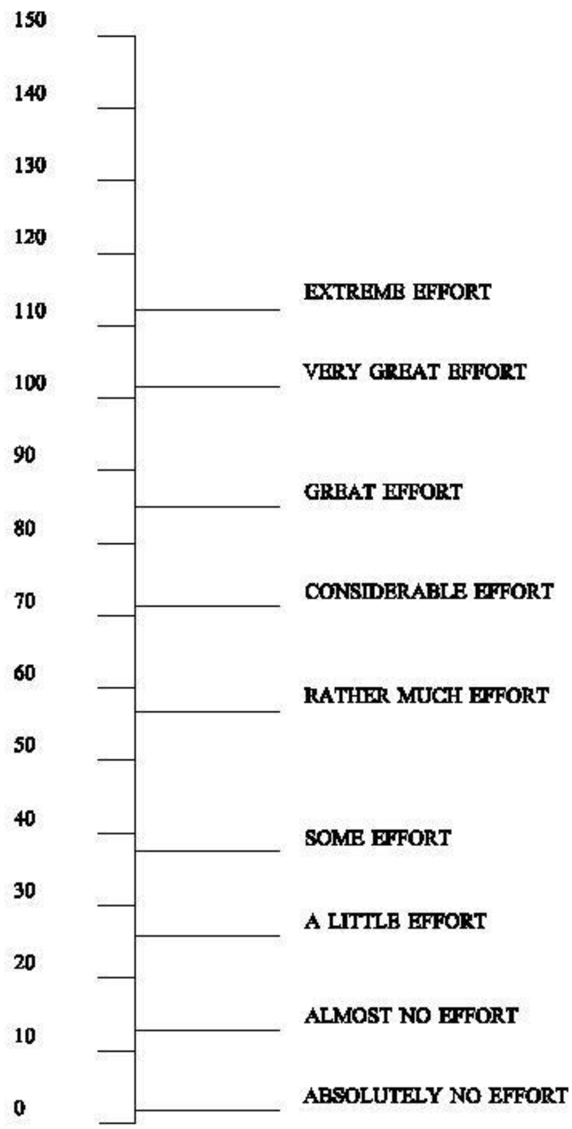
CL1	How much effort did <u>this flight</u> cost? Please - have a look at the scale - indicate the rating by writing down the number **HERE**: __________	
CL1	How much <u>time pressure</u> did you experience during this scenario?	

	Please - have a look at the scale - indicate the rating by writing down the number **HERE**: __________	1 2 3 4 5 6 7 low high
CL1	Did it feel as if there were <u>many tasks</u> that had <u>to be attended to at the same time</u>? Please - have a look at the scale - indicate the rating by writing down the number **HERE**: __________	1 2 3 4 5 6 7 not really very much

CL1	How much effort did <u>flying in selected mode due to the autopilot failure</u> cost? Please - have a look at the scale - indicate the rating by writing down the number **HERE**: __________	
CL1	How much effort did <u>checking the antiskid constraints</u> cost? Please - have a look at	

	the scale - indicate the rating by writing down the number **HERE**: _________	

CL1	How much effort did <u>checking and implementing the runway change</u> cost? Please - have a look at the scale - indicate the rating by writing down the number **HERE**: __________	

CL1	How much effort did <u>performing the approach briefing</u> cost? Please - have a look at the scale - indicate the rating by writing down the number **HERE**: __________	

End of Questioning for this scenario - THANK YOU!

9.4 End questionnaire

The questionnaire below is filled in by the pilots at the end of all experiments.

In your judgement, how great is the risk for the safe operation of the aircraft,
if the following checks are not performed on the AHMI (considering all additional information available in the GECO and based on your routine procedures and checks).

Checks in Horizontal View:	
Routing and waypoints in general	1 2 3 4 5 6 low high
Comments/Explanation:	
Routing ends at the runway	1 2 3 4 5 6 low high
Comments/Explanation:	
Checks in Vertical View:	
Cruise Flight Level	1 2 3 4 5 6 low high
Comments/Explanation:	
Intercept altitude	1 2 3 4 5 6 low high
Comments/Explanation:	
Vertical profile ends at runway	1 2 3 4 5 6 low high
Comments/Explanation:	
Airport elevation	1 2 3 4 5 6 low

	high
Comments/Explanation:	

How much effort was necessary to perform these checks?

Horizontal view:	
Routing and waypoints	1 2 3 4 5 6 low high
Comments/Explanation:	
Routing ends at the runway	1 2 3 4 5 6 low high
Comments/Explanation:	
Vertical view:	
Cruise Flight Level	1 2 3 4 5 6 low high
Comments/Explanation:	
Intercept altitude	1 2 3 4 5 6 low high

Comments/Explanation:	
Vertical flight-path ends at runway	1 2 3 4 5 6 low high
Comments/Explanation:	
Airport elevation	1 2 3 4 5 6 low high
Comments/Explanation:	