

FORGE[®]

WORLD LEADING
SIMULATION SOFTWARE
FOR METAL FORMING
MANUFACTURING
PROCESSES



Fast, Accurate, Reliable, Versatile
Simulation becomes your new strategic partner
for the development of your high value-added
forged components

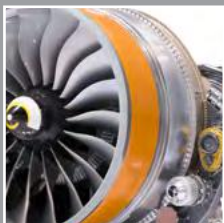


M A T E R I A L F O R M I N G S I M U L A T I O N

FOR SIMULATION
TO BECOME A
REAL LEVER OF
COMPETITIVENESS



Product design and process development
are now driven by simulation



On extremely competitive and ever-changing markets, and in order to cope with the constraints encountered in producing high value-added products, simulation is now an essential step in the forging development cycle.

A concrete solution in response to your needs

FORGE® allows you to quickly and accurately analyze all the stages of your manufacturing processes. Use a reliable solution **to face your daily challenges:**

PRODUCE HIGH-QUALITY COMPONENTS,

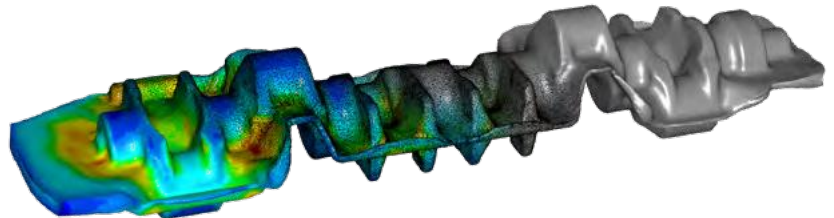
ACCELERATE TIME TO MARKET,

REDUCE PRODUCTION COSTS,

DIFFERENTIATE YOURSELF WITH INNOVATIVE PRODUCTS

Thanks to the FORGE® software, you will be able to:

- Control your manufacturing processes thanks to a better understanding of physical phenomena
- Guarantee part feasibility according to a manufacturing process compatible with your means of production
- Propose the best costs by anticipating material quantities and the number of steps required to produce the parts
- Limit non-quality costs by upstream detection of forging defects
- Make rational engineering choices that meet the needs expressed by the customer
- Adopt a continuous improvement approach by optimizing existing productions
- Meet your customers' forging quality and performance requirements
- Capitalize engineering know-how held within the company



Significant benefits at multiple stages of your activity

- During the **R&D phase**, for the development of innovative or complex products
- During the **quotation phase**, to be able to position quickly with respect to a new manufacture
- During the **design & process development phase**, to reduce time to market
- During the **production phase**, to control manufacturing costs

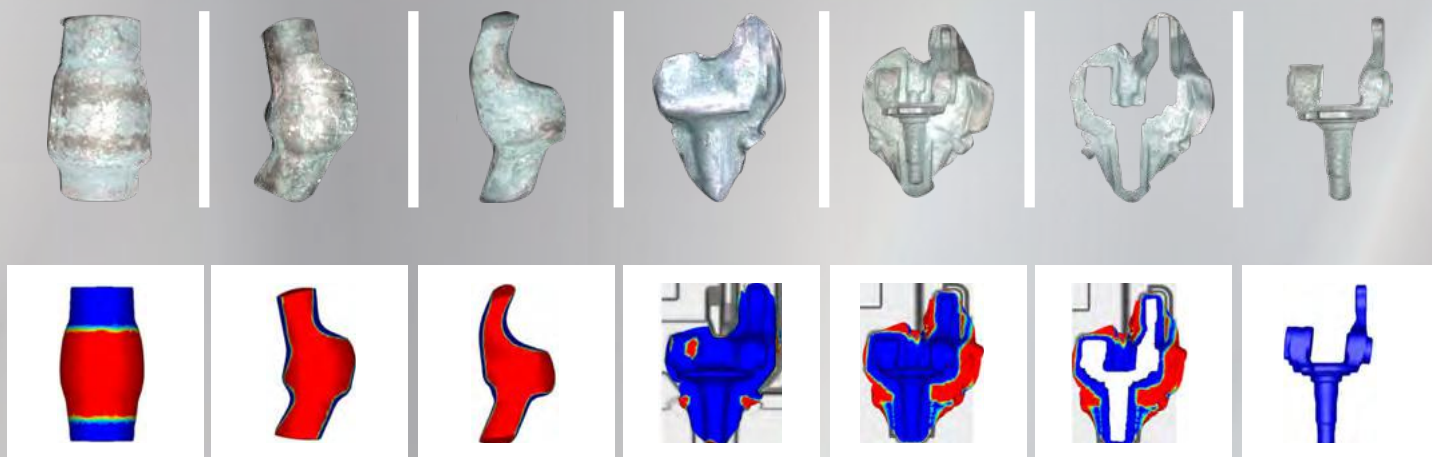


VERSATILE SOFTWARE WITH MULTIPLE POSSIBILITIES

*FORGE® is aimed at metal forming processes, from the most traditional to the most demanding. Suitable for both hot, warm and cold deformation for all types of metal alloys, **it meets the requirements of forged component manufacturers.***

A 100% predictive solution

FORGE® delivers results that perfectly reflect reality to **produce high-quality parts from the first batch!**



Precise geometry prediction at all stages of the forging sequence - Courtesy of Bharat Forge Ltd

