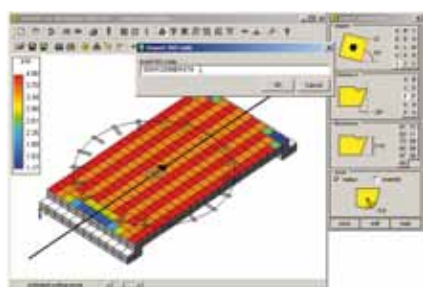
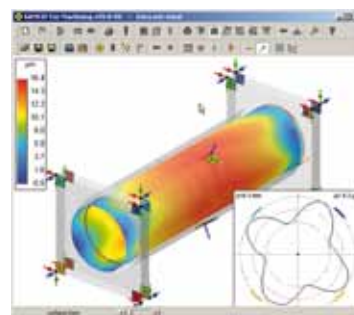


SAMCEF for Machining

SAMTECH Manufacturing Solutions



Innovative professional solution dedicated to machining of mechanical parts combining structure FE analysis and specialized features

SAMCEF for Machining offers a unique environment for analysis and optimization of machining processes using SAMCEF solvers.

MACHINING SIMULATION

SAMCEF for Machining proposes an innovative approach based on the analysis of machining systems at a macroscopic scale. Several aspects of machining such as part dimensional errors, process stability and thermo-mechanical distortions are covered. With SAMCEF for Machining, process engineers may validate and improve their machining operations by changing different parameters such as clamping system, tool trajectory or cutting conditions.

In other simulation software, the elements of the machining system - part, tool, clamping devices - are modelled as rigid bodies so that crucial issues cannot be detected (part deformation, chatter...). In SAMCEF for Machining, the system elements are modelled with Finite Element meshes so that their real behavior is taken into account. Consequently, Manufacturers are able to predict and avoid machining issues for various operations such as face milling, turning or drilling.

- **Simulations:**
 - o Evaluate the efficiency of clamping devices using flexibility maps;
 - o Define the most appropriate tool trajectory;
 - o Set the optimal axis tilt for face milling operations;
 - o Adapt the cutting conditions to the stiffness of the clamped part;
 - o Check chatter issues locally using stability diagrams;
 - o Reduce the risks of chatter in face milling with the chatter maps;
 - o Set the best order for holes in drilling;
 - o Automatically improve the tool trajectory to compensate the part deformations.

GENERAL FEATURES

SAMCEF for Machining has a very intuitive graphical user interface. Most functions are very similar to the CAD/CAM environments process engineers are used to. Menus and dialog boxes are easily understood by using technical words taken from the field of machining. Easy choices are proposed to help the user during the data preparation and the post-processing steps. The user may automatically create analysis reports including pictures, tables and comments. The on-line help includes wide descriptions of all the available features as well as a tutorial with some examples.

- **User interface:**
 - o Interactive model manipulation with the mouse;
 - o Programmable mouse buttons (rotate/zoom/move);
 - o Control model aspects (colour, transparency...);
 - o Save and reload camera positions;
 - o Automatic generation of analysis reports;
 - o Intuitive machining-oriented menus and toolbars;
 - o Measure of geometric features (nodes, circles, lengths...);
 - o On-line help and documentation.

SYSTEM MODELLING

In SAMCEF for Machining, the user may import a Finite Element model of the machined part in various formats. Meshes of components of the clamping system may also be imported and assembled with the machined part mesh thanks to an easy-to-use gluing function. In addition, an integrated mesher allows creating the model of simple elements such as supports or clamps. The material properties can be imported from the material database. It contains predefined common materials (steel, aluminium...) but may be enriched with the user-defined materials.

- **Finite Element features:**
 - o Finite element model of the machined part;
 - o Import of SAMCEF, NASTRAN and ABAQUS formatted meshes;
 - o Rotating and positioning imported meshes;
 - o Gluing function to assemble separate meshes;
 - o Extrusion and revolution mesher;
 - o User material database;
 - o Mesh quality checking (aspect ratio and unconnected sub-domains);
 - o Visualisation of cuts in the model.

MACHINING DATA

SAMCEF for Machining is designed to ease the data creation steps. Specific zones of the machined parts are defined with various selection tools (surface recognition, selection masks...). Boundary conditions and local axes are set with macro commands. The user may use parameters in order to define various entities such as clamping forces. A user database is available to load and save the tool characteristics (diameter, number of inserts, cutting angles...). The insert characteristics may be defined by importing its ISO code from a tool supplier catalogue. The cutting parameters (forces, power, thermal fluxes...) are computed with a choice of various analytical models for which data are proposed for various groups of materials (soft steels, high carbon steels, stainless steels, cast irons...). The tool trajectory may be created interactively in SAMCEF for Machining or imported from a NC (numerical command) program in ISO format.

