

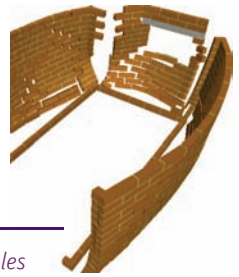
ANSYS®

Realize Your Product Promise™

**ANSYS®**

# Explicit Dynamics





*“ANSYS explicit dynamics repeatedly enables us to solve complex explicit problems for our customers. We can get answers to them quickly due to the program’s ease of use. The state-of-the-art solution methods and extensive material models produce accurate results, a necessity for creating follow-on business.”*

**Chris LeBoeuf**  
Principal Engineer  
ABS Consulting

## ANSYS explicit dynamics takes over when implicit isn’t enough.

For specialized applications, ANSYS offers the split-second insight you need along with ease of use and trusted results.



Sheffield Hallam University used our explicit solution to simulate ball-on-tennis-racket impacts. Their research centered on the coefficient of friction between strings and ball, and the position of the racket’s balance point. The value of physical testing is limited in evaluating these potential improvements because of the high cost and time involved in building the huge number of new designs that need to be evaluated.

If your product needs to survive impacts or short-duration high-pressure loadings, you can improve its design with ANSYS® explicit dynamics. Specialized problems require advanced analysis tools to accurately predict the effect of design considerations on product or process behavior. Gaining insight into such complex reality is especially important when it is too expensive — or impossible — to perform physical testing.

The ANSYS explicit dynamics suite enables you to capture the physics of short-duration events for products that undergo highly nonlinear, transient dynamic forces. Our specialized, accurate and easy-to-use tools have been designed to maximize user productivity.

With ANSYS, you can gain insight into how a structure responds when subjected to severe loadings. Algorithms based on first principles accurately predict complex responses, such as large material deformations and failure, interactions between bodies, and fluids with rapidly changing surfaces.

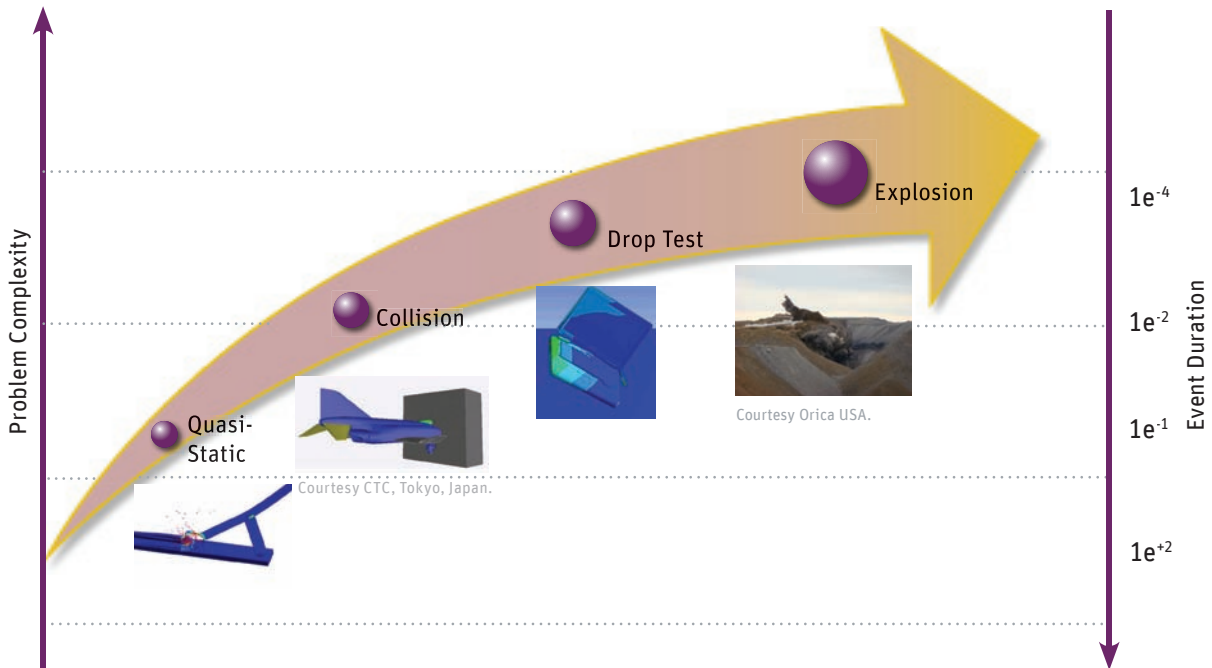
An extension of our structural mechanics suite, explicit dynamics software shares the same graphical user interface (GUI), serving mechanical engineers who need to study highly complex problems — especially ones with high strain rates

and other complications that are difficult to solve with general-purpose implicit solution methods.