Suitable for all types of process

- Closed die forging
- Ferrous and non-ferrous forging
- Open die forging
- Rolling of flat/long products
- Ring rolling
- Rolled preform
- Cold forming
- Near Net Shape
- Orbital forming
- Thread rolling
- Mechanical assembly
- Bending
- Deep drawing
- Sheet metal forming
- Hydroforming
- Fine blanking
- Trimming, shearing
- Induction heating
- Heat treatment
- Electrical upsetting,
- Machining

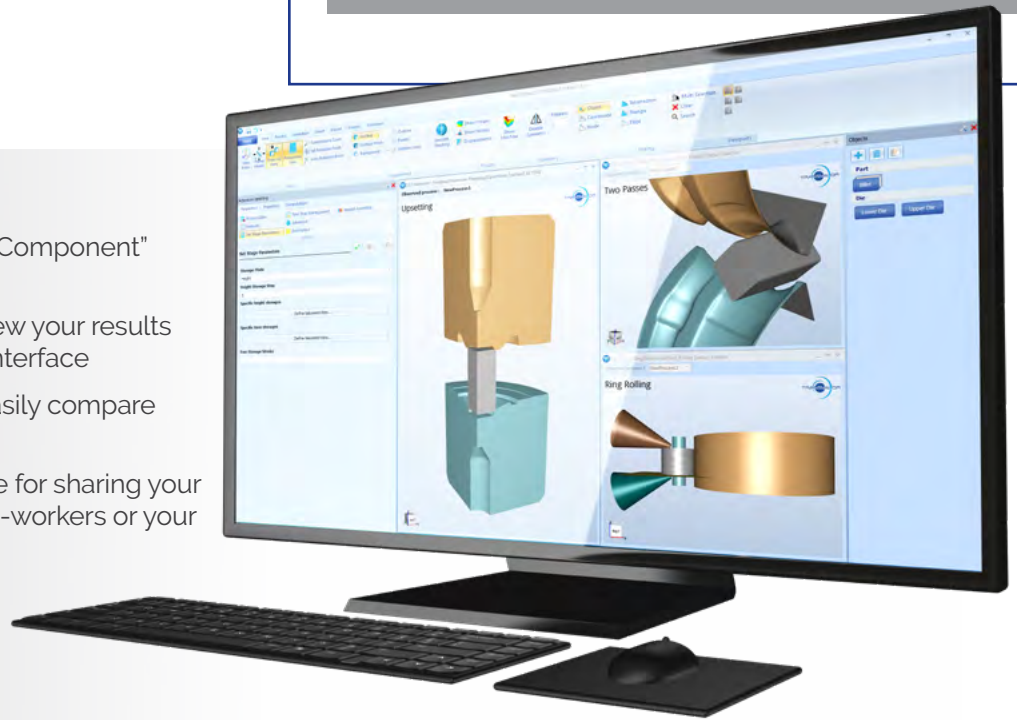
"I have been using FORGE® since 2008 to simulate many forging processes. I highly recommend this software for its accuracy and reliability"

*M. Cherri
Schaeffler Technologies GmbH & Co. KG, Germany*

Immerse yourself in a multilingual graphical interface for a “100% business-oriented” experience.

A MODERN AND INTUITIVE USER EXPERIENCE

- Customize your “Process or Component” simulation templates
- Make your data setups or view your results anytime in the same unified interface
- Use “multi-view mode” to easily compare alternative sequences
- “Export to Cloud”: the feature for sharing your results internally, with your co-workers or your customers



Comprehensive material databases

- Access +1000 references for ferrous alloys (low-carbon steel, stainless steel, alloy steel) and non-ferrous alloys (aluminum, titanium, copper base, nickel base, etc.)
- Create your cold rheology with properties derived from the supplier data sheet
- Export JMatPro® data to the FORGE® material file.

Reliably transcribe forging equipment kinematics

- Hydraulic press
- Vertical mechanical press
- Automatic transfer press
- Spring- or hydraulic-mounted floating die
- Single-acting, double-acting, or counter-blow hammer
- Screw presses
- Rolling mill
- Forging machine
- Special equipment: knuckle joint press, variable speed hydraulic press, orbital forging press, etc.

Compatibility with CAD systems and other CAE simulation software

- Support for exchange formats (Parasolid, STL, STEP, UNV, Nastran, Patran, etc.)
- Support for native formats (Catia, Creo Parametric, NX Siemens) with the CADdoctor Transvalor Edition option
- Export FORGE® results to structural analysis software to perform design calculations with the initial conditions from the forming process analysis!



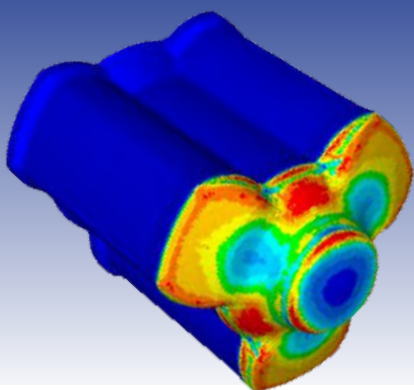
EXCLUSIVE FEATURES TO MEET YOUR CHALLENGES

Prevent deformations, wear and tool breakage

Whatever the stage of the process, FORGE® predicts stress distributions in tooling, abrasive wear, temperatures as well as areas subjected to elastic or plastic deformation.