- **Analysis data:**
 - o Creation of groups for specific surfaces (machined surface, clamping zones...);
 - o Automatic group generation of symmetric zones in turning applications;
 - o Import/export selection;
 - o Macros to define local axes and boundary conditions (clamping, supports...);
 - o User-defined parameters to simplify data generation/modification;
 - o ISO code to define insert characteristics;
 - o User tool database (face mills, turning tools...);
 - o Several models to compute cutting forces;
 - o User database for material characteristics;
 - o Interactive creation of tool trajectory;
 - o Define cutting conditions in proper units (m/min, mm/rev...);
 - o Import NC programs.

ANALYSES

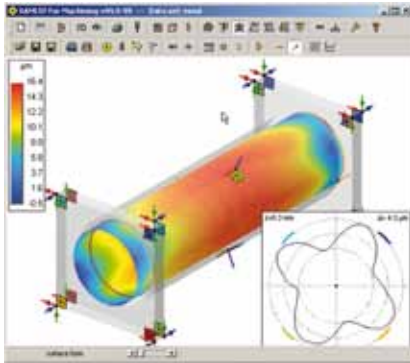
SAMCEF for Machining launches SAMCEF solvers according to the calculation step. Static Super-Elements are used to dramatically speed up the simulation process. They are created with the SAMCEF Asef linear static solver in a transparent way (the user has only to select the retained surfaces). The SAMCEF Dynam solver is launched in a similar way to compute the eigen modes and eigen frequencies of the machined part in the clamped configuration. SAMCEF Thermal and SAMCEF Mecano solvers are used to calculate the thermo-mechanical behavior of the part during drilling processes. In addition, several specific solvers for various specific simulation steps (surface defect, form errors...) are called from SAMCEF for Machining with a single mouse click.

• Solvers:

- Super-Element creation with SAMCEF Asef linear static solver;
- Mode calculation with DYNAM;
- SAMCEF Thermal and SAMCEF Mecano for thermo-mechanical analyses;
- Specific solvers for matrix inversion and machined surface defect;
- Specialized tools for post-processing (flatness, run-out, Fourier components...).

RESULT ANALYSIS

SAMCEF for Machining is designed to meet the user requirements in term of general and specific post-processing. Flexibility maps of the machined surface reveal the effect of the clamping devices on the part stiffness. Eigen modes, frequency responses at nodes, chatter maps and stability diagrams are used to control and improve the dynamic behaviour of the clamped part, especially for chatter issues. Form errors (flatness, cylindricity...) are computed according to ISO standards and displayed in a very intuitive way. Run-out curves may be created interactively by displacing the mouse pointer along the machined surface. In addition, the Fourier components (bilobes, trilobes...) may be extracted from a run-out curve. For some machining operations, the tool trajectory may also be improved automatically to compensate the part deformations during the machining process.

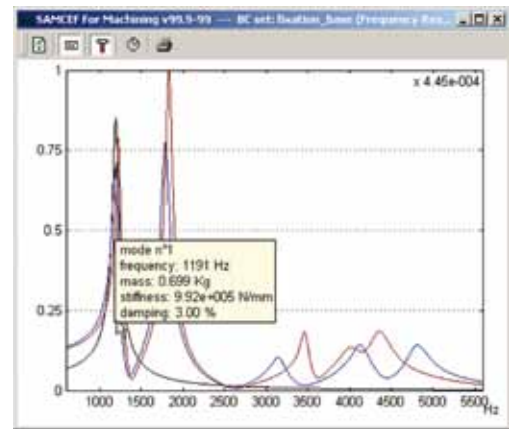


• Post-processing:

- Flexibility maps of the machined surfaces;
- Mode visualization;
- Frequency Response Functions at nodes;
- Chatter maps of the machined surfaces;
- Stability lobes;
- Form errors (flatness, cylindricity...);
- Position and inclination errors (concentricity, parallelism...);
- Axial and radial run-out curves;
- Visualization of Fourier components (bilobes, trilobes...);
- Mill axis tilt effect and adjustment;
- Optimization of the tool trajectory (compensation of part deformations).

