

Conceptual Models Reduce Risk in Landing Gear Design

Engineers at Liebherr-Aerospace build and test conceptual ADAMS models of landing gear even before detailing their designs in CAD. This better prepares the team to handle performance issues as they arise in detailed design.

Designing landing gear requires the testing of many different loading conditions to assure the gear's structure is sound. Landing angles, sink rates, and stiffness conditions are just some of the varying parameters that an engineering team must consider when evaluating a new landing gear design.

Engineers at Liebherr-Aerospace Lindenberg GmbH in southern Germany find it important to examine the dynamic characteristics of a proposed landing gear at the very earliest stages of development — even before laying out design details with computer-aided design (CAD) software. The Liebherr-Aerospace team simply doesn't want to waste time detailing a landing gear design that won't work.

Liebherr-Aerospace engineers are able to perform these upfront dynamic studies with the help of conceptual landing gear models created with ADAMS[®] mechanical system simulation software from Mechanical Dynamics, Inc. The team uses conceptual models to immediately answer key questions about a design concept's viability. For example:

- How will the landing gear perform through taxi, takeoff, landing, braking, rejected take-off, and a variety of other conditions?
- Will trade-offs be necessary between system stiffness and weight?
- How are stiffness and weight distributed through the main strut and cross-bracing?



Designing better landing gear faster — that's the aim of the Liebherr-Aerospace engineering team as they exercise conceptual ADAMS models in simulation. These conceptual tests provide the early insight needed to minimize problems later in detailed design. The result can be top-quality finished products like this nose gear, which Liebherr-Aerospace supplies for the Embraer Regional Jet 145.

The conceptual landing gear model can be a tool for designing brakes and fuselage attachments, as well as the landing gear itself.

To answer these questions and understand design trade-offs for all operating conditions, different load cases must be generated and applied to the landing gear design.

Fast "What-If" Studies

Liebherr-Aerospace received help from Mechanical Dynamics consultants in automating the task of building conceptual landing gear models. The design team works from a tabular ADAMS

input file containing nodes, beams, forces, and other data. A custom program reads the standard input file and automatically creates all ADAMS entities required for deflected load analysis.

Routines were written to run approximately 225 load cases. These are read from a table to calculate reaction forces in beams, and are constrained for subsequent component analysis. Users can export results for all load cases in tabular format for post-processing.

Changes in dynamic parameters can be easily made, and deflected load analyses are run quickly. This is important when moving into the detailed design phase, where engineers often need to perform fast "what-if" studies when considering the fit of parts and the layout of the retraction mechanism.

Having the conceptual landing gear model can be useful in areas beyond just the design of the landing gear. Landing gear is such a crucial part of an aircraft's structure that its performance can have significant impact on the design and behavior of other parts of the plane. The conceptual landing gear model can thus be a critical tool in designing brakes, fuselage attachments, and other aircraft subsystems, as well as the landing gear itself.

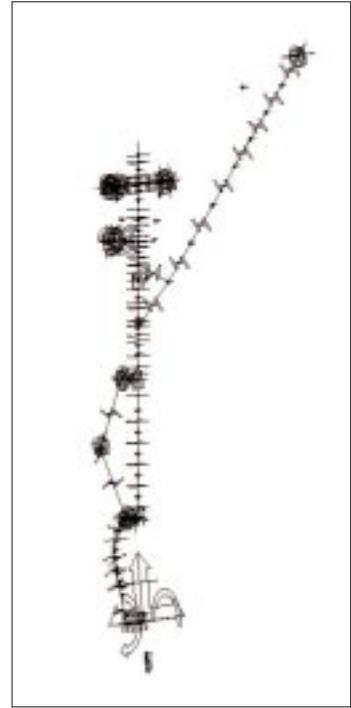
Conceptual models let the engineering team immediately answer key questions about a design concept's viability.

Better Designs, Integration

The bottom line for Liebherr-Aerospace is that conceptual ADAMS models give their engineers increased insight into the quality and workability of their landing gear designs right from the start of development. As a result, the Liebherr-Aerospace team is better prepared to handle performance issues as they arise in the detailed design phase.

The economic impact of this is difficult to quantify directly, but the reduction in design risk is surely substantial. For Liebherr-Aerospace, the use of conceptual ADAMS models should pay dividends in the speedier development of more robustly performing landing gear, better integrated into the complete aircraft design.

Liebherr-Aerospace Lindenberg GmbH was founded in 1960. The company manufactures aircraft operating systems (including primary and secondary flight controls, among others) and hydraulic landing gear, as well as air systems and associated electronics. In the civil sector, large-capacity aircraft, commuter and regional aircraft, business jets, combat aircraft, military transport and training aircraft, and civil and military helicopters are equipped with Liebherr-Aerospace products.



Conceptual models can be exercised and studied in ADAMS without the benefit of the design's geometry. Immediately recognizable here to landing gear designers who use ADAMS are the icons for the beams representing the flexible strut and cross brace, the joints that connect the various parts, and the applied force at the wheel hub.



Corporate Headquarters

Mechanical Dynamics, Inc.
 2301 Commonwealth Boulevard
 Ann Arbor, Michigan 48105 USA
 Phone: 734-994-3800
 Fax: 734-994-6418
 E-mail: info@adams.com

www.adams.com

International Subsidiaries

Mechanical Dynamics Ltd.
 400 Carlingview Drive
 Toronto, Ontario M9W 5X9 Canada
 Phone: 416-674-2144
 Fax: 416-213-0946
 E-mail: mdi-canada@adams.com

Mechanical Dynamics China
 Room 1412-1413, Jingyu Plaza
 No. A129, Xi Da Jie of Xuan Wu Men
 Xicheng District, Beijing 100031 China
 Phone: 8610-66077421
 Fax: 8610-66077424
 E-mail: mdichina@public.bta.net.cn

Mechanical Dynamics France
 58, rue Pottier
 F-78150 Le Chesnay, France
 Phone: 33-1-3966-04-00
 Fax: 33-1-3966-94-74
 E-mail: info@mdi.fr

Mechanical Dynamics GmbH
 Universitätsstr.51
 D-35037 Marburg/Lahn, Germany
 Phone: 49-6421-17070
 Fax: 49-6421-22296
 E-mail: info@mdi-ger.de

Mechanical Dynamics India
 Hi-Tech Business Centre
 S-262, Greater Kailash Part II
 New Delhi 110048 India
 Phone: 91-11-623-5032, Ext. 46
 Fax: 91-11-647-0632
 E-mail: bsridhar@nde.vsnl.net.in

Mechanical Dynamics Italy
 via Palladio, 98
 I-33010 Tavagnacco, Italy
 Phone: 39-432-573942
 Fax: 39-432-570823
 E-mail: info@mdi.it

Mechanical Dynamics Japan
 BABA Building, Sixth Floor
 3-8-4 Nishi-Shinjuku, Shinjuku-ku
 Tokyo 160-0023, Japan
 Phone: 81-3-5354-7381
 Fax: 81-3-5354-7382
 E-mail: hbaba@adams.co.jp

Mechanical Dynamics Sweden AB
 Regementsgatan 8
 SE-211 42 Malmo, Sweden
 Phone: 46-40-231296
 Fax: 46-40-235296
 E-mail: info.se@adams.com

Mechanical Dynamics Intl. Ltd.
 3 Clarendon Square
 Leamington Spa
 Warwickshire CV32 5QJ
 United Kingdom
 Phone: 441-926-420-230
 Fax: 441-926-420-494
 E-mail: mdi_uk@adams.com