FORGE® is built on solid scientific foundations:

- coupled thermomechanical analysis (calculation of tool deformation and impact on the dimensions of the forged component)
- temperature map calculation after reaching the steady-state thermal regime
- Archard model for abrasive wear with consideration of the steady-state thermal regime
- predicting the number of cycles to failure



Anticipate the presence of defects

FORGE® has unique features such as point tracking to easily detect any cold-shut areas in the part.

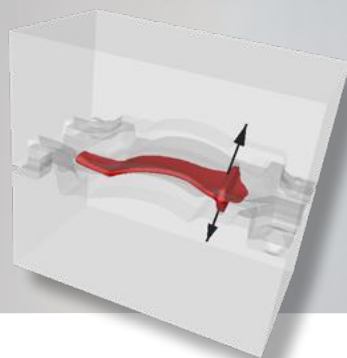
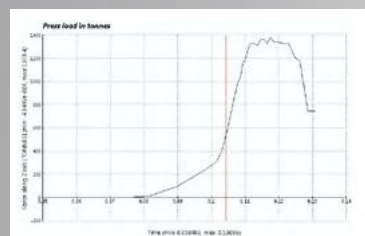
- Identify laps at each stage of forging
- Follow progression and determine whether the fold moves to the flash
- Measure the depth of the fold
- Ability to perform a reverse analysis and understand the origin of the fold



Select the appropriate forging equipment

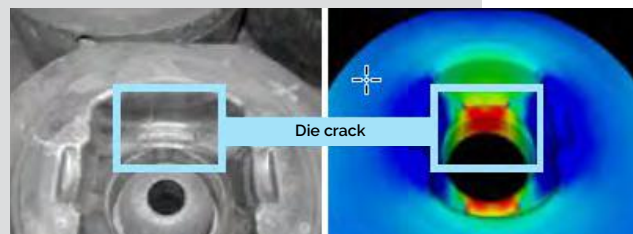
FORGE® predicts forging loads, energies consumed, torques and powers developed during each deformation operation.

- Anticipate whether the effort required does not exceed the maximum capacity of your equipment.
- Balance forging loads between the different stages
- View die balancing and deflection problems.



Your benefits

- Identify areas subject to excessive stress (compression, tension)
- Test changes to geometrical parameters (fillets, etc.)
- Size pre-stressed tools
- Increase tool service life



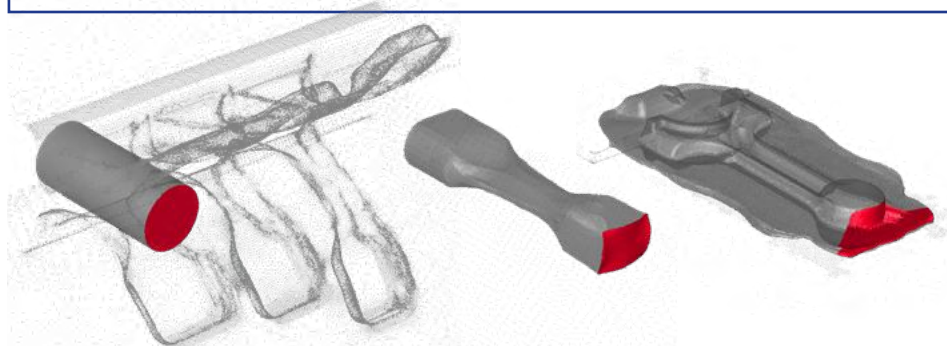
Ensure part health with good fibering

Predicting metal fibering is essential to ensure that forgings possess good mechanical properties, especially in terms of fatigue resistance and resilience.

- View fibering at all stages of the process
- Prevent "fibering exits" as flash



TAKE ACTION TO ELIMINATE THE RISKS AND VALIDATE THE FORGING PROCESSES



Track sheared faces, segregated areas and flow-through defects

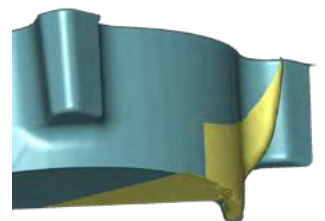
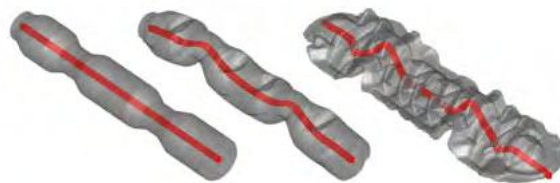
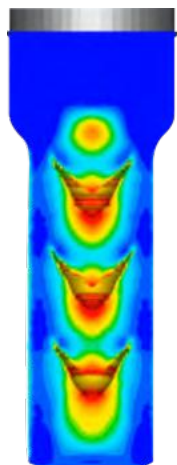
FORGE® possesses innovative marking techniques to represent and monitor the evolution of critical surfaces throughout the forging process.

- Determine the impact of sheared surfaces on the final part
- Materialize the segregations located in the center of the billet (**central looseness**) and monitor their evolution
- Identify **flow-through defects** in the immediate vicinity of the surface and detectable only by non-destructive testing

Predict areas subject to damage

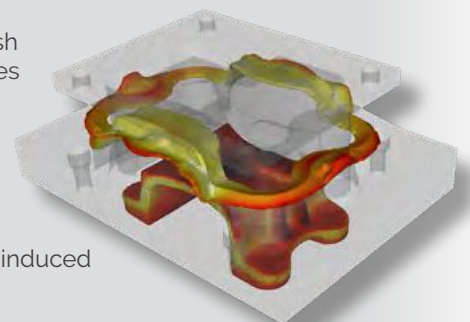
FORGE® incorporates several damage criteria that can be enabled to detect critical areas on the part.

