

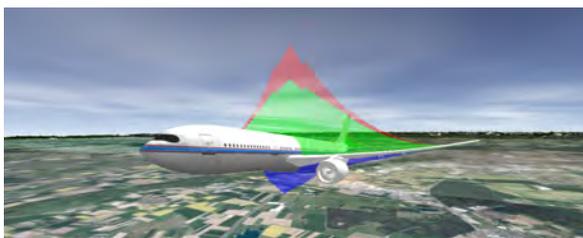
# Advances in Flight Dynamics Modeling and Flight Control Design by Using the DLR Flight Visualization and Flight Instruments Libraries

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## Abstract

Modelica has become an important language in the field of flight dynamics modeling and flight control design. Moreover, the possibility of rapid prototyping within these fields has become a key technology within the development of modern aircraft.



**Figure 1.** Example of a visualization created with the DLR Flight Visualization Library.

This paper presents the Flight Instruments and Flight Visualization Libraries developed within the DLR Institute of System Dynamics and Control. For the design of dynamic models and control systems, a visual evaluation of the dynamic simulation (Figure 1) is indispensable for a successful design and test process. Especially when it comes to aircraft models, an overview of the overall dynamics is needed. Therefore, the presented libraries provide fast assembly of fully configurable and generic flight visualization tools in which the view positions as well as the setup of Primary Flight Displays can be chosen freely. This provides the visual components of a rapid prototyping environment which can be used in the development of flight dynamic models and flight control laws.

In addition to the enhancement of this rapid prototyping process, a visualization framework has been developed and proven helpful in supporting the design process in terms of configuration analysis, simulation and experiments. The camera views and displays can easily be re-configured for each purpose and research focus area. Furthermore, the libraries can be used for desktop simulation, motion simulator experiments as well as flight testing on a real aircraft (Figure 2).

Thus, the developed libraries close the gap for integrating flight dynamics visualization into the Modelica environment using the DLR maintained Modelica Visualization Library. The two libraries open up the possibility of a completely accessible, in-house developed aircraft visualization and simulation environment.



**Figure 2.** Cockpit instruments in use for flight testing on a Cessna Citation aircraft.

The libraries are not only restricted to use in aircraft simulation, but can also be used for any dynamic vehicle simulation, e.g. underwater vehicles. The first part covered is the simulation of a moving vehicle in an environment, which provides the user with easy accessible visual information of the vehicle's attitude and moving direction. Secondly, instruments and displays can efficiently be used to embed important information into the visualization model or to generate a separate display. Thus, the overall process chain from model development, control design, simulation and testing is further enhanced and simplified. Additionally, all steps of the process chain are kept completely accessible for the engineer and no "black box" visualization tools are required. Both libraries are currently not distributed since development and extension are still ongoing.