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# DATA ACQUISITION AND PROCESSING TECHNOLOGY FOR FLIGHT SIMULATOR DATA PACKAGE

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**ABSTRACT**

In this paper, we present the data acquisition and processing technology for the flight simulator data package, which is the key stage for the development of the flight simulator data package. It is important to cooperate with the aircraft manufacturer, flight simulator manufacturer and the Civil Aviation Administration of China (CAAC) to develop the flight simulator data package. The data package is considered in the design and test stage of aircraft, including wind tunnel tests, ground tests and flight tests. Design and performance data for the flight simulator need to consider in the flight test, such as column forces, wheel forces, pedal forces, displacement and rudder angle in certain flight status and the corresponding parameters of aircraft movement, height, speed, attitude angle and angular velocity history curve. With the required data package, the quality and development cycle for a flight simulator are improved.

**KEYWORDS**

Flight simulator, data package, data collection technology, data processing technology.

## 1. INTRODUCTION

Data package provides adequate fidelity for flight simulators to meet flight crew training requirements. The data required by flight simulator manufacturers and users to support their activities can be categorized as: (1) configuration/design data; (2) simulation modeling data; (3) checkout data; (4) validation data; (5) flight test validation data; (6) proof of match data; (7) system verification data. Flight test validation data are defined as time histories, snapshots and graphical presentations of data obtained from airplane flight test. The data are provided by the airplane manufacturer, or other sources of approved data to allow comparison with FSTD performance in order to, among other things, gain approval from Aviation Regulatory Authorities for use of the flight simulator. Based on a study, on new or major derivative programs flight test data are typically used to validate all test conditions [1,2]. The aircraft manufacturers in the world have invested a lot of manpower and funds to develop the flight simulator data package. Airbus established the GO5 organization in 1981 dedicated to do the research and operation on the flight simulator data package. The data collection and processing technology for the flight simulator data package in China is in a blank state. With the lack of data package, it is a limitation for the Chinese flight simulation training device manufacturers to develop high-level flight simulator. In this paper, the author focuses on the flight test validation data and presents the data collection and processing technology for the flight simulator data package.

## 2. TEST PROGRAM PLANNING

According to a research, flight simulator data package not only need to meet the relevant CAAC regulations and civil aviation standards, but also to meet the civil aviation authority requirements of major advanced countries, such as CCAR-60, FAA Part 60, ICAO Doc 9625-AN/938, 2nd Edition and EASA FSTD-A [3-5]. The aircraft specifics such as flight envelope limits and flap, gear, airspeed limits should be known to develop the test program planning. Moreover, the data acquisition system and special sensors and equipment should be installed on the aircraft to get the performance data of the aircraft, such as pilot force measurements. The procedure of test program planning is shown in Figure 1.

## 3. FLIGHT TEST PLAN DEVELOPMENT

The objectives, procedures, flight conditions, and aircraft configurations for each maneuver will be presented. All of the test procedures are within the normal flight envelope of the aircraft. The flight test envelope of certain aircraft is shown in Figure 2.

## 4. INSTRUMENTATION REPORT

After the flight test plan is developed, special sensors and equipment should be installed on the aircraft to get the performance data of the aircraft.].