- Latham & Cockcroft, Oyane, Chaboche-Lemaitre, Rice-Tracey fracture criterion
- Dang Van criterion for fatigue damage
- Identify areas subject to high triaxial stress
- Isolate risk areas with crack formation

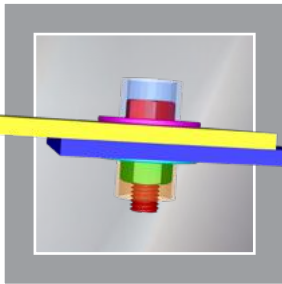
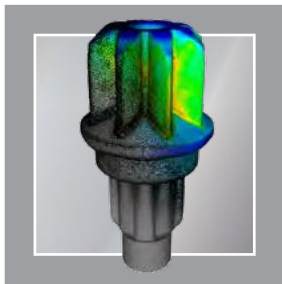
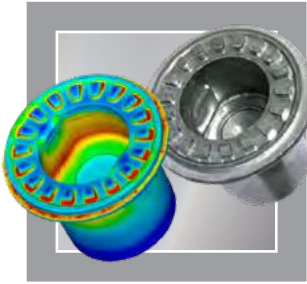


Application to cutting, shearing and trimming

- Coupling criteria with mesh element removal techniques
- Simulation of material fracture by localized damage
- Results: cutting profile, forces generated, deformations and stresses induced



FORGE®: A SOLUTION DEDICATED TO YOUR BUSINESS



Cold forming

FORGE® meets your needs for cold heading and more generally for all cold forming processes such as **riveting, wire drawing, heading or cold extrusion.**

- Balancing of heading stations
- Tracking of dimensional variations due to springback
- Multi-domain tooling analysis (die, punch, insert, die case) with consideration of pre-stress
- Self-contact and stress resistance management of mechanical assemblies

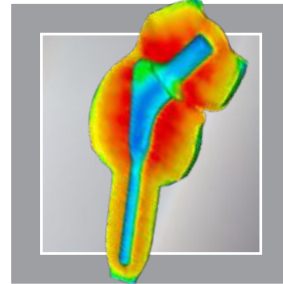
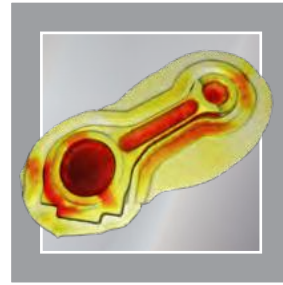
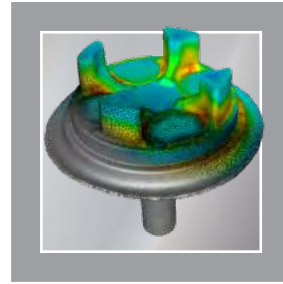
Closed die forging

Whether you are dealing with the production of large or medium series, FORGE® is the reference simulation tool for all your parts made by closed die forging.

- **Automotive:** chassis parts, transmission, powertrain
- **Aeronautics:** fan blade, disc, landing gear, batten
- **Equipment:** fittings, connectors, valve housings
- **Mining, Agriculture:** crown gear, pinions, hub
- **Medical:** orthopedic implants, medical devices
- **Luxury:** fine watchmaking and jewelry components

FORGE® for closed die forging is the guarantee of a faithful representation of material flows and the possibility of:

- Reducing flash by optimizing yield
- Simulating all forging process operations (heating - preforming - roughing - finishing - trimming - heat treatment) and locating defects (fold, underfill, cracks)
- Contributing to innovative in lightweight forging processes



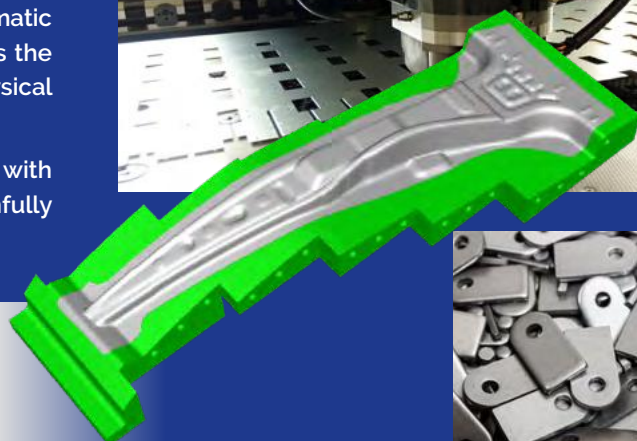
Sheet metal forming & fine blanking

FORGE® has an exclusive AAA (Adaptive Automatic Anisotropic) remeshing technology that naturally refines the mesh in sensitive areas and precisely captures all physical phenomena.

For fine blanking, FORGE® combines fracture criteria with renowned mesh element deletion techniques to faithfully represent the cut profile following excessive damage.