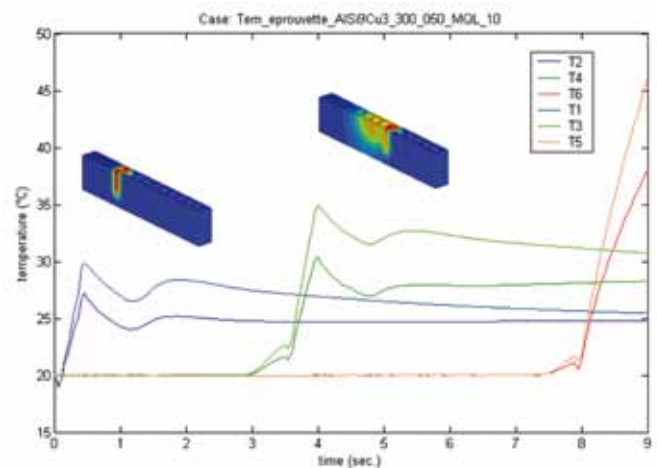
EXPERIMENTAL RESULTS

SAMCEF for Machining includes several tools to exploit experimental data. For modal aspects, the computed frequency response function may be compared to a measured one in order to adjust damping of the most important modes. The user may import a set of measured points coming from a coordinate measuring machine and compare it with the simulation results. A new surface mesh is automatically created on the measured points and the computed surface is interpolated on this mesh in order to compare the measured and the computed surfaces on the same mesh. For thermo-mechanical analyses, the user may define points on the part mesh for which curves of temperature or displacement versus time are displayed in order to compare to curves measured with thermocouples or displacement sensors. Data used in the calculations may then be adjusted automatically to reflect more accurately the real behaviour of the machining process.



• Experimental features:

- Import a measured FRF;
- Adjust mode damping;
- Import a cloud of points measured on a CMM;
- Generate mesh on measured points;
- Create curves of temperature or displacement versus time for several nodes;
- Import temperature evolution measured with a thermocouple;
- Import displacement evolution measured with a sensor;
- Adjust machining parameters.



About SAMTECH

SAMTECH is a European specialist in the development and worldwide marketing of Computer Aided Engineering software, commonly called "simulation software" or "Virtual Prototyping". It is well established that as well as increasing the quality of the design, such software not only enables drastic reductions in product development cycle and consequently the associated costs, but also dramatically reduces the need for expensive physical testing.

"General-purpose software tools": this SAMTECH offer includes the general linear and implicit non-linear Finite Element Analysis package SAMCEF with the CAD/CAE modeling environment FIELD, the general explicit and fast dynamics code EUROPLEXUS; the task management and optimization platform BOSS quattro; TEA Mecano and TEA Thermal CAA V5 Based as non-linear thermo-mechanical solution embedded in CATIA V5 and SAMCEF Gateway CAA V5 Based, the SAMCEF integrated interface within CATIA V5.

SAMTECH most recent product, CAESAM, is a high level CAE centric Application Framework allowing the customization and the management of the whole engineering process, involving any commercial software and in-house skill tools. This environment based on Knowledge Based Engineering concept encapsulates customer skills and knowledge into Analysis Processes and Analysis Methods and ensures reusability of models in order to reduce Time-to-Market.

"Professional products": this SAMTECH offer is based on its general-purpose software tools and is dedicated to specific domains of application such as rotor dynamics (SAMCEF for Rotors), modeling of pipes for automotive industry (TEA Pipe), modeling of high voltage substations, electrical lines (SAMCEF for Power Lines and Substations), prediction of dynamic loads on wind turbine drive trains (SAMCEF for Wind Turbines).

"Third party and customized solutions" like the SAFE tool (fatigue analysis of aeronautic structures) and the Application COMPOSITES (analysis of aeronautical structures made of composite materials) from AIRBUS, where SAMTECH provides its clients with services such as development, reengineering, packaging and deployment of proprietary professional solutions on the customer site.

"Customized multi-physics solutions", based on OOFELIE. OPEN ENGINEERING, the SAMTECH subsidiary, which allows SAMTECH to be present in the multi-physics design markets and to provide services for the development of original highly coupled analysis solutions covering specific needs, commercializes OOFELIE.

Visit www.samtech.com for further details on SAMTECH Product/Service offer!

Some references

Space

ASTRIUM ST, SAFRAN GROUP, ESA / ESTEC, CNES, ALENIA, ISRO...

Aeronautics

AIRBUS, SPIRIT AEROSYSTEM, AVIC-GROUP, SABCA, SONACA...

Aero engines

TECHSPACE AERO, SAFRAN GROUP, GTRE, MTU...

Automotive

DAIMLER, PORSCHE, PSA, TOYOTA, DELPHI AUTOMOTIVE, MITSUBISHI, TATA DAEWOO...

Energy

AREVA, EDF, GENERAL ELECTRICS, SIEMENS, REPOWER...

Defense

MBDA, GIAT INDUSTRIES, FORGES DE ZEEBRUGGE...

Miscellaneous

GLAVERBEL, SAINT GOBAIN, PICANOL...

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