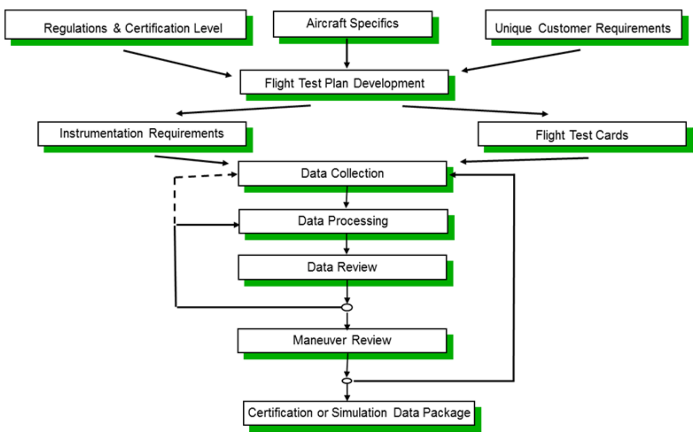


**Figure 1:** Flow chart of test program planning.

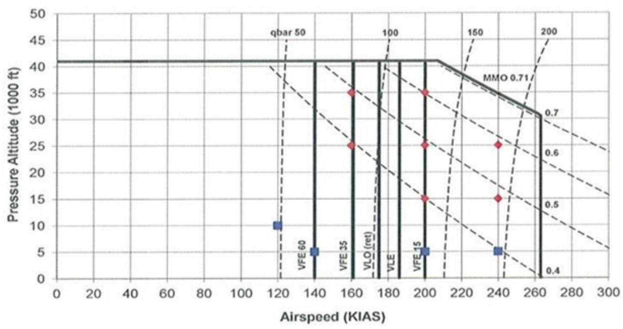


**Figure 2:** Flight test envelope of certain aircraft.

### 4.1 Measured Parameters

According to the requirement of data package, parameters such as column forces, wheel forces, pedal forces and rudder angle in certain flight status should be measured [6-8]. An example list of measured parameters is shown in Table 1.

**Table 1**: An example list of measured parameters.

| Name | Parameter Description | Units | Source |
|---|---|---|---|
| AX | Longitudinal Acceleration | g | AHRS Bus |
| AY | Lateral Acceleration | g | AHRS Bus |
| AZ | Vertical Acceleration | g | AHRS Bus |
| ROLL_RATE | Roll Rate | deg/sec | AHRS Bus |
| PITCH_RATE | Pitch Rate | deg/sec | AHRS Bus |
| YAW_RATE | Yaw Rate | deg/sec | AHRS Bus |
| PITCH_ATT | Pitch Attitude | deg | AHRS Bus |
| ROLL_ATT | Roll Attitude | deg | AHRS Bus |
| HEAD_MAG | Magnetic Heading | deg | AHRS Bus |
| HEAD_T_FMC | True Heading | deg | L-IOC-1 |

### 4.2 Instrumentation Installation

he data acquisition equipment to measure some parameters, such as column forces, wheel forces, pedal forces, displacement and rudder angle in certain flight status and the corresponding parameters of aircraft movement, height, speed, attitude angle and angular velocity history curve should be installed on the aircraft [9-11]. The equipment to measure pedal forces and column forces are shown in Figure 3 and 4.

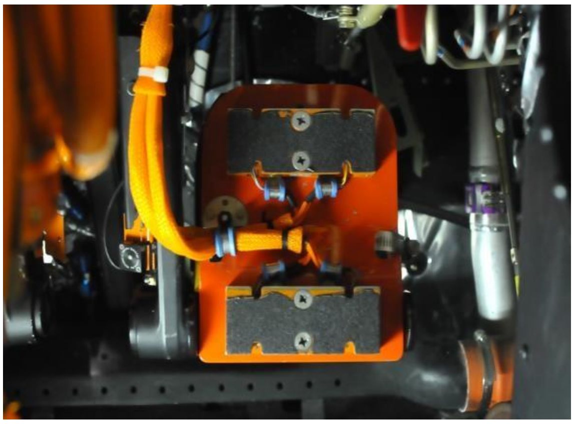

**Figure** 3: The data acquisition equipment to measure pedal forces.

**Figure 4**: The data acquisition equipment to measure column forces.

### FLIGHT TEST RESULTS

The aero code uses a standard buildup of stability- axis aerodynamic coefficients for the six degrees of freedom. This includes typical terms to define the contributions of primary and secondary control surface deflections, rate effects, and configuration effects (flap and gear).

Study showed the basic lift curve (CLBASE) can be developed directly from flight test data [12-15]. Maneuvers that cover a wide range of angle of attack are analyzed (stalls and slow acceleration / deceleration). These maneuvers are quasi-stable, so lift is approximately equal to weight. Body axis data transformed to the stability axis. The result is shown is Figure 5 and 6..

