Didactical approach for the design of a learning environment for airline pilots

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Abstract: The aim of this article is to present how a regional airline carrier enhances its pilots training resources. In this work context, we present how a didactical analysis of the concepts associated with the airplane take off sequence gives a framework to design a simulator. The goal of this environment is to create a context for experience and learning in which all the senses related to the airplane take off limitations (with one engine failure) will be made. This "virtual model" focuses on user's sense building, associated with the daily working skills required.

Key words: simulation, pilot training, senses building.

Introduction

Nowadays, the airlines have to face new challenges in order to provide the more appropriate training, according to European (international) regulations, efficiency and profitability criteria.
The pilot training is divided into two parts, the theoretical courses i.e. the declarative and procedural knowledge and then the practical training based on flight time which focuses on procedural, decisional and gestural knowledge. Following the initial training a pilot must complete the Type Rating to be allowed to fly the company's type of airplane.

Currently, full flight simulator is used in initial and recurrent training (twice a year). These full flight simulators, through hydraulic actuators and realistic visualisation, reproduce every phase of flight. This very sophisticated equipment is quite expensive to use (the acquisition price of one unit is approximately the price of one airplane) and deals with the learning of declarative, decisional and gestural knowledge. Up to today, there is a gap between these two aspects of learning. While full flight simulator is pointing out procedural and decisional aspects of the training, through realistic exercises (phase of flight, systems failure, that may be encountered in real flights), the declarative knowledge is not reviewed but is considered acquired, this is why, our target is to fill this gap, designing a learning environment to develop the declarative knowledge, by operating the different concepts related to a dedicated knowledge of handling the airplane. In our research we are focusing on the take off sequence. This tool will be used during initial training prior to starting the full flight sessions; it will facilitate acquisition (storage) and retrieval of declarative and decisional knowledge, gestural training is not taken into account (we do not consider how to handle the airplane in this flight sequence).
A technology-based learning environment which simulates a take off sequence according practical criteria such as aircraft weight, outside air temperature, airport altitude etc; requires a multifaceted vision: a didactical approach and a computer science one. We will present first how the didactical analysis defines the knowledge model and the diagnosis core and then how the computer science' vision provides its computational representation: Finally we will address further concerns; the implementation and use of technology-based training environment in professional practice meet time and cost savings criteria and moreover provides an operative dimension of the knowledge.

1- Professional didactical analysis

1.1 – Methodology

We have divided this didactical analysis into three main parts[1]

-First, the knowledge of the studied field; through the airline pilot courses (definitions and graphical representation of the take off), the company's standard operations and procedures (which relates the way data have to be used).

In airline operations a take off is a phase very accurately defined (figure 1) during which, criteria must be checked and met prior each take off. These criteria provide the maximum take off weight according to the conditions (temperature, runway length, environment –mountains in the vicinity of the airport- , etc.): these criteria induce limitations due to: runway length, climb requirement in the different segments (figure 1), climb requirement to meet the obstacle clearance

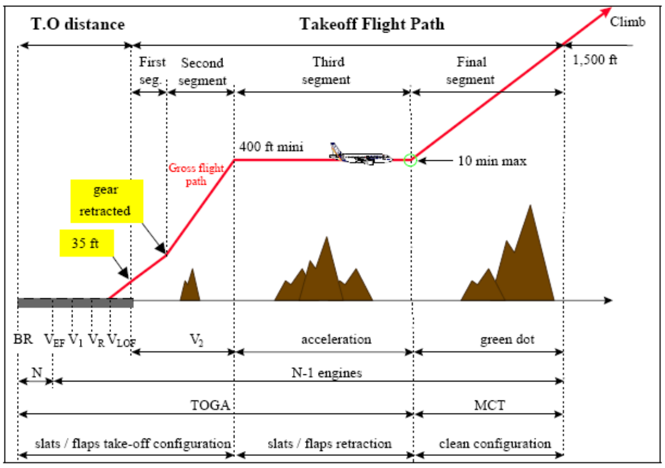


Figure 1 – take off representation

-Secondly how this data is used and how sense is made of it: We studied different crews in several working situations (they were supposed to work in pairs to improve their verbalization). As there are a lot of parameters, linked all together, should one be modified this makes an impact to other data. For instance, if the runway length is modified, there is an obvious and direct effect on the maximum take off weight due to runway, but there is also an <u>induced</u> effect on maximum take off weight due to obstacle clearance.

We focused our observations on these induced links, which are not clearly explained in training manuals (these are static and not dynamic like in the "real world").

The diversity of situations may generate false interpretation and action in operation if these induced concepts are not perfectly known.

The aim of the daily take off limitations computations is to assess what is the airplane maximum weight when taking off in order to meet the runway length, segments climb gradient and climb requirement for obstacles, according to several variables (changing parameters).

-Finally we underlined the gap between the required skills in working situations and knowledge from theoretical courses (extracted from different manuals).

1.2 – Knowledge modelling

From this didactical analysis we gathered all the concepts involved in the take off sequence and every link between them. This conceptual field is described as the referential one. From our observations and an *a priori* analysis, we noted all the trainees misconceptions: These were either that a connexion was created between concepts which should not exist or that there is a lack of connexion where one is required. From this we drew up the whole conception of our experience and research represented in. figure 2a and figure 2b.