Geometry inspections

- Validate the final shape and thicknesses
- Control cutting profiles and limit part distortion
- Anticipate residual stresses



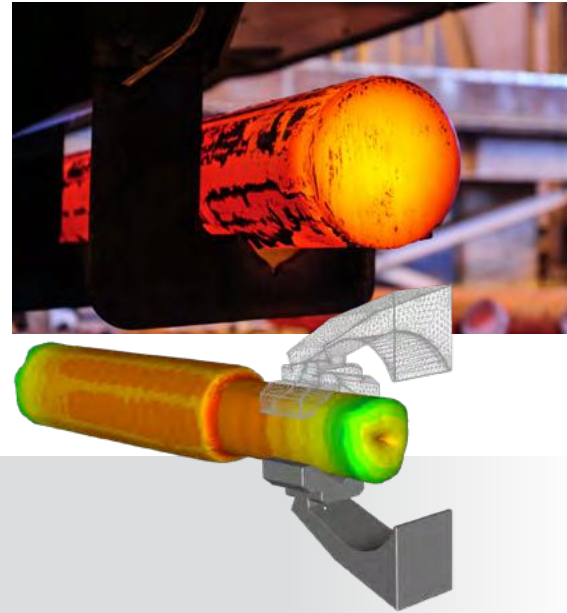
FORGE®: a solution dedicated to your business

Open die forging

FORGE® simulates all the main open die forging processes: **cogging, becking, mandrel drawing and blooming.**

With **the actual manipulator geometry**, FORGE® integrates the impact of the contact zone, temperature and local heat exchange. Passes below critical thresholds are detected using sensors that control both core and surface temperatures.

A **one of a kind MPFx file (Multi-Pass-File)** to easily define the process sequence (pass advance and depth, successive part rotations, manipulator gripping and release).



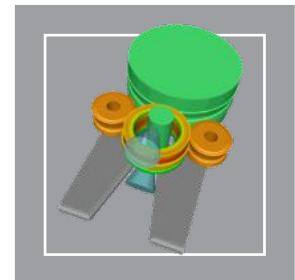
Your advantages for open die forging

- Simulate all forging process passes in a single calculation thanks to the MPFx file
- Use the true geometry of the manipulators with spring-controlled movement if necessary
- Optimize the forging process to obtain the required deformation rate and to close any porosities
- Predict metallurgical and microstructural changes
- Act on the overall process time and limit energy costs

Rolling processes

Ring rolling

The different types of rolling (radial, radial-axial, wheel rolling), both in hot and cold conditions, can be simulated for the production of seamless rings. FORGE® simulates all the operations of the process: heating - preforming - punching - rolling - heat treatment.



Your advantages for ring rolling

- Controlling the geometry of the rolled ring at every moment of the process
- Control the action of centering rolls and axial rolls
- Determine the forces and torques generated on the cylinders
- Detect defects (underfilling, fish-tail, ovalization, eccentricity)
- Predict part properties (deformation ratio, temperature, grain size)
- With the "Carwin-like" mode, manage rolling curves and kinematic control (with return loops) in accordance with actual rolling mill control

Rolling of long or flat products

For long products, the so-called "incremental" approach allows to check the compliance of the rolled profiles and to check defects such as centering or twisting effects at the bar entrance. For hot rolling, FORGE® has a so-called "stationary" approach with formidable efficiency to quickly simulate the rolling mill and evaluate inter-stand tensions.



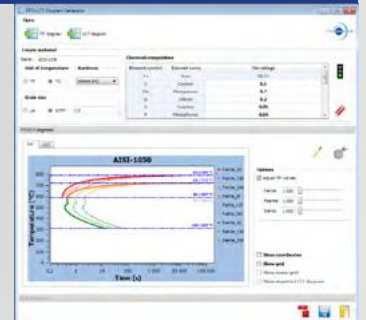
GOING FURTHER WITH THE STUDY OF METALLURGY

Faced with an increasing demand for the prediction of the in-use properties of forged parts, it is crucial to be able to simulate the heat treatment operations as well as the metallurgical changes inherent to the manufacturing process.

Thermal & thermochemical treatments

FORGE® simulates a wide range of heat treatments (austenitization, annealing, tempering, quenching, normalization, controlled cooling) and thermochemical treatments (carburizing and nitriding).

For steels, FORGE® includes an automatic TTT diagram generator that calculates transformation curves from the chemical composition. From a CCT diagram, this same generator can deduce the corresponding TTT diagram by reverse analysis.



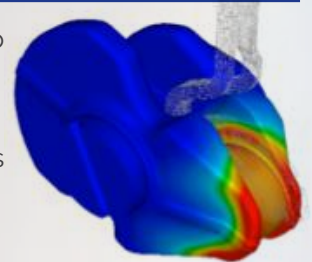
Features & Benefits:

- Test the influence of treatment conditions (temperature, cycle time, fluid efficiency, etc.) to guarantee the expected mechanical properties (hardness, resistance, ductility)
- Determine the effectiveness of thermochemical treatment by measuring the depth of enrichment (carbon, hydrogen, nitrogen)
- Guarantee the quality of treated parts by observing residual stress results, geometrical distortions and the risks of cracks during quenching
- Predict phase transformations for steels according to various implemented models (JMAK, Li, Leblond-Devaux, Koistinen & Marburger) and for titanium alloys
- Leverage the best data sources with JMatPro® software compatibility
- Use a single material file for both deformation and heat treatment simulations

Induction forge heating & induction heat treating

FORGE® has an exclusive solver capable of taking electromagnetic phenomena into account and solving Maxwell equations.