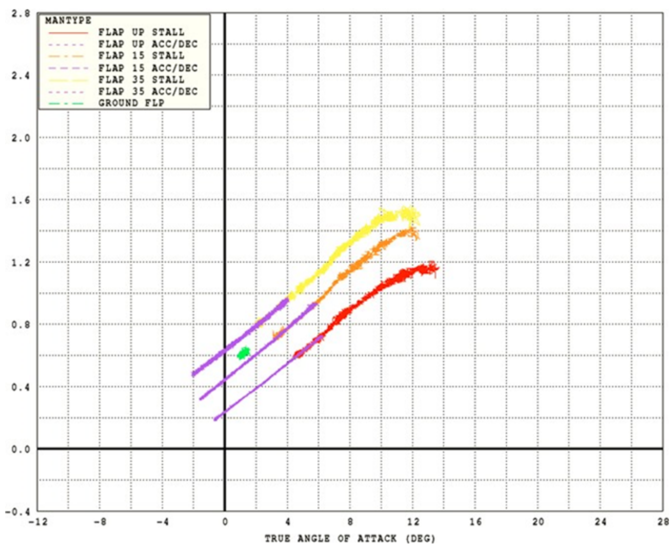


**Figure 5:** Lift curve slope from flight test data.

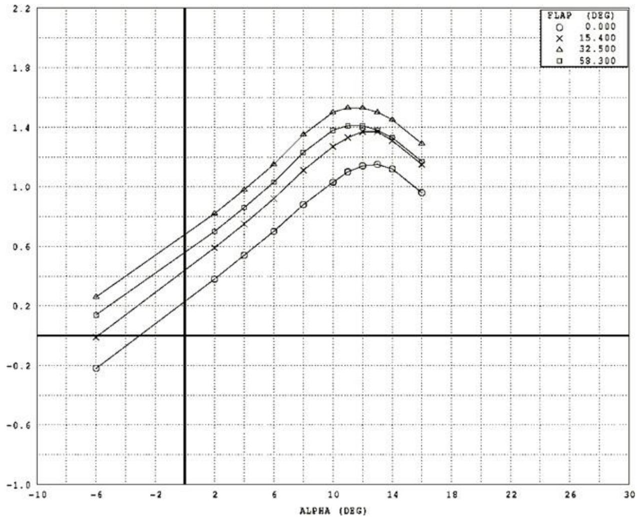


**Figure 6:** Lift curve slope used in the final model.

The aerodynamic drag of the aircraft must balance the thrust for trimmed flight conditions (no acceleration). Thrust is generated from the engine model. The trim portion of all straight and level maneuvers can be analyzed to determine the drag required to balance the computed thrust. The result is shown is Figures 7 and 8**.**

