

Concept

CAE System Partner for Product Development

- Integrating simulation into the development process from the concept phase to the start of production
- Making simulation an efficient resource to optimise the customer's product
- Developing innovative solutions
- Use of the expert know-how provided by **INPROSIM** in a system partnership
- Providing a close and flexible collaboration with our customers, being aware of their individual problems and requirements
- Maintaining a regular communication with the corresponding departments (e.g. construction, assembly and test) in order to successfully merge the various requirements and ideas

Customer Advantages

- Efficient product development
- Innovative solutions
- Saving overhead during the development process
- Saving resources during the development process
- Saving time during the development process
- Earlier time to market
- Better and safer products for end customers



Company

Location

- Kriftel is located in the business and industrial centre of the Rhine-Main-Area (central Germany)

How to get to **INPROSIM**

- By car: From A5 (North/South) or A3 (East/West) via A66 (Exit Frankfurt Main-Zeilsheim / Hofheim)
- By train: From the Frankfurt am Main central station, with line S2, to the Kriftel train station
- By plane: Frankfurt am Main, Rhine-Main-Airport
- Detailed directions are available as a PDF download on our website under "Contact"

Contact

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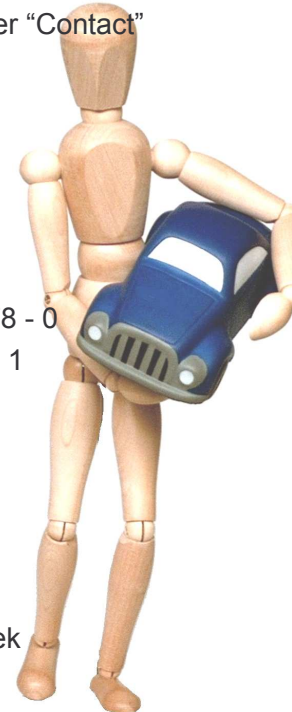
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Info

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INPROSIM GmbH

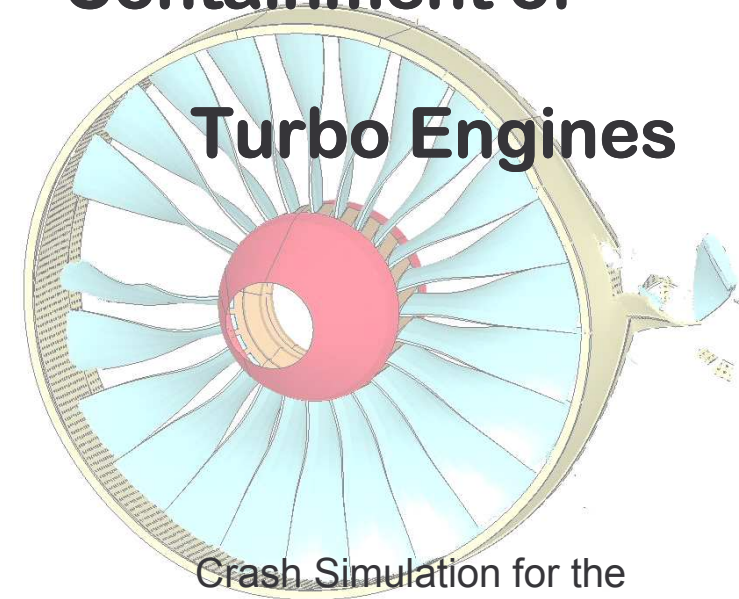
Innovative Product Simulation

Your CAE Partner

For Efficient

Product Development

Containment of Turbo Engines



Crash Simulation for the
Containment Safety of the
Turbines and Turbochargers

Requirements

Specialisation

Implementation

Enormous Challenges

- Rotating parts of turbo engines endure extremely high loads
 - High centrifugal forces due to the high speed
 - High thermal loads and gradients
- In the case of non-stationary turbo engines such as turbofans and turbochargers, additionally the following requirements occur:
 - High cyclic loads of the engines
 - Requirement of minimised masses

Safety

- Rotating components of turbo engines hold an enormous potential energy, released at failure
- Local faults or early material fatigue of a component may lead to failure
- Failure might also be caused by the external factors e.g. bird strike on propulsion unit
- Failure occurs in terms of disc burst, tear-off of rim or blade
- As fragments still hold a vast amount of energy, even after breaking through the housing structures, they put people and the machinery in danger
- Therefore, there are requirements to hinder the break-through of the fragments at failure

Development and Calculation

- The sequences caused by failure take place within a few milliseconds
- The process is highly non-linear (non-linear deformation of the geometry, dynamic material properties and interaction of the components and their fragments)
- That's why neither simple analytical approaches nor linear calculation methods are adequate for containment analysis
- Up until recently, expensive tests have been necessary resulting in overdue, highly time consuming and costly design changes

Explicit Crash Simulation

- Explicit programmes like LS-Dyna, also known as crash codes, find a remedy to this situation
- Crash codes incorporate non-linear material data including various failure parameters
- Crash codes are able to handle the complex contact situations of fragments and housing
- Thus, the highly dynamic process with all its non-linearities can be modelled and calculated
- This enables a target-oriented and safe dimensioning of the housing structures and the additional safety devices, if / when necessary

CAE Simulation

- Integrating simulation into the development process as soon as possible
- Simulation of typical burst scenarios, e.g. „Three-Hub-Burst“ of rotor disks
- Simulation of „Fan-Blade-Off“ tests of axial compressor and turbine rotors
- Construction approaches for the improvement of the containment behaviour
- Evaluation and comparison of the variant options
- Integration of further requirements such as mass, assembly, costs and functionality
- Final simulation of a real test in order to validate the simulation model as well as the material data
- Thus, a highly reliable simulation forecast of the potential product's containment behaviour can be attained
- Optimising the development process of the new products rendering costly containment tests partly or even completely unnecessary

Turbo engines

- Power plants: turbines for power generation
- Engines in aerospace industry
- Exhaust turbocharger for surface and water crafts