- Simulation of billet or bar induction heating in 'static' or 'on the run' mode
- Simulation of induction heat treating with possibility of mobile inductors or concentrators
- Use of power control with automatic generator current and frequency adaptation
- Fully parallel calculation for faster computing times
- Main results: temperature, heat affected zone, induced magnetic field, heating time, surface hardness, core impact resistance
- Optimization of heating time, applied frequency and energy consumption



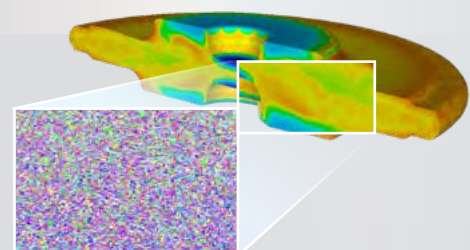
PSA Groupe &
EFD induction

Microstructure

For a large panel of materials (low carbon-stainless-microalloyed steels, nickel base alloys) FORGE® uses JMAK-type macroscopic models or mid-field models to take into account nucleation, growth and recrystallization phenomena during the heating or cooling phases as well as during stages with deformation.

Phenomena taken into account

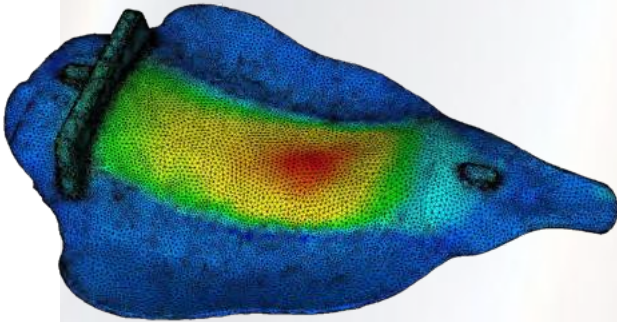
- Dynamic recrystallization
- Static recrystallization
- Post-dynamic recrystallization
- Grain growth
- Recrystallization kinetics
- Recrystallized fraction
- Phase transformation for titanium alloy
- TRIP (Transformation Induced Plasticity) effect



In order to anticipate market expectations, Transvalor develops its products around cutting-edge solutions allowing major technological leaps.

TRANSVALOR: PIONEERING IN SEVERAL KEY TECHNOLOGIES

Thus, Transvalor has positioned itself very early and continues to innovate on remeshing technologies fully adapted to the requirements of large deformation simulations. Transvalor has been also the first software provider to promote the concept of automatic optimization applied to process modellings, and forging in particular.



Get a head start with our remeshing technologies

ROBUST: the software uses tetrahedral elements perfectly adapted to the successive and intensive remeshing.

- No limit with the number of nodes and elements
- **Remeshing of unanimously recognized stability**
- Guaranteed volume preservation
- Fully parallelized remeshing and transport operations
- Technologies compatible with multi-material configurations.

FAST: thanks to its **Bi-Meshing technology** applied to open die forging processes, reduce computation times on average by a factor of 5 over typical coggng processes.

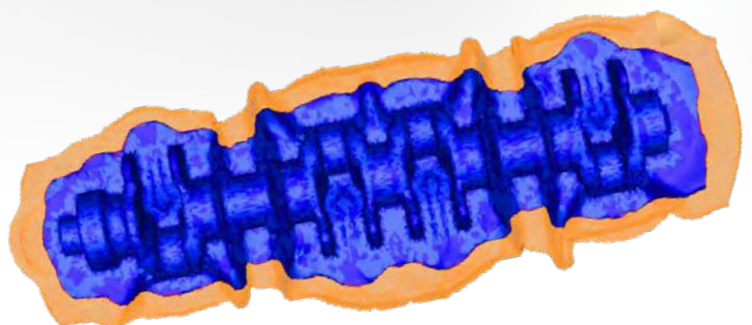
INNOVATIVE: the **AAA (Automatic Adaptive Anisotropic)** remeshing technology combines automatic adaptation of the mesh in all the sensitive areas of the part with anisotropic mesh generation to optimize computation times.

Maximize your material savings thanks to the automatic optimization

- **Optimizing the starting billets** to automatically improve yield
- **Determining the ideal rolled preforms** to ensure complete and defect-free die filling
- **Optimizing tooling geometry** to minimize stress and increase tool life
- Conducting sensitivity studies through **design of experiment (DOE)** on key parameters
- **Identifying process parameter values** (friction, heat exchange, rheology) by reverse analysis

Automatic optimization is 100% compatible with conventional CAD systems* (Creo Parametric, SolidWorks, Catia) and parallel computing. Be even more efficient by launching your optimization on multiple cores and taking advantage of FORGE®'s unmatched efficiency in highly parallel computing.

* subject to modifications without notice



■ Optimized design
■ Original design

COMPETITIVE ADVANTAGES OF FORGE®

FORGE® software has enjoyed an excellent reputation for more than 30 years and has always distinguished itself from the competition by offering many differentiating factors. FORGE® stands out as a leader in its market and supports your design and engineering activities for the development of high value-added parts.

**Reliable
& accurate results**

"FORGE® is a very powerful software for metal forming simulation. For many years, it has enabled us to develop new forming processes with a high level of confidence and reliability. Continuous improvement in areas such as heat treatment, metallurgy or material data gives us the opportunity to study in depth the process parameters that influence the properties of the final part. The use of FORGE® is essential in our daily work because it plays a key role in the design of forging processes."

