Breaking the Testing Pyramid with Hybrid Simulation and Virtual Testing

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Airplane design and validation processes are changing rapidly. Virtual testing and hybrid simulation have become an important trend in the industry. In order to reduce the huge research cost and shorten the lengthy development cycle caused by design iterations and changes, the Model-Based System Engineering (MBSE) method is introduced across the industry. The traditional Building Block approaches that emphasis on uniaxial coupon test and full structure certification test are being challenged. Researchers are trying to use advanced testing and simulation methods, such as hybrid simulation and virtual testing, to replace the Building Block approach.

Hybrid simulation technique is an innovative and powerful approach of analyzing an integrated large-scale structural system under realistic loading conditions. Hybrid simulation combines the lab testing with numerical analysis to explore the benefits of both methodologies. The basic idea is to numerically represent part of the substructures using well-established mathematical models, while physically testing rest of the other substructures that may have complicated or unknown mechanical properties. The coupling between the two substructure sets is achieved by enforcing equilibrium and compatibility at the interface using transfer systems such as servo-hydraulic actuators.

In this study, general purpose FEA package ANSYS was used to model the numerical part of an airplane wing structure. ANSYS was connected to MTS test system through a unified framework of OpenFresco to perform hybrid simulation. A generic client element was implemented into ANSYS using its published programming interfaces. OpenFresco acted as the middleware to manage the communication between computational elements and MTS testing systems. This user element approach allows connected codes to run continuously and concurrently with high computational efficiency. Using an advanced compensation method, the hybrid tests were conducted successfully.

Before hybrid testing, virtual testing was conducted to simulate the hybrid test. Virtual model of the full testing system including controller, actuators, and fixtures was constructed and validated. Virtual testing provided valuable insight of the real test and played an important role in design evaluation.

Hybrid simulation and virtual testing are effective ways to evaluate aircraft design. These activities can be conducted before the full aircraft is available. They are alternative methods of Building Block approach and are effective tools to “break the pyramid”.

Full scale tests are still required for certification but the more that is known about the test article the greater chances of success in the full scale certification testing.

Keywords: *Virtual Testing, Hybrid simulation, Fatigue testing, ANSYS, OpenFresco*

The abstract should be written in one or two pages in reference to this format to describe objectives, results, conclusions, innovative steps and the significance of your work. It is encouraged to include several key figures and important references.

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Text of the summary. <Times 10, regular> The abstract should be written on regular 21 x 29.7 cm paper (A4) within a frame of 15 x 24.7 cm (margins left and right: 3 cm; top and bottom: 2.5 cm.). Use only original photos and illustrations, photocopies will not be accepted.
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Table 1. Table captions should be placed above the table. <Times 10, italics>
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LSP solution	Manufacturing technology	Costs of LSP	Effectiveness of LSP
Highly conductive metal coatings	Simple (metallized paints or sprays)	Low	Low
CFRP structure	Standard manufacturing process	Low	Very low
CNT-reinforced composite	Simple (possible difficulties with dispersion of CNTs)	Very high	Excellent
Composite with metallized fibre or immersed metallic meshes/foils	Complicated (fibre metallization, metal-polymer adhesion)	High	Fine
ICP-based composite	Simple (possible difficulties with dispersion of CNTs)	Medium	Fine

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Tables should be numbered consecutively in Arabic numbers, independent of figures. Tables and captions should be left justified.
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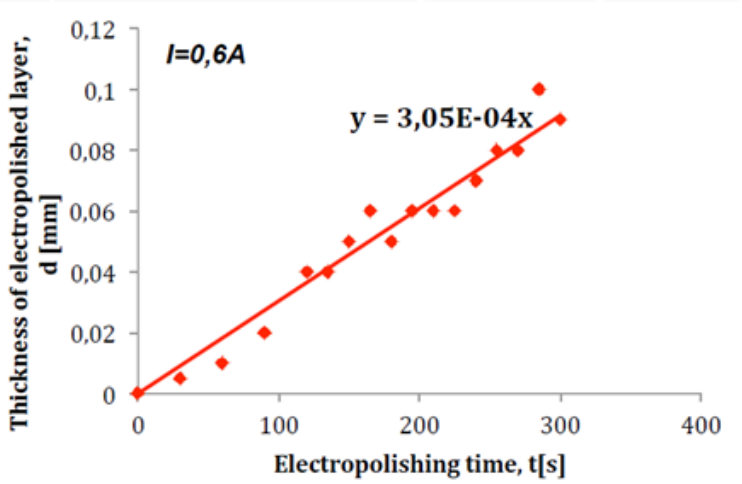

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