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Design of an Aircraft Cabin Testbed for Stress-Free Air Travel Experiment

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ABSTRACT

The paper presents an aircraft cabin testbed that is designed and built for the stress free air travel experiment. The project is funded by European Union in the aim of improving air travel comfort during long haul flight. The testbed is used to test and validate the adaptive system that is capable to improve the passenger comfort during the long haul flight.

Keywords: aircraft cabin, testbed

1. INTRODUCTION

Test bed is a platform on which an assortment of experimental tools and products may be deployed and allowed to interact in real-time. Successful tools and products may be identified and developed in an interactive, evolutionary, and interdependent process. A test bed also can be defined as an environment that is created for testing and validating purpose. The aircraft cabin testbed is built for work package 4 of the European Project, "Smart Technologies for Stress Free Air Travel". It is used to test and validate the intelligent system that is developed. The test bed is the cabin like testing platform for the system and designed to simulate the real freight experience. The testbed consists of economy class section, business class section, a galley and a lavatory. The built up size for the testbed is approximately 36 m^3. A sky like interactive environment is created at external location to enable real flight experience. In addition, the testbed is built on top of the motion platform. The motion platform is used to simulate the flight environment such as taxi, taking off, turbulence, descending and landing. The design of the testbed is to give the total user experience in the air travel environment. In this paper, the aircraft cabin testbed is presented.

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2. EUROPEAN PROJECT: Smart tEchlogies for stree free Air Travel

The Smart tEchnologies for Stress free Air Travel (SEAT) project is funded by Europeran Union that focuses on upstream questions of an integrated system in the aircraft cabin that i) creates a healthier and more comfortable cabin environment through reduction of noise and vibrations and user specific climatic controls and ii) provides a high level of customer focused services that simulate home and office environment. The SEAT project aims to develop such new radical approach through integration of cabin systems with multi media features and will strongly draw on preceding European projects where some of the partners have been already involved. The project is focused on [SEAT, 2006]:

- creation of a "smart seat" that adapts the climatic characteristic to the passenger physiological status;
- integrated physiological monitoring system with health alert options;
- development of a system for active/passive vibration dampening incorporating smart textiles;
- development of interactive entertainment; and
- development of fully integrated cabin passenger services.

The SEAT consortium contains 12 partners. The project runs from September 2006 till August 2009. The consortium focuses on an integral approach to a new generation of cabin environment through [SEAT, 2006]:

- integrated system that incorporates smart technologies to actively address users' requirements
- context aware entertainment
- active and passive dampening
- use of integrated wearable technologies for physiological modeling and adaptable environment
- smart noise control and vibration dampening

Technical University Eindhoven, contribute as the Work Package 4 (WP4) leader. We aim is to develop a new intelligent in-flight entertainment system where both entertainment contents and entertaining interactive patterns are sensitive to passengers' personal information and different fly phases to address the passenger's personalized entertainment requirements.

3. THE FLIGHT SIMULATOR

A flight simulator is a system that simulates the flying experience of an aircraft as realistic as possible. The flight simulator can be a video games or a full size high-end aircraft model that controlled by state of the art computer technology. There are various flight simulator or air trainer are available in the market. The flight simulators are used by the aviation industry for design and development purpose as well as for the training of pilots and flight cabin crew. Figure 1 shows a flight simulator that used to train the airline cabin crew. Figure 2 shows the interior view of a commercial flight simulator.

Figure 1 Commercial flight simulator [EDM Ltd., 2009]

Figure 2 Interior of a commercial flight simulator [TFC, 2009]

For the aviation industry, Czech Airlines have a cabin simulator that used to train the cabin crews and the pilots; it will use for other purposes as well, such as public usage and standard on-board passenger services. The simulator is mounted on a movable base, which allows it to rehearse all routine, as well as non-routine, procedures which take place on board the aircraft in realistic flight conditions. For the motion, the cabin simulator is mounted on a hydraulic base. Some of the cabin windows are equipped with monitors for the visualization of simulated landscapes [Czech Airlines, 2008].

United Airlines Training Centre is equipped with aircraft simulator for training purpose. The simulator is a fully operational mockup of a Boeing 747 passenger cabin. The cabin trainer and its video system help provide hands-on instruction. United uses the cabin trainer primarily for instruction in food preparation and presentation, passenger safety equipment demos and customer interaction. The cabin trainer is unique for United in two ways. First, it is complete in every detail, offering trainees a fully operational galley, aircraft video and audio systems, and first class, business class and economy class sections. Second, its elaborate video system allows instructors to show demonstration taking place on board the simulator to large groups in an adjoining classroom [United Visual, 2008].