A short learning curve is a hallmark of our products. The GUI speaks the language of the engineer or scientist. Consequently, the software’s internal complexity is hidden from view, even as sophisticated, state-of-the-art mathematical algorithms resolve problems.

Defaults are safe and reasonable values for most options, which means that you spend less time setting up and running problems and more time optimizing products for performance, durability and cost, as well as removing design flaws.

In many cases, the accuracy of an explicit solution can be verified only via comparison with physical experiments. For some problems (such as explosions), it may be too expensive or impossible to perform tests. Yet ANSYS users around the world rely on the accuracy of explicit results: An extensive list of publications is testament to the correctness of our algorithms and models.



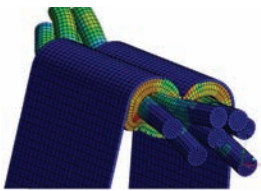
**ANSYS Mechanical™**  
Broad spectrum of capabilities covering range of analysis types

**ANSYS Explicit STR™**  
Entry level; well suited for designers and Mechanical users who need to solve highly nonlinear problems requiring explicit solutions

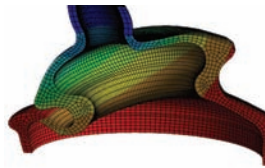
**ANSYS LS-DYNA®**  
General purpose with extensive capabilities; best suited for expert analysts and researchers

**ANSYS Autodyn®**  
Easy to use for multiphysics and sophisticated material response; well suited for designers and analysts who use ANSYS Workbench™ to easily solve complex realities

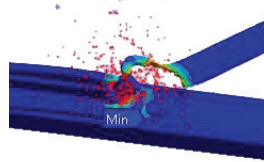
ANSYS explicit dynamics tools help users meet solution requirements of various complexities based on problem details and user expertise.



Wire crimping, a complex contact problem



Deformation of constant velocity boot



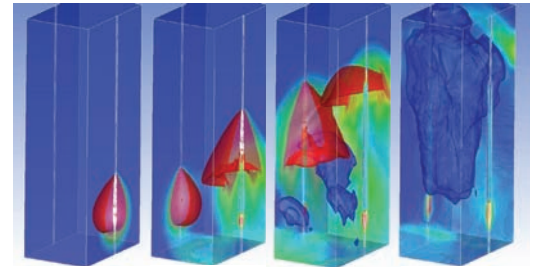
Failure of window crank mechanism, modeling material failure under dynamic loading



Blade-off containment demonstrating failure of bonded connection and subsequent complex body interactions (contact)

ANSYS explicit dynamics tools help engineers to explore a wide range of challenges:

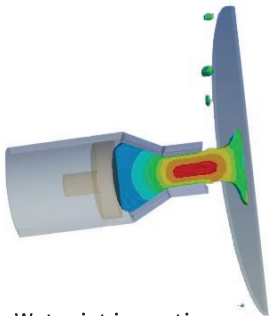
- Short-duration, complex or changing-body interactions (contact)
- Quasi-static
- High-speed and hypervelocity impacts
- Severe loadings resulting in large material deformation
- Material failure
- Material fragmentation
- Penetration mechanics
- Space debris impact (hypervelocity)
- Sports equipment design
- Manufacturing processes with nonlinear plastic response
- Drop-test simulation
- Explosive loading
- Explosive forming
- Blast-structure interactions



*“The ability to couple Eulerian and Lagrangian frames of reference is especially helpful in blast field modeling. With ANSYS explicit dynamics, energy is easily transferred between the two for accurate modeling of the entire blast process.”*

**Dale Preece**  
Global Technology Development  
Orica USA Inc.

## Almost any severe application can benefit from the embedded deep physics in our explicit suite.



Water jet impacting surface

With ANSYS explicit dynamics products, you get a comprehensive set of advanced tools to help gain insight into virtually any event that can be simulated.

