THE VIRTUAL PROTOTYPING ENVIRONMENT FOR AIRCRAFT DESIGN AND TESTING

With ADAMS/Aircraft, engineering teams can quickly build and test functional virtual prototypes of complete aircraft and landing gear. This helps cut time, cost and risk in aircraft development and improve the quality of new designs.

Using ADAMS/Aircraft Landing Gear, the specialized aircraft and landing gear simulation software from MSC.Software, an engineering team can quickly build a complete, parameterized model of a new aircraft, easily defining its landing gear layout, wheel arrangement, energy absorption, and other vital characteristics.

Then, without leaving their engineering workstations, the team’s members can run the model through a battery of kinematic, static, and dynamic simulations to determine the vehicle’s flotation, stability, loads, passenger comfort, and more. Test measurements can be analyzed immediately and test equipment can be quickly modified.

The key is that all this is done on the computer where the team can refine and optimize the performance of its landing gear design before cutting a single piece of metal or running a single physical test.

TEST AND CERTIFY THE RIGHT DESIGNS

Millions of dollars and years of effort are put into building the first physical prototype of an aircraft design. Building a number of alternatives is prohibitive in cost and time. But with simulation, a variety of designs can be quickly built and tested under the same conditions as the physical prototype. The result is an environment where the right designs can be determined without this extensive time and cost investment – a process that reduces the risk when you build the physical prototype.

ADAMS/Aircraft is built upon MSC.Software’s flagship MSC.ADAMS product widely recognized as the world’s leading mechanical system simulation tool.
MSC.ADAMS has demonstrated accuracy in modeling a wide spectrum of complex system problems, so you can believe the results you see. And MSC.ADAMS features the most robust solution capability to be found, so you can be assured that all design variations can be accurately compared.

ADAMS/AIRCRAFT PROVIDES CAPABILITIES TO:

• Quickly build, test, and refine aircraft landing gear designs, exploring many "what-if alternatives." A user can, for example, change a strut metering pin with only a few mouse clicks, instead of waiting for a mechanic to install a new metering pin, as required with physical testing.

• Run designs over a variety of conditions, without having to duplicate those conditions with expensive tests. For example, an ice-covered runway or a special runway such as San Francisco can be tested and compared with baseline results in minutes, instead of waiting months for the right test conditions.

• Directly compare the critical data from different virtual tests with side-by-side animations and plot families, which can be done quickly using predefined plot templates. The result is an environment that allows you to build and compare hundreds of different aircraft and landing gear systems, all before you commit the physical prototype to manufacturing.

DESIGNED FOR AND BY AIRCRAFT ENGINEERS

Development of ADAMS/Aircraft grew out of several challenges faced by aircraft manufacturers. With the down cycles seen in the aerospace industry, companies had a difficult time retaining the process and design knowledge that went into their aircraft designs due to downsizing and experienced personnel leaving for other industries. Then boom cycles would come, and the industry had difficult times ramping up their personnel to meet market demand for new airplanes.

Recognizing that the software architecture from ADAMS/Car could be leveraged into the aircraft design process, MSC.Software worked with key customers to identify the requirements for an aircraft template-based product. One of these key customers was Lockheed Martin Aeronautics in Ft. Worth, Texas. Lockheed Martin had an initiative to build aircraft and preserve the process and design knowledge for up to 50 years – much longer than the cycles seen in the general aircraft market – to satisfy their military customer’s maintenance needs. As part of the

SUBSYSTEM TEMPLATES

NOSE AND MAIN LANDING GEAR
• Tripod
• Trailing arm
• Post

NOSE AND MAIN WHEEL ARRANGEMENTS
• Nose single and double
• Main single
• Main double
• Main 2 x 2
• Main 2 x 3

AIRFRAME
• Rigid
• Flexible
• Military and civilian

GENERAL
• Wheel/tires for handling, durability
• Retraction and lock
• Controls
• Brake
• Hydraulics
• Testrigs
Virtual Product Development Initiative, MSC.Software partnered with Lockheed Martin to assist in the detailed design and validation of the ADAMS/Aircraft Landing Gear Module.

