The Flying Laboratory – Multipurpose Surveillance and Observation Platform

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Abstract. The Flying Laboratory is the name of the project created in Air Force Institute of Technology. Is it an autonomous system that can be used for testing avionics systems in real flying conditions as well as for surveillance or reconnaissance purposes. The Flying Laboratory enables conducting tests outside big airports, on small private airports or even in the areas with poor aviation infrastructure. Wide range of research equipment can be carried on the airplane, including interferometer, spectrometer, pollution measurement system, contamination measurement system, surveillance head. The system consists of specially converted and equipped light airplane (Sonex), ground mobile station, cooperating with the airplane during flight tests and special trailer for carrying the airplane. The data obtained during flights is not only recorded on a recorder mounted onboard of the aircraft, but is also transmitted in real time to the mobile ground station. The crew in the mobile ground platform can analyze data during the airplane's flight, without having to wait until the plane lands. At the beginning of December 2011 the Sonex airplane was registered in the Polish Registry of Civil Aircrafts and since then has been used in several projects.

Keywords. flying laboratory, flight tests, data transmission, data registration, avionics systems

1. Introduction

Equipment used in avionics need to be thoroughly checked before it can be mounted on the real aircraft. Sole laboratory testing is not enough as some equipment may change its performance during real flight conditions. That's why the possibility of testing the equipment during in-flight conditions is so important.

The aim of the project conducted in Air Force Institute of Technology was to build an autonomous and universal flying platform on which different avionics and other onboard equipment could be mounted and tested in real flight conditions, before it is mounted on a target aircraft [1]. One of the assumptions was to enable the system to be also used for surveillance or reconnaissance purposes, as different sensors or a surveillance head could be mounted on the aircraft itself or under the wings or fuselage. The system is called The Flying Laboratory and since the beginning of December 2011 the Sonex airplane (which is the main part of the system) is registered in the Polish Registry of Civil Aircrafts. The Flying Laboratory since then has been used in several projects.

2. The System Description

The system consists of [2] :

- specially converted and equipped light airplane (Sonex) (Fig.1a);
- mobile ground platform cooperating with the airplane during flight tests (Fig.1b);
- special trailer for carrying the airplane (Fig.1c and 1d).

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a)


b)


c)


d)


Figure 1. Elements of the Flying Laboratory a) Sonex airplane b) mobile ground platform, c) and d) special trailer for carrying Sonex airplane – c) empty, d) with loaded airplane.

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2.1. The Airplane

The light airplane that is the basis of the Flying Laboratory is a commercially offered airplane, built on the kit provided by Sonex Aircraft LL. The aircraft is a single-engine two-seater monoplane and its structure has been modified to meet the requirements of conducting flight tests. The modifications included changes in the structure of the wings – they were strengthen and equipped with beam attachment elements with pylons for mounting containers with research and measuring instruments. Also the floor of the storage compartment of the aircraft has been strengthen, ensuring the possibility of carrying the test equipment weighing up to 18kg. The second seat of the airplane can be used either as a seat for equipment operator or as an additional storing space. The airplane is equipped with data (spatial position of the airplane, speed, altitude etc.) and picture (from the camera built-in in the cockpit or other visual sensor generating PAL signal) transmission system the mobile ground station. Tested devices can be placed in the following locations:

- on the underwing pylons (carrier variant) - the maximum weight of the carrier together with tested equipment amounts to 35 kg. Flight test has to be conducted with two carriers, to ensure symmetric flow around a body and the symmetry of weights.
- inside the cockpit – for devices that are intended for internal installation and supplied by the airplane wiring system; maximum weight of the tested devices together with the frame is 60 kg. There is a door in the cockpit which makes possible for equipment to be oriented on the terrain under the airplane (sensors, surveillance head).
- under the cockpit - external devices (sensors, observation payloads, antennas etc.) may be installed under the front right part of the fuselage; the maximum weight of tested equipment amounts to 30 kg.
- on the wing tips – only for testing small and light equipment (up to 2kg – e.g. antennas).

2.2. The Mobile Ground platform

The main advantage of the Flying Laboratory is the fact that the data obtained during flights is not only recorded on a special recorder mounted onboard of the airplane but is also transmitted in real time to the mobile ground platform. The crew in the ground platform can analyze data during the airplane's flight, without having to wait till the airplane landing. Data received from the airplane can be analog or digital and come from both the device-under-test and airplane's avionics systems [3]. The base of the mobile ground platform is a "Van" car in which the cargo space has been converted to enable transport of research team (consisting of three or four persons) and to provide them comfortable working space at the destination site (Figure 2).

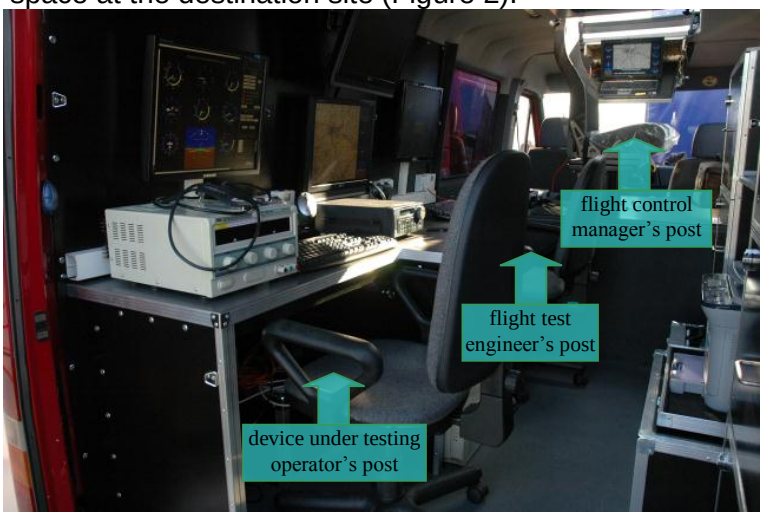

Figure 2: Ground mobile platform working posts.

The ground platform is designed to provide working space for 3 people [4]:

- flight control manager

This person's task is to organize the flight, contact with the Air Traffic Center, ensure conflict-free flight of the airplane in the airspace and supervise the safety of research task performance. For this reason the station is equipped similarly to a control tower (Air Traffic Control) and has an air band radio station, weather station, telephone and fax communication with air traffic services.

- flight test engineer

This post is intended to receive, analyze and archive digital and analog data transmitted from the airplane. It is supplemented with a TV screen for the image received from an onboard camera. It can present the image of the inside of the cabin, of the terrain above which the aircraft is flying or the image documenting the behavior of tested devices and components attached to airplane's fuselage.

- device under testing operator

This post is intended to receive, analyze and archive digital and analog data transmitted from the airplane, which are connected with the device-under-test.

2.3. Trailer

The airplane is designed in such a way that its wings can be dismantled and the airplane with its equipment can be mounted on the trailer, pulled by the mobile ground platform. The airplane can be then easily transported to its destination airfield, without the necessity of performing long flights. On the trailer there is a power generating unit supplying equipment of the research stations, toolkit necessary to service the airplane and aviation fuel reserve. The entire equipment of Flying Laboratory enables conducting tests outside big airports, on small private airports or airports belonging to flying clubs or even in the areas with poor aviation infrastructure.

3. Conclusions

The Flying Laboratory is a fully autonomous research platform, which can be used for testing avionics equipment in real flying conditions or for surveillance purposes. Tests conducted in Air Force Institute of Technology have proved full functionality of the platform and full compliance with initial assumptions. Since 2012 the Flying Laboratory has been used in several project, proving its usefulness.

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