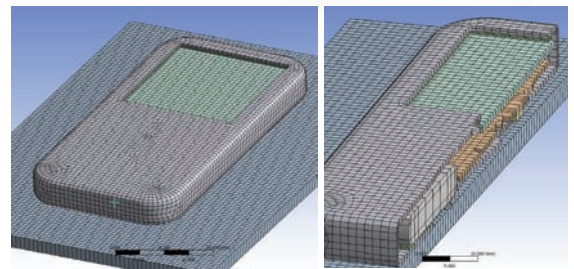
For example, the FE (Lagrange) solver is the most commonly used and the computationally fastest method to represent structures. It is best suited for tracking shock waves and peak pressures. Within each element, Lagrange captures the material location of the discretized model and follows its deformation as forces are applied, resulting in distorted elements.

The Euler method follows the flow of materials throughout a region represented by a fixed mesh. It is ideal for modeling severe deformations of solids as well as the flow of liquids and gases. With the ANSYS virtual Euler solver, the mesh is generated automatically without any user input.

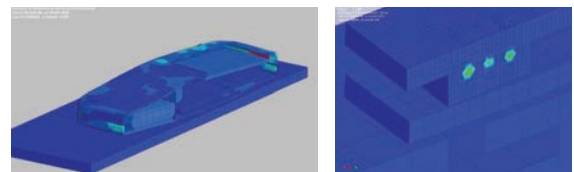
Arbitrary Lagrange–Euler (ALE) combines the advantages of Lagrange and Euler while eliminating some of their shortcomings. It is ideal for simulating materials with severe deformations in which high-resolution shock response is desirable.

Smooth particle hydrodynamics (SPH) is a mesh-free method best suited for problems involving material separation, such as hypervelocity impacts or crack propagation in brittle materials.

You can combine Lagrange, Euler, ALE and SPH in a single problem to produce the most efficient and highest accuracy results possible.



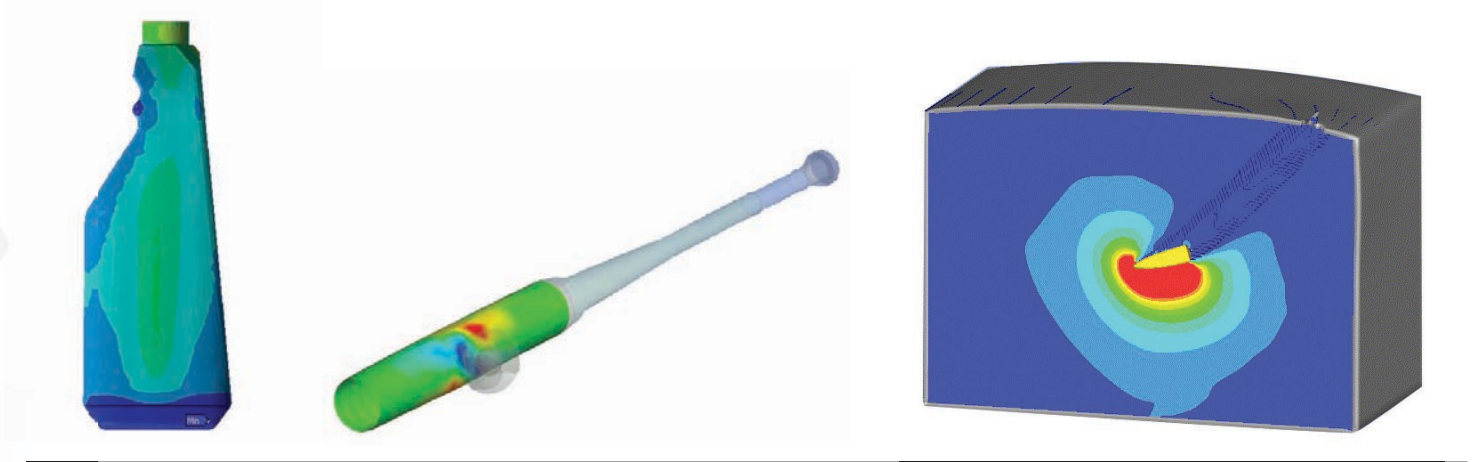
Automatic body-by-body meshing for analyzing cell phone assembly via explicit drop testing



Cell phone with solder connection submodel

Courtesy Ozen Engineering.

