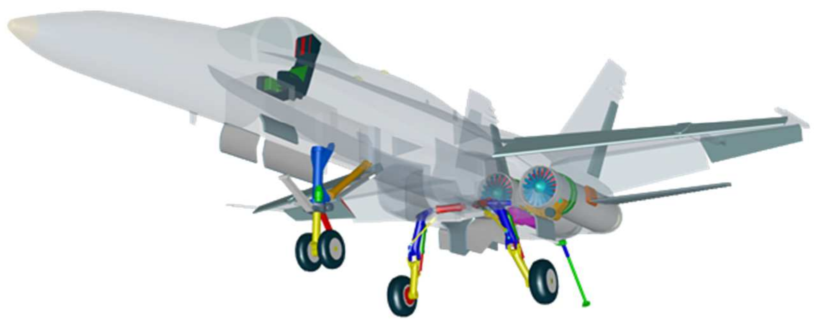
VI-Aircraft

With VI-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 improves the quality of new designs.

Using VI-Aircraft Landing Gear, the specialized aircraft and landing gear simulation software from VI-grade, 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.



VI-Aircraft allows full–vehicle landing and taxi simulation. Users can build, test, and refine their designs using the Functional Digital Aircraft.

Designed for and by Aircraft Engineers

Development of VI-Aircraft originally named 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 plays a key role in the aircraft design process, the VI-Grade specialists 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 Virtual Product Development Initiative, Lockheed Martin assisted in the detailed design and validation of the Landing Gear Module.

Capabilites

VI-Aircraft is an engineering environment for the simulation of aircraft.

- The **Subsystem Architecture** separates complex tasks and provides an intuitive interface
- The **Template Builder** helps to build new designs quickly and efficiently
- The **Data Libraries** assure component standardization and allow easy data management
- The **System Level Approach** helps the understanding of aircraft behaviour by cross-correlating all individual components and subsystems
- **Modelling** within the VI-Aircraft environment provides full support of several specialized modules for FEA, Hydraulics, Control Systems and other concurrent disciplines
- The **Simulation Menu** allows for various types of maneuvers for complete virtual testing of the aircraft model
- The **Plotting environment** offers a convenient method for reviewing results in all their details in a familiar fashion for aerospace engineers

Benefits

With VI-Aircraft it is possible to make design decisions in the shortest possible time at minimum cost, allowing you to:

- **Reduce Risk** by running more design variants prior to building costly prototypes
- **Beat the competition** by finding the optimal design and advancing your technology faster
- **Save Time** in the testing process by shifting tests into the virtual world reaching certification faster
- **Cut cost** by reducing the number of prototypes

Test and Certify the right Design

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.

VI-Aircraft is built upon MSC.ADAMS, widely recognized as the world's leading mechanical system simulation tool.

Virtual Testing

In VI-Aircraft, you replicate your real world tests that are usually conducted in a costly hardware based environment. The virtual tests are conducted in the following categories:

Full–Vehicle Tests

Ground Tests

- Ground attitude
- Carrier pre–launch attitude
- Dynamic tipback

Taxi Tests

- Dynamic taxi
- Shimmy
- Turning
- Braking
- General pilot maneuvering

Landing Tests

- General landing
- General pilot maneuvering

In–Flight Tests

- Retraction
- Extension
- General maneuvering

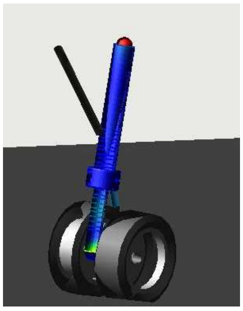
Landing Gear Tests

- Steady axle loads
- Retract / extend
- Drop

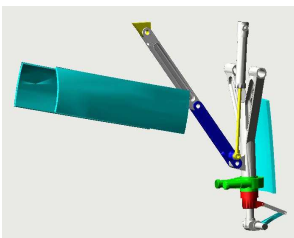
Wheel Tests

- Single tire tests

Shimmy Test on Flexible Telescoping Gear



Retract/Extend Test with Gear Doors



The virtual tests use the same setups as your real world tests, so you conduct taxi tests on the San Francisco runway profile or Russian runway profiles. The landing gear can be attached to a drop test rig and you can run drop tests with different tire inflation pressures, different metering pin characteristics, and tested under various drop mass and impact angle combinations.

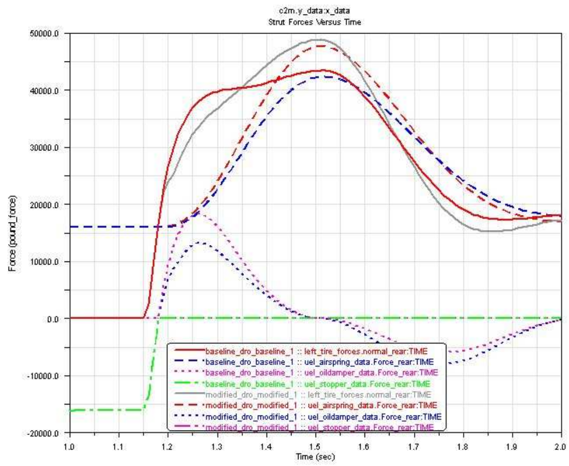
And you can run retraction/extension tests with or without airloading and simulating a gravity drop and lock condition.