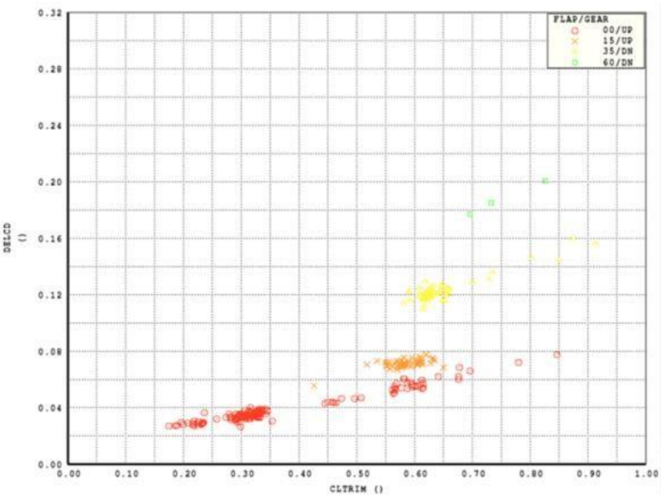


**Figure 7:** Basic drag curve from flight test data.

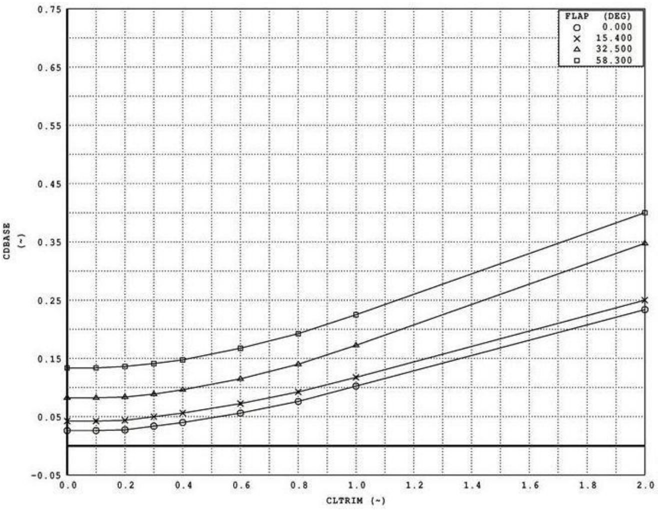


**Figure 8:** Basic drag curve used in the final model.

## 6. CONCLUSIONS

The data acquisition and processing technology for the flight simulator data package is presented in this paper. The flight test plan is developed according to the procedure of test program planning. Based on the requirement of data package, the test parameters are measured by the special sensors and equipment installed on the aircraft. As a case study, the basic lift curve and the basic drag curve can be developed from flight test data. With the required data package, the quality and development cycle for a flight simulator are improved in China.

## REFERENCES

[1] CCAR-60. 2005. (China Civil Aviation Regulations), Flight Simulation Training Device Qualification and Use.

[2] FAA. 2008. (Federal Aviation Administration), 14 CFR Part 60 Flight Simulation Training Device Initial and Continuing Qualification and Use.

[3] IATA. 2009. (International Air Transport Association) Flight Simulation Training Device Design & Performance Data Requirements.

[4] EASA. 2008. (European Aviation Safety Agency), JAR-FSTD A: Aeroplane Flight Simulation Training Devices.

[5] Ga, G., Li, Zhang, H.Z., and Z. G. Ba, Z.G. 2013. Development and application of flight simulator management information system based on Web technology, Journal of Applied Sciences, 13, 3936-3940.

[6] Tarantino, G., Fazio, C., Sperandeo-Mineo, R.M. 2010. A pedagogical flight simulator for longitudinal airplane flight, Computer Applications in Engineering Education, 18, (1), 144-156.

[7] Vossner, R., Braunstingl, H., Ploner-Bernard, Sontacchi, A. 2005. A new framework for a sound system for realtime flight simulation, in Proceedings of the 8th International Conference on Digital Audio Effects (DAFX-05), Madrid, Spain, 20-22.

[8] Meng, K.W., Huang, M.C., Yang, D.L., Chung, Y.C. 2008. Implementation of an Intelligent HLA-Compliant Application Layer Gateway for Real-Time Flight Simulation, Computer Intelligent Systems Design and Applications, 1, 421-426.

[9] Zhang, L., Jiang, H.Z., Li, H.G. 2007. PC Based High Quality and Low Cost Flight Simulator, Automation and Logistics, 10, 1017-1022.

[10] Anon. 2009. Manual of Criteria for the Qualification of Flight Simulation Training Devices. Volume 1 – Aeroplanes, ICAO, 3rd edition.

[11] Zaal, P.M.T., Pool, D.M., De Bruin, J., Mulder, M., Van Paassen, M.M. 2009. Use of Pitch and Heave Motion Cues in a Pitch Control Task, Journal of Guidance, Control and Dynamics, 32, (2), 366-377.

[12] Zaal, P.M.T., Pool, D.M., Chu, Q.P., Van Paassen, M.M., Mulder, M., Mulder, J.A. 2009. Modeling Human Multimodal Perception and Control Using Genetic Maximum Likelihood Estimation, Journal of Guidance, Control and Dynamics, 32, (4), 1089-1099.

[13] Beukers, J.T., Stroosma, O., Pool, D.M., Mulder, M., Van Paassen, M.M. 2009. Investigation into Pilot Perception and Control during Decrab Maneuvers in Simulated Flight, in Proceedings of the AIAA Modeling and Simulation Technologies Conference and Exhibit, Chicago.

[14] Grant, P.R., Reid, L.D. 1997. Motion Washout Filter Tuning: Rules and Requirements, Journal of Aircraft, 34, 2, 145-151.

[15] Hosman, R., Hamman, B., Lehman, C., Pelchat, Y., Schroeder, J. 2001. Summary of the Panel Discussion on Motion Cueing Requirements, in Proceedings of the AIAA Modeling and Simulation Technologies Conference and Exhibit, Montreal, Canada.