**TEMPLATES SIMPLIFY SIMULATION**

Users of ADAMS/Aircraft select from two operational modes:

- A standard interface, which allows users to enter model data at the subsystem and assembly level to modify model parameters (hardpoint locations, spring rates, etc.) without affecting model topology, and run both standard and custom design tests; and

- Template-builder mode, enabling experienced users to build their own design templates from libraries of core and user-defined modeling elements.

ADAMS/Aircraft’s template-based modeling and simulation tools greatly simplify the tasks of aircraft design and testing. Users simply supply the required data to the templates, and ADAMS/Aircraft automatically constructs subsystem models and full-system assemblies. This helps assure consistency throughout the aircraft design.

To place components such as struts, actuators, and bushings in subsystem models, users select from ADAMS/Aircraft’s data libraries. This speeds the modeling process, saving users from having to enter all of the data associated with each component. Standardization and consistency are thus assured.

**PRECISE LANDING GEAR TESTING**

ADAMS/Aircraft’s design tools include both nose and main landing gear, modeled as a tripod, a trailing arm, simple post, or other strut arrangements. The shock absorber can be modeled as an equation-based single or dual stage air spring and oil damper, a property file-based oleopneumatic, or a table-based gas spring or metered oil damper. User-defined strut models can also be combined with the aircraft model. The analytical results from MSC.ADAMS have been validated against physical tests – so the results you get can be relied on for accuracy when making design decisions.

**ADAMS/Aircraft Highlights**

**COMPLETE SIMULATION SOLUTION**

- Component-level
- Subsystem-level
- System-level

**OLEO-PNEUMATIC MODELING**

- Equation-based
- Property file-based
- Table-based Virtual Modeling
- Hierarchical structure
- Interactive in both standard-user and template-builder modes

**FILE-BASED MODELING**

- Through subsystem files
- Through property files

**DATABASE**

- Derived from ADAMS/Car
- Proven and commonly used

**EASY CUSTOMIZATION**

- Open architecture
- Dialog-box builder
The landing gear can be attached to a drop test rig and tested under various drop mass and impact angle combinations, duplicating the real-world results with which manufacturers validate their designs. A retraction/extension can also be performed to size the actuators and hydraulic valves.

Finally, the landing gear can be quickly attached to a rigid or flexible airframe and put through the same paces the real aircraft landing gear will experience: taxi, turning, braking, takeoff, and landing. Now you can run through the complete test suite, collect the same data you expect from physical tests, such as loadstroke curve, hydraulic demand during retraction, and tire side forces, and use this test data to refine your designs, understand the sensitivities, and tune the parameters.

INTEGRATION WITH CAD/CAE
CAD and CAE software packages are used at aircraft companies to define detailed geometry, perform structural analysis, or develop control and hydraulic systems designs. ADAMS/Aircraft provides two-way interfaces with all of these packages to make the process as seamless as possible.

MODELING ELEMENTS IN THE ADAMS/AIRCRAFT LIBRARY

- Flexible or Rigid Parts & Attachments
- Oleo-Pneumatic Elements
- Equation-based single stage air spring
- Equation-based dual stage air spring
- Property file-based oleo-pneumatic
- Table-based gas spring
- Table-based metered oil damper
- Equation-based oil damper
- Stoppers

- Retract Actuators
  - Single-actuated hydraulic actuator (head-end restrictor)
  - Single-actuated hydraulic actuator (rod-end restrictor)
  - Double-actuated hydraulic actuator
  - Constant force actuator
  - Smooth motion actuator
  - Steering Actuators
    - Smooth motion steering actuator
    - Variable torque steering actuator

- Bearing pairs (joint-based and force-based)
- Flex bearing forces
- Friction/stiction

- Aerodynamics
  - Aircraft
  - Landing gear

- Tire / Ground Forces
  - General-purpose
  - Specific aircraft tire models

- Simple or complex engine forces
- Simple or complex brakes
- User-defined forces - for oleo, tires, aero, others

- All standard MSC.Software template components

Characteristic curves for component behavior are easily viewed and modified by “what-if” scenarios.

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