Precise Landing Gear Testing

VI-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 oleo-pneumatic, or a table–based gas spring or metered oil damper. Isotropic vs. polytropic effects can be easily added through alternative property files. User–defined strut models can also be combined with the aircraft model.

The analytical results from VI-Aircraft have been validated against physical tests, so the results you get can be relied on for accuracy when making design decisions.

The plot below shows typical force output from such a virtual test including damper, tire, airspring, and stopper force.

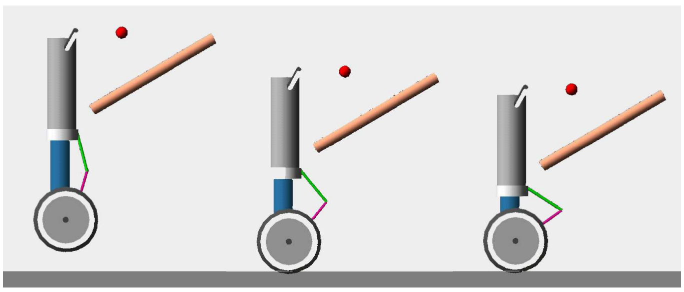


"We used to run multiple drop tests with different metering pins. Now we go into the tests with only two pins—one that the simulation results tell us is right and one just in case. We don't even need to run a second test now, we are that confident in the results."

Engineering Manager,

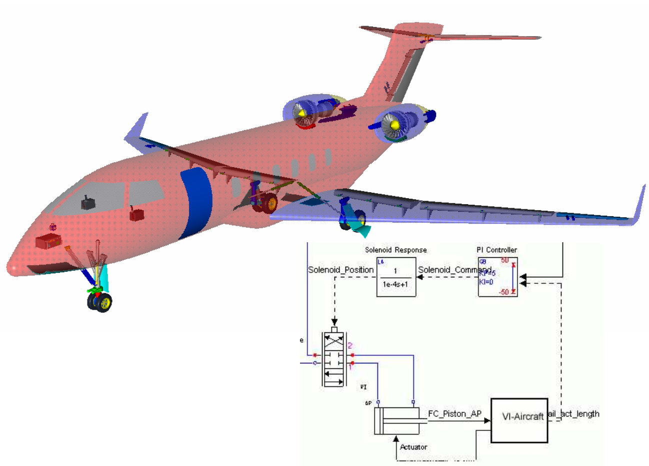
Major landing gear manufacturer

Drop Test Sequence



Flight Controls

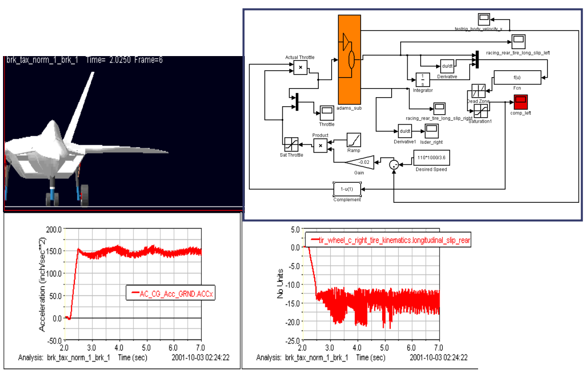
The complete simulation and resultant loading effects of flight maneuvering is possible with VI-Aircraft. Avionic systems models which generate the control system command either from the pilot input or the autopilot, can be linked from industry leading tools such as MATLAB and MSC.EASY5. The actuation system is accurately represented directly in VI-Aircraft, which includes mechanisms, hydraulic actuators, and electric motors and drives with friction, stiction, and freeplay included.



Here an MSC.EASY5 hydraulic control system model is embedded into the VI-Aircraft mechanical model of an aileron. The EASY5 model contains all the hydraulics and control systems, whereas the VI-Aircraft ADAMS model defines the mechanical dynamics of the aileron system. Each tool provides the best-in-class solution in it's given domain, while providing a common solver that runs the simulation efficiently.

Anti-Skid Simulation

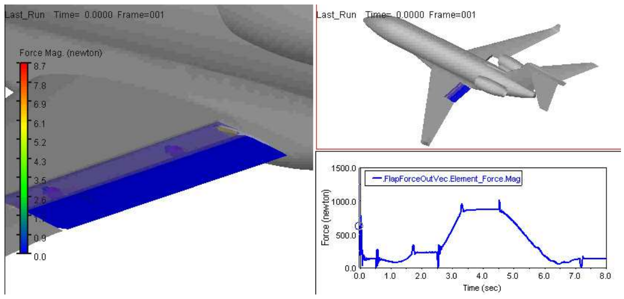
VI-Aircraft lets you add your own control system, providing all relevant states for the controller. The process of adding control systems can be applied to any aircraft subsystem. One good example for using this approach is the simulation of the Anti-Skid system.