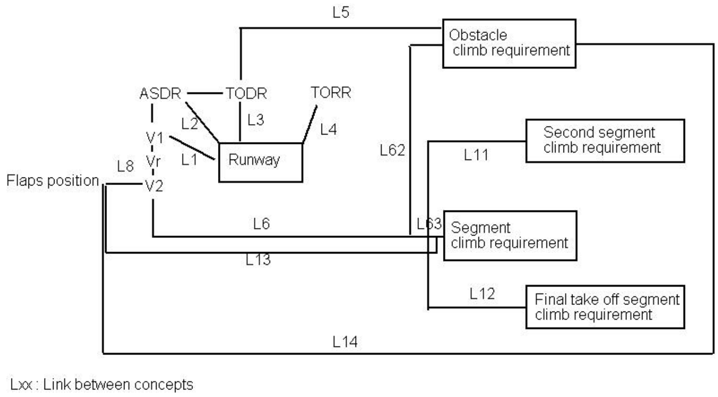


Figure 2a – Referential conceptual field

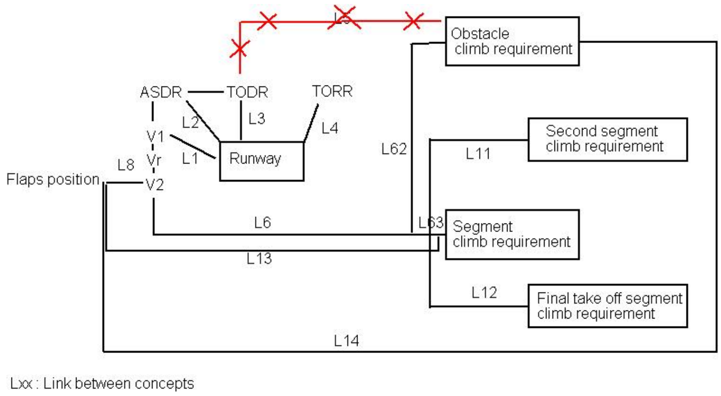


Figure 2b – trainee conception representation

2- Computational representation: real world transformation for knowledge modification

The simulator design relies on a set of research led on the use of simulation tools in professional training (airline pilot, forest fire management) **[2]**, **[3]**

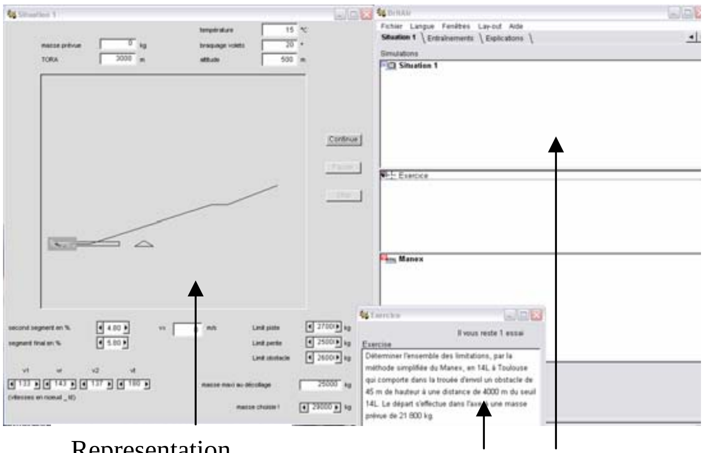
Moreover, this design is supported by our previous analysis, it becomes the link between one learner (and his/her own knowledge – conception-) and a referential field via simulated situations (scenarii consistent with work operations). This referential situation has been validated by training experts such as the flight chief instructor.

From these experimentations, we have built situations allowing user's to work on his/her conceptions.

These situations allow skills building through the decomposition of concepts and their links and offering the learner choice by representing different solutions.

The environment was designed with a self-discovering feature, it fulfilled all procedural aspects of the work (choice of the operational documentation, charts, etc.) and featured with a realistic representation.

As these concepts are built in action, controls are given by the representation of the choices made. The system must produce relevant feedback to the learner’s actions at the interface. When starting the simulation of the take off, after having defined what was the take off weight and associated take off speeds, if the airplane is too heavy for the runway length the learner will observe the airplane “crashing” out of the runway, and similarly for obstacle clearance.



Representation environment

Exercices and situations

Figure 3 – Training environment take off representation

This environment presents problems to be solved using simulation software. The platform used for this design is SimQuest 2.0 (especially suited for creating discovery learning environment).
SimQuest enables to design multimedia learning environment in which can be built :

- models,
- learning interfaces,
- assignments,
- explanations.

User’s activity is analysed in terms of possible involvement in identified conceptions (learner’s own organised pieces of knowledge). Afterwards, the didactical decision core determines the more appropriate feedback to provide to the user. Possible feedback includes:

- presentation of another problem to solve,
- redirection to the definition of the dedicated concept or to a precise part of the training course,
- representation of the take off sequence, according the learner’s selected parameters.

This simulator is currently used as concept demonstrator; hosting all the didactical scenario: Later on it will be designed as “open” in order to make easy the integration of new situations, the learner’s actions tracking module should allow one to understand the users reasoning through his/her actions.

3- Conclusion

This article points out that the design of this simulator has been supported by an interdisciplinary approach; first a deep analysis of the take off sequence (professional practice study), then with a computational work.
In other words, initially we developed a knowledge model that will have to be integrated in the system thus to link the didactical core to the user’s diagnosed state of knowledge (conceptions).
Usually simulated oriented training allows the user to build experience for complex systems management. The trainee is provided with relevant feedback on his/her knowledge during the problem solving activity.
This developed learning environment will be used prior to being confronted with Full Flight Simulators (i.e. prior to being confronted with “real simulated” situations). It will enhance the understanding of the take off and its implication and consequently improve the decision making in professional situations when work load is important.
For these reasons this learning tool will complement current training equipment.

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