FORGE
WORLD LEADING NUMERICAL SIMULATION SOFTWARE
FORGE is a world leading numerical simulation software for all bulk metal forming processes. It is used both at design and R&D levels by many forming companies and universities worldwide working in various industrial fields.

- Reduce design cycle
- Minimize real scale tryouts
- Increase yield
- Extend die life
- Optimize and consolidate quotations
**FORGE** is a world leading numerical simulation software for all bulk metal forming processes.

FORGE is best suited for the simulation of hot, warm and cold forming processes of various materials such as:

- Steel
- Aluminium
- Copper
- Brass
- Titanium
- Nickel based alloys
- Noble metals

When it comes to producing forged components the forming industry faces various challenges.

**Challenges related to the part:**
- Final shape / dimensions
- Underfillings / excess material
- Folds / laps
- Porosities / segregations
- Microstructure
- Grain flow
- Final in-use properties

**Challenges related to die:**
- Die life (cracks, wear...)

**Challenges related to the equipment:**
- Appropriate equipment selection
- Press jam
- Equipment deflection

These challenges often lead to costly shop floor trials.

With **FORGE** real scale tryouts are minimized, productivity is increased.
FIRST TIME RIGHT DESIGN OF FORGED COMPONENTS

FORGE makes it fast and easy to predict accurately:
Final shape and dimensions, underfillings and excess material, folds/taps, porosities, grain flow, microstructure.

"For the Hirschvogel Automotive Group not only technical but also economic advantages result from the application of the FORGE software. Lately, these have been approved via monetarily assessable as well as non-monetary assessable criteria. Furthermore the good relationship between Hirschvogel Automotive Group and Transvalor S.A. - which has evolved over more than 10 years of collaboration - is remarkable."
Jochen Heizmann, Research & Development, Hirschvogel Umformtechnik GmbH, Denklingen, Germany

Grain flow analysis of a one-cylinder crankshaft: close correlation between prediction and real part.

Grain size prediction of a Ni-based alloy disk.

Fold/lap analysis: accurate folds/taps prediction of a mining steel component. Fold/lap area is shown in red inside the frame.

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FORGE allows the accurate prediction of stress, wear and temperature in the dies, through both coupled or uncoupled analysis applicable over the complete process simulation. FORGE also offers advanced features to optimize and select the appropriate equipment on the shop floor thanks to accurate prediction of forging load and equipment deflection.

FORGE offers the most unique advantages for equipment dimensioning and die life extension.

INCREASE DIE LIFE AND OPTIMIZE EQUIPMENT USE

Uncoupled die stress analysis allowing accurate stress prediction. High stresses are shown in red.

Hirschvogel Umformtechnik GmbH

6-cylinder crankshaft forging load graph (mechanical press).

Buderus Edelstahl GmbH

Actual die

Simulation result

Thermo-mechanical analysis fully coupled between the dies and the part offering the highest accurate results. Von Mises stress distribution is represented here.

Closed correlation between FORGE compressive force prediction and experiment.

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Access to the prediction of material flow and geometry of the final shape, distribution of many fields during the complete process:

- In the workpiece: contact distance to the dies, temperature, displacements, effective strain, strain rate, stresses, damage, folds, microstructure, hardness, metallurgical phases, and many additional user fields.
- In the dies: temperature, stresses, wear, resulting force and many others.

**CUTTING EDGE TECHNICAL FEATURES**

**Powerful**

**Unique backward & forward surface tracking features**
Easy to setup tracking features of points or surfaces:
Defect area can be localized in the final geometry,
Flash or final shape’s position in the initial geometry can be determined.

Access to the prediction of residual stresses after quenching in a crankshaft.

Prediction of temperature by induction heating in the initial billet of an energy component.

**Fully embedded features in the FORGE software**

Heat treatment capability for the simulation of heating, soaking and quenching. Prediction of phases, hardness, residual stresses and part distortion during quenching.

Induction heating feature for the simulation of initial billet heating and heat treatment.