For the educational institution, Cranfield University houses two aircraft cabin simulators, the Large Cabin Evacuation Simulator and the Boeing 737 cabin simulator. Both of these simulators are used to conduct research into various aspects of cabin safety. For example, previous research has examined the effectiveness of cabin crew procedures and behaviour in emergencies, passenger evacuation rates under various scenarios and conditions, and passenger attention to safety information. Research trials in both simulators can be filmed using a range of video recording equipment, and cameras can be located as required. Video footage can be taken in conditions of darkness using infra-red lighting and IR sensitive cameras. Thermal imaging cameras can be used to obtain footage where non-toxic smoke has been introduced into the cabin(s). A video editing suite is also available, with time-coding equipment, to analyse research footage [Cranfield University, 2009].

Oklahoma State University and Boeing conducted the study to determine participants' comfort levels at various pressurization levels in a flight simulator. For this study, the participants experience a 20 hour flight regime in an airplane-cabin simulator. The simulator was pressurized to five different altitude equivalents, and each level was tested nine times. Participants sat in standard economy class seats, ate typical airline food, watched movies and slept as they would during a real flight. In this case, the simulator is used for research purpose [Boeing, 2008].

4. SEAT Testbed

The SEAT testbed was constructed from a mix of high quality durable materials such as aluminum, steel, composites and wood. Due to the short timeline of the project and to minimize costs, the final material for the structure is aluminum, wood and MDF materials. All materials were finished with a primer and an appropriate paint finish to common aircraft interior color scheme. The testbed structure is designed and built based on modular method, where each section can be dismantle and assembly easily. The structure and floor is made from wood to provide the required fuselage strength & profile. The roof of the aircraft cabin testbed is flat.

The final dimensions of the testbed is: L 4.8 m x W 2.8 m x H 2.7 m. The size is constraint by the funding and space that is available in the building. The challenge for the testbed is to build with low cost and able to simulate a real flight condition during the experiment. Figure 3 shows the conceptual design of the testbed. Figure 4 shows the plan view of different section inside the testbed.