VI-Aircraft can be used in CO-Simulation mode with MSC.EASY5 and MATLAB/Simulink

Aerodynamics

In VI-Aircraft it is possible to include the effects of aerodynamics as point or distributed loads on the aircraft's rigid or flexible structures. Predefined linear and nonlinear aerodynamic models are provided, or link in your own CFD codes through the cosimulation utilities. This allows you to investigate the influence of component flexibility in combination with models of the hydraulic or electro mechanical actuation and its controller. Find if the flaps will bind under flight conditions before the aircraft is assembled and tested by running a system simulation with VI-Aircraft. Reduce weight by determining actuation and hydraulic system requirements from the simulations.



Ease of Use

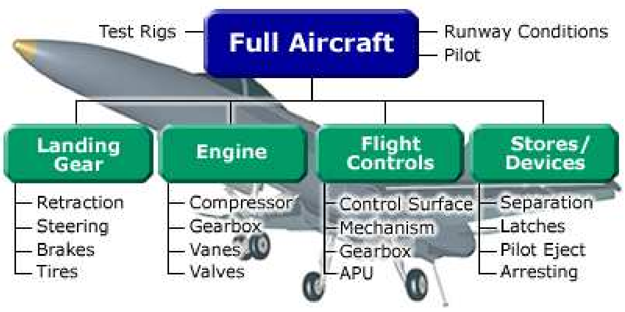
Users of VI-Aircraft select from two operational modes:

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.

VI-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 VI-Aircraft automatically constructs subsystem models and full–system assemblies. This helps assure consistency throughout aircraft design.

To place components such as struts, actuators, and bushings in subsystem models, users select from VI-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.



The VI-Aircraft software suite consists of modules to be used separately or in combination for complete aircraft simulation.

Modeling Elements

The environment offers a large amount of specific modeling elements, that can be used in conjunction with standard modeling elements such as parts, forces and joints. Some of the elements are listed below:

- 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
- Bearing pairs (joint–based and force–based)
- Flex bearing forces
- Friction/stiction
- 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
- Smooth motion steering actuator
- Variable torque steering actuator
- Aircraft aerodynamics
- Landing gear aerodynamics
- Tire / ground forces
  - General–purpose
  - Specific aircraft tire models

Another important factor for the aircraft performance is the component flexibility, which can be modeled with flexible bodies imported from FEA codes or automatically generated within VI-AutoFlex.

Integration with CAD and 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. VI-Aircraft provides two–way interfaces with all of these packages to make the process as seamless as possible.

The result is a complete and consistent aircraft model that provides insight into the aircraft design – "complete" because all of the key design data, geometry, flexibility, controls, and hydraulics systems, can be integrated with the functional virtual prototype, and "consistent" because the data does not have to be re–entered, and so the results will be consistent with an up–to–date snapshot of your complete design.

Subsystem Templates

For a quick start with VI-Aircraft, some templates are included:

Nose and Main Landing Gear

- Tripod
- Trailing arm - rigid, flexible
- Post—rigid, flexibile

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

Key Topics of v16 Release

- VI-Aircraft solver subroutines are now in C++
- Tutorials (PDF version) have been updated with new naming and image
- Road Data File (.rdf) can now be used to perform Full-Aircraft Taxi Analyses
- More control over solver options through a combination of aircraft.cfg MDI_ACAR_RES_OUTPUT choice and Solver Settings Output Results Content
- User-Defined Forces now can be built in two ways - Subroutine -Based and Function-Based
- Added a Session Setting dialog box under Settings menu to change left right single preference without having to close/ reopen VI-Aircraft
- Subsystem file now holds non-default flex body damping properties for both TeimOrbit and XML file formats
- Possibility of changing runway orientation during drop test
- Possibility of stepwise gravity increase during attitude analyses
- General improvements of flexible bearing, wheel testrig, retract/ tiedown analyses

To learn more about our products and services please contact:

Worldwide Web: www.vi-grade.com

Germany:
VI-grade GmbH
Zum Rosenmorgen 1-A
D-35043 Marburg
Germany
Tel: +49 6421 30 92 18
E-mail: info@vi-grade.com

Italy:
VI-grade srl
Via Galileo Galilei 42
I-33010 Tavagnacco (UD)
Italy
Tel: +39 0432 68 91 51
E-mail: info_italy@vi-grade.com

UK:
VI-grade Ltd
37 Church Road
Ryton on Dunsmore
Warwickshire • CV8 3ET • UK
Tel: +44 247 630 4835
E-mail: info_uk@vi-grade.com

USA:
System Level Simulation, Inc.
2723 South State Street
Suite 150, PMB 251
Ann Arbor, Michigan 48104
Tel +1 734 4187155
E-mail: info_us@vi-grade.com

Japan:
VI-grade Japan
Shinjuku Tochi Tatemono N.10
Bldg. 6F, 3-9-1, Shinjuku
Shinju-ku, Tokyo, 1600022
Tel.:+ 81 3 6457 8503
E-mail: info_japan@vi-grade.com