Courtesy Ozen Engineering.

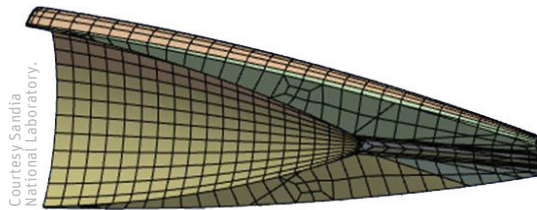


Virtual prototyping, from CAD to blow molding to drop-test analysis

Sports equipment design using composite materials

Additional complexities with material response are enhanced with tools that enable fluid-structure interaction (FSI). Examples include a high-speed projectile moving through a liquid (shown here) or movement of a structure from a blast wave.

A critical requirement for efficient and accurate explicit analysis is a high-quality mesh. Our explicit products benefit from integration in the ANSYS Workbench environment, which includes powerful automatic mesh generation. You can create high-quality hex (brick) elements for more complex geometries using multi-zone meshing, a standard tool within Workbench that automatically decomposes more complex geometries into parts that can be swept to create hex elements.



Courtesy Sandia National Laboratory.

High-quality mesh generated in ANSYS Workbench using automatic multi-zone method

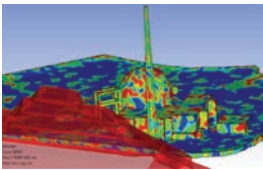


Some geometries, especially those created for manufacturing and imported from CAD data, are too complex to be swept to produce a full hex mesh. Tetrahedral (tet) elements can accurately represent small portions of a part's geometry that cannot be swept. An ANSYS explicit special tet-element formulation called nodal-based strain (NBS) eliminates shear locking, a problem encountered with traditional tet elements. Accurate tet elements make it easier to create working meshes that can represent complicated geometries.



## Our single resource offers clarity and insight into your advanced technology needs.

Courtesy, ESSS, and Eletronuclear S.A.



Eletronuclear S.A. used ANSYS explicit dynamics tools to simulate a hypothetical explosion near a nuclear power plant. The initial stage was simulated with the multi-material fluid (Euler) solver, as different types of materials can all be modeled in the same region. The Euler FCT solver came into play after the explosion, as it simulates the response of ideal gases with second-order accuracy very quickly.

ANSYS explicit dynamics tools are one part of our suite that delivers cutting-edge functionality — depth, breadth, a plethora of advanced capabilities and integrated multiphysics — providing confidence that your simulation results reflect real-world outcomes. The comprehensive range of solutions provides access to virtually any field of engineering simulation that a design process requires. Organizations around the world trust ANSYS to help them realize their product promises.

### Productive Environment

The interface for our tools, ANSYS Workbench enables users to model all applications, from very simple to very complex. The platform can take weeks, sometimes months, out of a CAE process by eliminating manual file transfer, results translation and errors that often come from manual data entry. Workbench eliminates the labor required to produce updated simulation results brought about by design changes. It includes an extensive material library and automatic meshing, which further reduce problem setup effort and time.

### Advanced Study

Modern CAD tools create geometries that are real-life accurate. Because most CAD geometry models are created for manufacturing purposes (but not for analysis), they often include overlapping surfaces, gaps and other dirty forms. ANSYS pre-processing tools clean, correct and reduce CAD complexity, making it possible to increase accuracy and speed.

Explicit dynamics accuracy is, in part, a function of element size. Generally, the smaller the elements, the more accurate the results — but this requires longer compute times. ANSYS HPC techniques allow you to improve accuracy as well as to examine multiple designs in a given time. Reducing elapsed time for calculation leads to better, more optimized products. The end result is confidence that your product will thrive in the real world.

### Design Analysis and Optimization

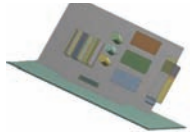
To understand a design's performance, you must identify the effect of all design parameters — which can easily lead to meeting product requirements. ANSYS DesignXplorer™ provides in-depth product understanding, illustrating the relationship between design variables and product performance — all before building a single prototype.