*Tecnia, Spain
Iñaki Perez Bilbao*

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

*Ohio state University
Rajiv Shivpuri*

High performance parallel computing

Parallel computing is available for all FORGE® processes and is compatible with all options. Moreover, FORGE® keeps **an almost constant efficiency** (ratio speed-up vs number of cores) for calculations launched **on a large number of cores**. Fully exploit your computing power for ever more accurate results.

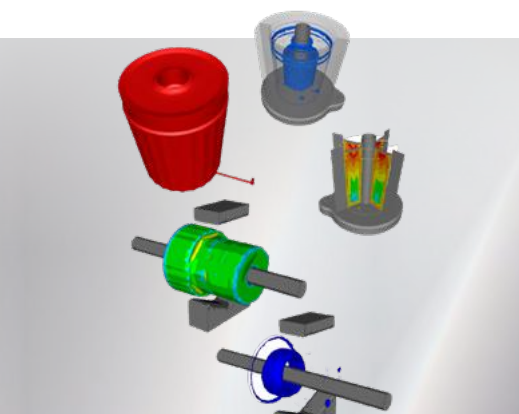
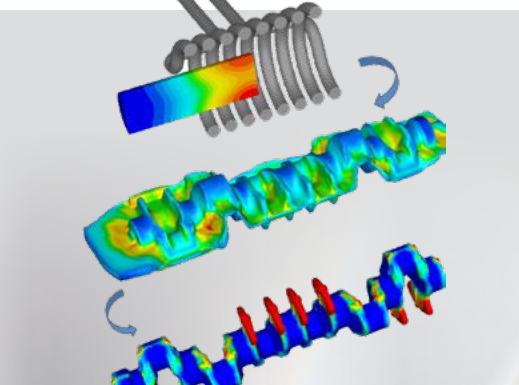
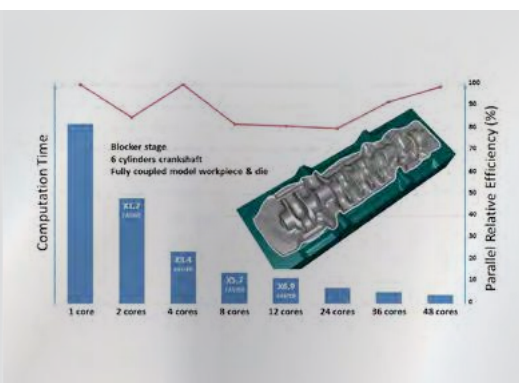
Simulate the complete manufacturing chain

With FORGE®, you can simulate all the operations required to manufacture your part: from furnace or induction billet heating, through all stages of preforming and forging to final operations (trimming, punching and heat treatment). This comprehensive approach is equally useful for simulating the full range for open die forging or ring rolling applications.

This guarantees **global consideration of the entire thermo-mechanical and metallurgical history** of the part to effectively predict its in-use properties.

Exclusive: Make the link between metal casting and forging processes

Benefit from the exclusive **coupling between THERCAST® foundry simulation software and FORGE® software**. You can simulate ingot casting (or continuous casting), then automatically transfer the foundry results (porosity, segregation) to FORGE®, without any loss of information. You can then simulate open die forging or rolling operations and thus predict the closing of porosities during forging, or the location of segregations in the finished part.



FORGE®

A robust and powerful solution that adapts to your needs

An “All-in-one” solution

FORGE® license offers immediate access to all the possibilities of the software.

Everything is included!

You are sure of being able to:

- **Take advantage of ALL the features** offered by the software (closed die forging, cold heading, ring rolling, heat treatment, open die forging, etc.)
- Avoid potential hidden costs in the future
- Develop designs that go beyond the usual framework of your production and run your simulations without worrying about possible missing features in the package

For academic use, or for your R&D projects

Thanks to the principle of user routines, the user has great flexibility to program new laws of evolution. It is thus possible to implement one's own models as behavior laws, friction laws, or damage criteria.

Flexibility of use

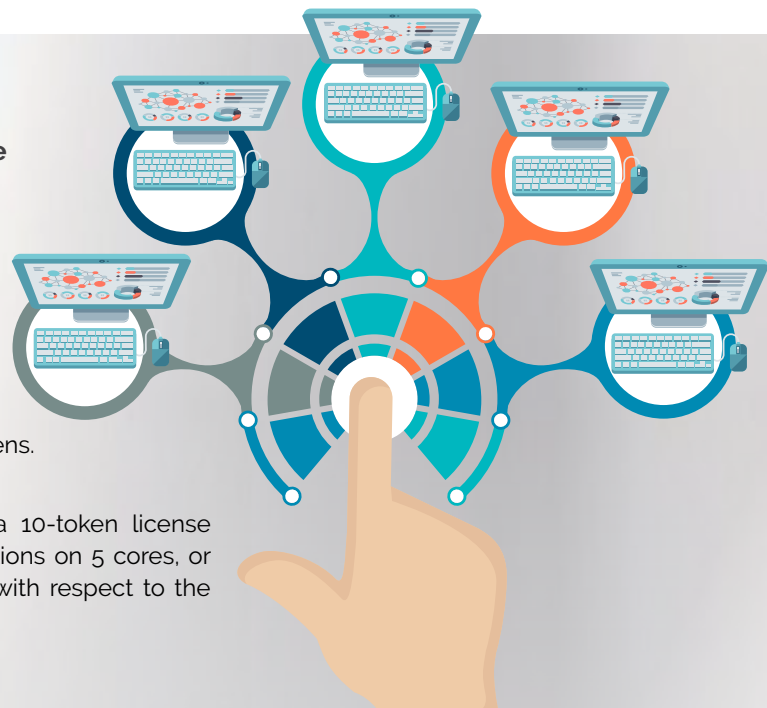
With FORGE®, you have a tool that you can use where, when and how you want:

- No limit on the number of users
- Pricing independent of the number of users; no additional fees if the number of team members increases
- No need for a dongle or dedicated workstation; simply access the license server installed on your corporate network or locally on your computer
- Run the software on any type of hardware architecture (laptop, workstation, server and cluster) in 'standalone' or 'client/server' mode
- Collaborative work: compatible with queue managers
- View and share your results free of charge between co-workers or with your customers thanks to our 'Ceetron 3D viewer' and 'Export to Transvalor Cloud' interactive solutions
- Access your data updates and analyze your calculation results at any time even if your license has expired

Licensing: Let's get rid of taboos!

FORGE® is marketed according to a floating license system with use of a maximum number of tokens.

- Determine the licensing scenario that best fits your usage level as well as your IT and budget requirements
- Adapt your choice of license and token pool on the fly, depending on changes to your teams or your business needs
- The pre & post-processing modules do not consume tokens. In other words, only calculations will use your token pool
- Manage your token pool as you wish: for example a 10-token license allows you to run 5 calculations on 2 cores, or 2 calculations on 5 cores, or 1 calculation on 10 cores. All combinations are allowed with respect to the maximum number of tokens



OUR PRIORITY IS TO BE AT YOUR SERVICE AND ACCOMPANY YOU ON A DAILY BASIS

From computer consulting to the most complex studies, Transvalor assists you in the context of engineering services.



EXPERTISE & CONSULTING

- You are faced with a new technical problem...
- You cannot devote the necessary time...
- You are faced with a loss of know-how due to the departure of employees...
- You have difficulties recruiting new talent...

Consult our experts who will make every effort to provide you with technical solutions tailored to your needs by combining their experience in finite element calculation with a solid background in engineering and the latest generation computing resources.

"Non-conventional" consultancy services

- Study of glass forming for vials and bottles
- Impact of the forming process on the fatigue strength of forged components
- Mechanical behavior of projectiles fired at armor
- Modeling the mechanical strength of a human jaw

TECHNICAL SUPPORT

A project does not stop when production starts. Our Technical Support team (level 1, level 2 and Expert) is there to help you, advise you and allow you to make the most of our solutions.

- Multilingual support (English, French, German, Spanish) open all year round on business days
- Team of engineers specializing in numerical simulation, forming processes and materials
- Ticket creation by email or phone
- Remote control for greater efficiency
- Access to newsletters
- Ability to submit improvement requests
- Access to new versions and patches for the current version
- Regularly updated online help
- Advice to your IT departments for hardware configurations and software installation

TRAINING

Transvalor is an approved Training Organization and assists you to train your teams, cultivate your know-how, support your technological changes and ultimately increase your competitiveness.

Choose your formula from a panel of proposed themes: custom, group or individual, for beginner or expert, in French, English or German...

Almost anything is possible for you to achieve your performance goals.

+100
TRAINING
DAYS

100%
SATISFACTION

"A support system that assists you in solving your problems from start to finish is more than just an accident. It is a fundamental aspect of Transvalor."

+250
TRAINEES

Gerdau, U.S.A.
Dave Fournie

TRANSVALOR - ABOUT US

Transvalor is a French company created in 1984 whose headquarters are located in the Sophia Antipolis technopole, in the south of France. It is a multicultural team of approximately sixty people passionate about advanced technology and driven by a desire for innovation to always offer the best solutions to its customers.



Transvalor's success stems from the extensive expertise gained in the field of forming processes and its very strong innovation capacity.

Transvalor came from the research sector and it continues to maintain close links with the **Centre For Material Forming** (CEMEF-Mines ParisTech), whose activities are centered around material forming technology and numerical analysis. This partnership brings in a steady flow of advanced scientific developments that are translated into new functionalities in Transvalor's products, all of which benefits its customers.



Staff Members



Worldwide Activity



Consulting & Expertise



Global Turnover



R&D Investments



Software Training

To opt for Transvalor is to trust the expertise of the teams and the excellence of the products, which have been a step ahead for its customers for more than 30 years.

FORGE[®]

OUR GLOBAL PRESENCE



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ISO 9001:2008

BUREAU VERITAS
Certification



TRANSVALOR.SA. IS ISO 9001 CERTIFIED BY BUREAU VERITAS AS PART OF ITS ACTIVITY OF DEVELOPMENT, INDUSTRIALIZATION AND COMMERCIALIZATION OF SCIENTIFIC COMPUTING SOFTWARE AND ASSOCIATED SERVICES. THIS CERTIFICATION UNDERLINES TRANSVALOR SA'S DESIRE TO BE PART OF A CONTINUOUS IMPROVEMENT PROCESS IN ORDER TO BETTER MEET THE EXPECTATIONS OF ITS CUSTOMERS.



M A T E R I A L F O R M I N G S I M U L A T I O N