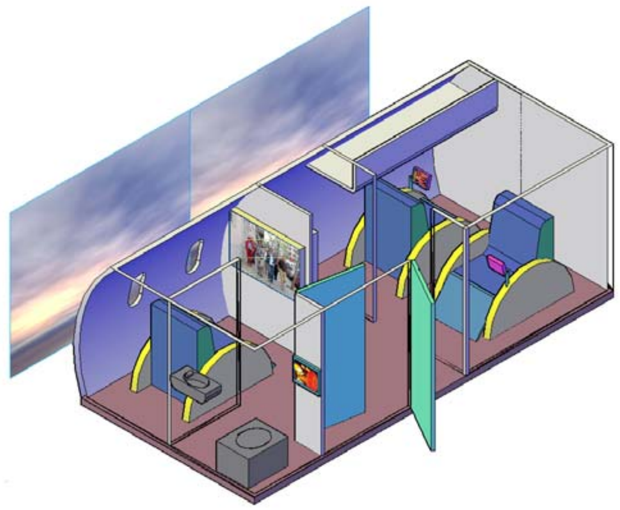

Figure 3 The conceptual design of testbed

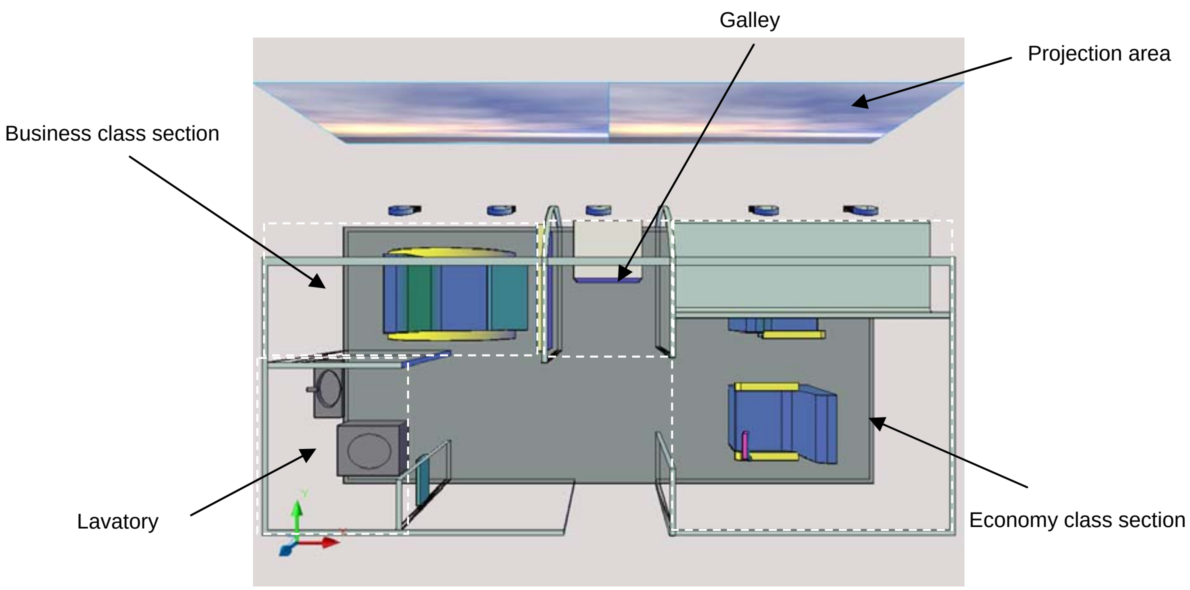

Figure 4 The testbed in plan view

During the design process, the arrangement of the testbed interior is change due to the constraints that are occurs during the process. For example, when the space that used to install the testbed become smaller, the entire testbed size will be reduced as well. The entire testbed is redesigned with a solution that is not affected the original plan and capable to fulfill the strength requirement. Figure 5 shows the final interior arrangement of the testbed.

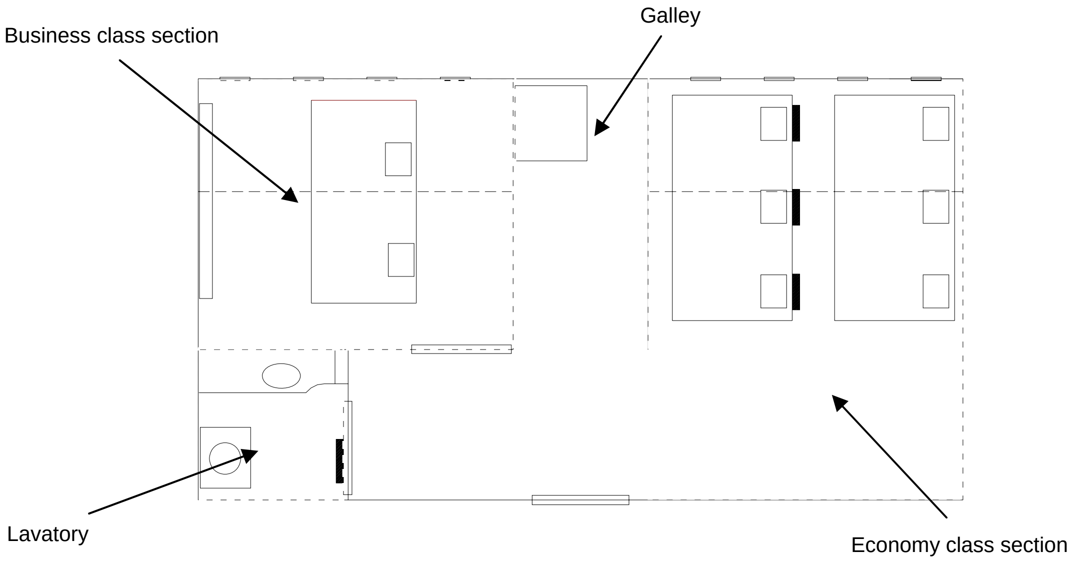

Figure 5 The final arrangement of the testbed cabin

4.1 Gang Way and Access Door

A short gang way is built to simulate the gang way as in the airport. The testbed is incorporated with one access door. This will have a lock in addition to a full scale picture of an aircraft door mounted on the inside. Figure 6 shows the gang way and access door.

Figure 6 The gang way and a access door

4.2 Interior

Internally the testbed cabin is fully fitted out with:

- window panels
- ceiling panels
- business class section
- economy class section
- galley
- lavatory
- partitions between seating areas and galley.

The port side window panels of the testbed were fitted with simulated windows with clear see through glass. The window is all with blinds. Commercial quality carpet will be fitted throughout the testbed with dark blue color. Figure 7 shows the internal side window panels.

Figure 7 The internal side window panels

Bussiness Class Section

In the business class section, it is equipped with a massage chair, a touch screen monitor, a high quality sound system and a 47 inch ambient television. Figure 8 shows the business class section.

Figure 8 The business class section

Economy Class Section

There are two row of economy class seat where each seat equipped with a touch screen monitor and a noise reduction ear phone. Figure 9 shows the economy class section.