### Managing Simulation Data

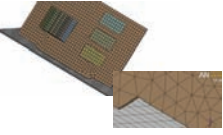
Simulation engineers — especially those performing explicit dynamics analyses — generate large volumes of data that need to be archived in a searchable format. ANSYS Engineering Knowledge Manager™ (EKM) enables capture and management of simulation data along with workflows and best practices. The tool can improve simulation efficiency and productivity.

## ANSYS Explicit Dynamics

### Geometry

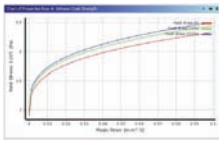


CAD geometry simplified for drop test



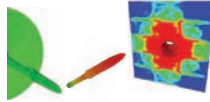
Robust NBS tet elements, which do not lock up in shear

### Engineering Data



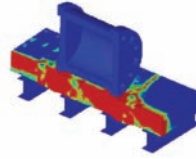
Material model for CU-ODHC2

### Remapping in Space and Solver



2-D Euler-shaped charge mapped into 3-D Lagrange oblique penetration into masonry wall

### Drop Test



Heavy equipment



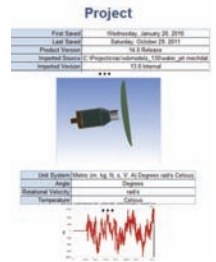
Water cooler bottle

### Post-Processing Tools



Deformation contour of failed fan (front cover removed)

### Automatic Report Generation



## Pre-Processing

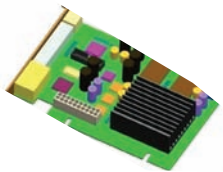
## Simulation

## Post-Processing

## Archive

## Other ANSYS Engineering Simulation Capabilities

### CAD



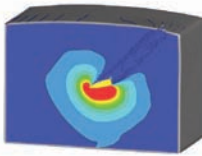
ANSYS DesignModeler™ and ANSYS SpaceClaim DirectModeler provide modeling and geometry creation functions for explicit analysis. The entire ANSYS suite is CAD independent, enabling data import from various sources. In addition, we collaborate with leading CAD developers to ensure an efficient workflow.

### Integration



ANSYS Workbench is the framework for the industry's broadest and deepest suite of advanced engineering simulation technology. It delivers unprecedented productivity, enabling Simulation-Driven Product Development™.

### Multiphysics



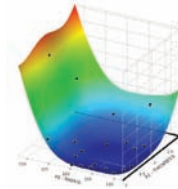
To help ensure a successful product, R&D teams must accurately predict how complex products will behave in a real-world environment. The ANSYS suite captures the interaction of multiple physics: structural, fluid dynamics, electro-mechanics and systems interactions. A single, unified platform harnesses the core physics and enables their interoperability.

### HPC



High-performance computing enables creation of large, high-fidelity models that yield accurate and detailed insight. ANSYS offers scalable solutions and partners with hardware vendors to ensure that you get the power and speed you need.

### Design Optimization



Good design starts with identifying the relationship between performance and design variables. ANSYS DesignXplorer enables engineers to perform design of experiments (DOE) analyses, investigate response surfaces, and analyze input constraints in pursuit of optimal design candidates.

### Data Management



ANSYS EKM addresses critical issues associated with simulation data, including backup and archival, traceability and audit trail, process automation, collaboration and capture of engineering expertise, and IP protection.

---

**ANSYS, Inc.**  
www.ansys.com  
ansysinfo@ansys.com  
866.267.9724

ANSYS is dedicated exclusively to developing engineering simulation software that fosters rapid and innovative product design. Our technology enables you to predict with confidence that your product will thrive in the real world. For more than 40 years, customers in the most demanding markets have trusted our solutions to help ensure the integrity of their products and drive business success through innovation.

ANSYS and any and all ANSYS, Inc. brand, product, service and feature names, logos and slogans are registered trademarks or trademarks of ANSYS, Inc. or its subsidiaries in the United States or other countries. All other brand, product, service and feature names or trademarks are the property of their respective owners. LS-DYNA is a registered trademark of Livermore Software Technology Corp.