Simulation of carburization.
Pioneer and market leader in automatic optimization

FORGE includes an automatic optimization feature based on the MAES algorithm (Meta-model Assisted Evolution Strategy). It can be coupled with some CAD packages. In this example, thanks to FORGE optimization feature linked with a CAD system, the initial billet weight has been reduced by **10% per part**.

![AUTOMATIC OPTIMIZATION](image)

### Extensive Databases

Press and equipment kinematics available and filtered to comply with product and process selection:

- Hydraulic press
- Hammer
- Counter blow hammer
- Knuckle joint press
- Mechanical press
- Multi-speed hydraulic press
- Screw press
- Link drive press
- Orbital forging press
- Incremental forging press
- Rotary swaging
- Forging machine
- Rolling mills including ring rolling.

### Numerical facts

Fast, accurate and efficient 2D and 3D Finite Element simulation software based on the use of 4-node triangles and 5-node tetrahedra, best suited elements for complex shapes

- Implicit solver for accurate stress prediction and volume conservation
- Fully parallel up to 64 computer cores: solving, automatic remeshing and mapping are done in parallel on each core
- Updated Lagrangian approach and Arbitrary Langrangian Eulerian for well suited processes
- Bi-mesh technique allowing CPU time reduction for localized deformation processes
- Automatic adaptive time step
- User variables and subroutines can be defined and visualized in the graphical post processing interface
- Automatic optimization feature based on the MAES algorithm (Meta-model Assisted Evolution Strategy) and coupling of optimizer with CAD packages.

"The analysis carried out with FORGE to model the evolution of defects in Aeroengine disk forging would not have yielded results this close to experimental values on many other metal forming software products. FORGE has a unique multi body approach to modeling such complicated phenomena which enhances the simulation capabilities of processes."

Rajiv Shivpuri, Manufacturing Research Group
Ohio State University, Columbus
OH USA

### Extensive material database for forming and heat treatment processes

Over 1000 materials are available in our database. Integration of your own material dataset is possible in tabulated format.

- Feature to import from Sente Software JMatPro.

Wide range of friction laws.
Non-uniform friction coefficient and HTC for the same die.
FORGE embeds a new bi-mesh technique for CPU demanding processes with localized deformation such as becking, cogging and incremental forging. This method allows significant CPU time reduction while retaining similar result quality.

FORGE runs on various Windows and Linux platforms, from standard workstations to multi-core High Performance Computing clusters.

Pioneer in parallel computation FORGE offers the highest scalability allowing more accurate results within very short computation times.

Market leader in parallel computation and numerical techniques to reduce computation time

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This method allows significant CPU time reduction while retaining similar result quality.

Computation time versus number of computer cores for the complete forging sequence (5 stages) of a steering sector shaft. Parallel computation efficiency is 80% on this simulation.
Geometry import Interface with most available CADs through neutral formats such as STEP, STL, UNV, Nastran/Patran, Parasolid.

Result export interface in DXF (for 2D simulations) and STL, UNV and Ansys file formats (for 3D simulations).

Batch processing and simulation chaining for increased productivity.

Automatic simulation report including setup data summary, selected results and computation details.

CUTTING EDGE TECHNICAL FEATURES

Flexible & Easy to Use

Unmatched Flexibility

FORGE provides the highest flexibility with unlimited access to the Graphical User Interface for 64-bit pre and post processing. License fees are related to the number of computer cores regardless of the number of users. Extra flexibility benefits are:

- Job scheduling
- 2D and 3D automatic transitions between stages
- Dynamic token allocation across multiple and remote sites (Floating License)
- Solver support for up to 64 cores in parallel (one simulation can be executed on 64 cores concurrently)
- Token borrowing
Customer services

Regular new releases and Service Packs when required. Customer support through NetViewer.
Customer on-site training on request.
Frequent customer visits. User meetings are held worldwide on an annual basis.

All processes and all features mentioned in this brochure are available in the FORGE software with no additional cost.