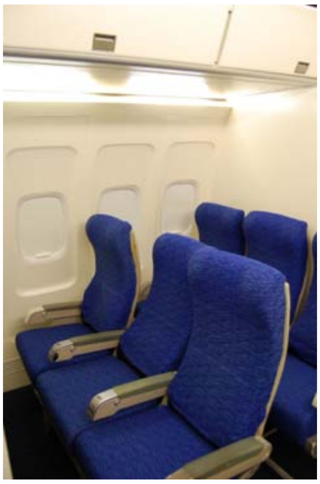

Figure 9 The economy class section

Galley

The testbed is designed with a galley functions and shelves to store items in the position of the galley. The galley equipped with a refrigerator, a microwave and peripheral compartment. Figure 10 show the galley of testbed.

Figure 10 The galley

Lavatory

The lavatory is designed and built for the passenger during the 10 hours flight experiment. The lavatory equipped with a portable camping car toilet, a wash basin and a touch screen monitor. Figure 11 shows the outside view of the lavatory.

Figure 11 The lavatory

Simulation Section

The simulation section is located outside of the testbed. The simulation section consists of a wall and a floor that were painted in white color. One wide screen LCD projector is used to project the real flight condition such as airport view, sunset view and night view. Figure 12 shows the simulation view from business class section.

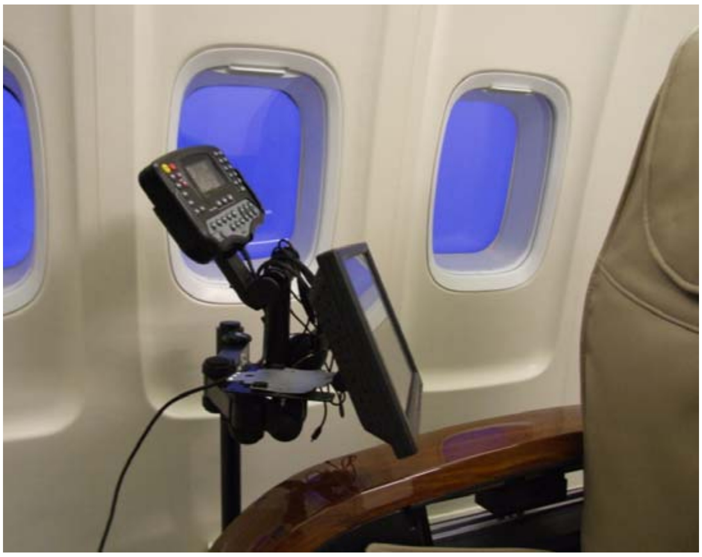

Figure 12 The simulation view from business class section

Motion Platform

In order to simulate the real flight condition and to keep the manufacturing cost low, an innovative solution has been created. In term of hi-tech motion solution such as hydraulic or pneumatic methods, we are using an innovative approach to simulate the flight experience. We have designed and constructed a motion platform to simulate the flight experience during air travel such as boarding, taxing, take off, on the air, turbulence, descending, touch down, etc. The testbed is designed to move in 5 axis (X, Y, Z, A and B) as shown in Figure 13. The movement of testbed can be manually control or automatically control. The industrial automation device is used to control the testbed motion.

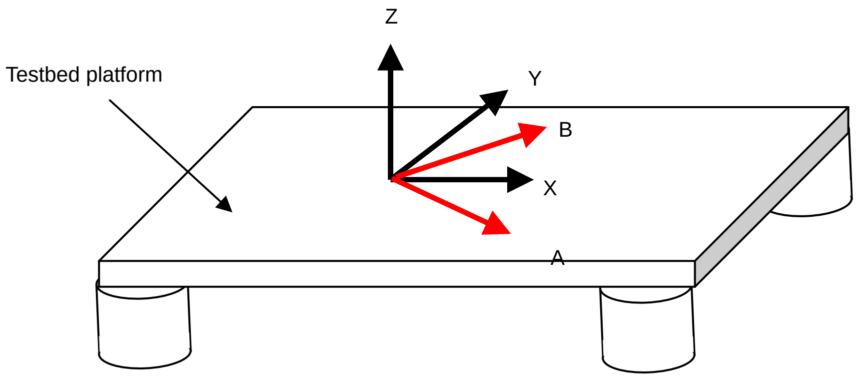

Figure 13 The motion platform

5. CONCLUSION

We have introduced and described the aircraft cabin testbed for the European funded project called SEAT. We described the interior design of the aircraft cabin testbed with description and photo. We have created an innovative low cost solution to design a motion platform for the testbed. Overall, we believe that the SEAT testbed installation can be seen as valuable contribution to small and medium scale research institution that focus on aviation industry research and development.

ACKNOWLEDGEMENTS

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