

CUTPRO & SHOP-PRO

*Maximize material removal rates, accuracy and performance
of machining operations with cost effective:
Shop-Pro, CutPro, SpindlePro, and
Virtual CNC Simulation Software Modules*

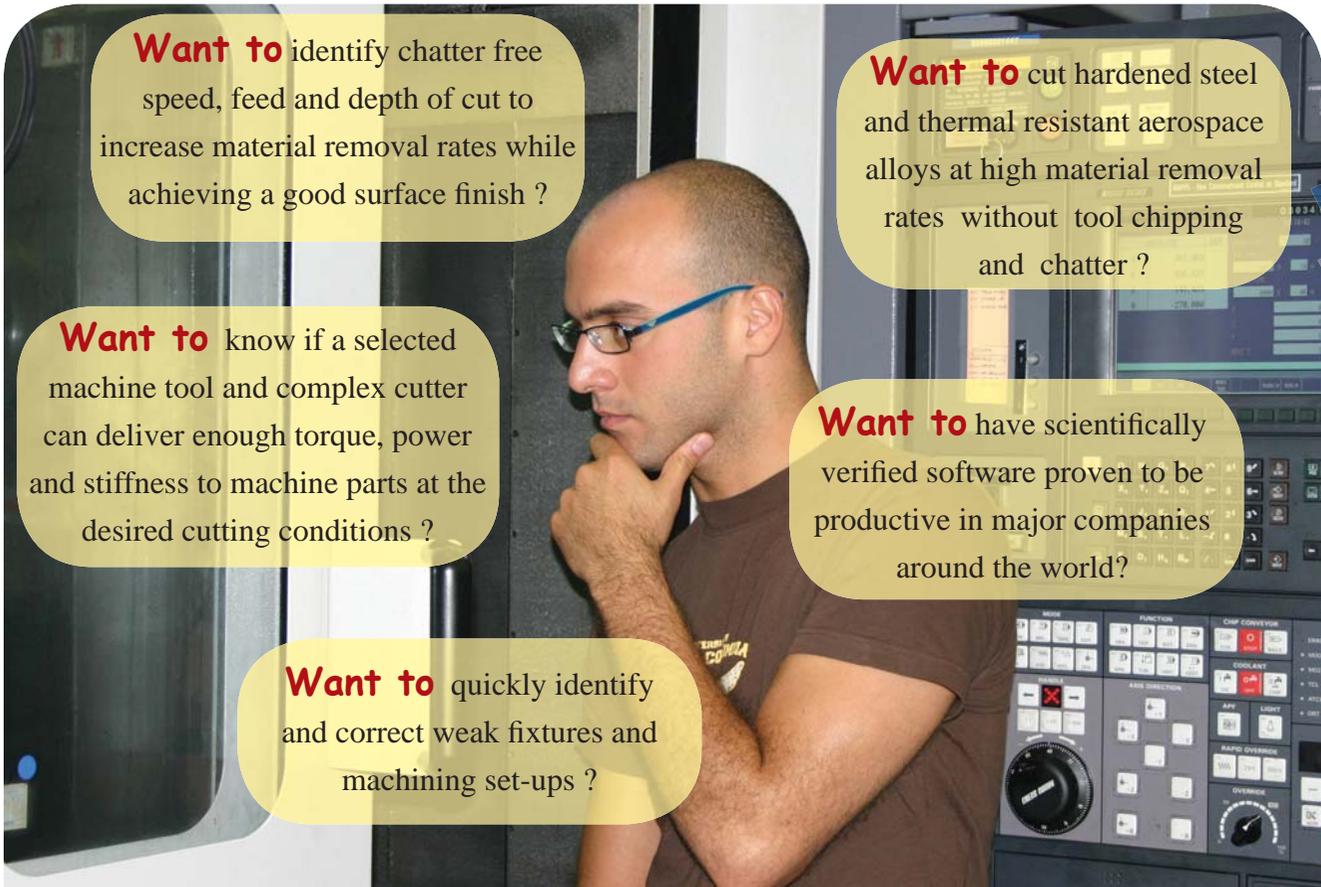
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Machining Process Simulation Module



Want to identify chatter free speed, feed and depth of cut to increase material removal rates while achieving a good surface finish ?

Want to cut hardened steel and thermal resistant aerospace alloys at high material removal rates without tool chipping and chatter ?

Want to know if a selected machine tool and complex cutter can deliver enough torque, power and stiffness to machine parts at the desired cutting conditions ?

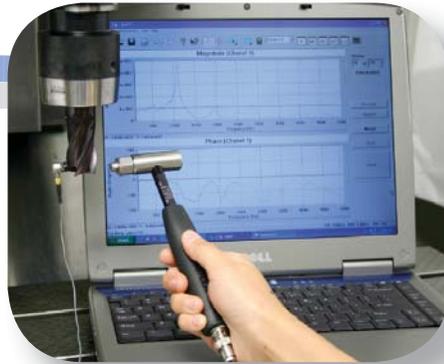
Want to have scientifically verified software proven to be productive in major companies around the world?

Want to quickly identify and correct weak fixtures and machining set-ups ?

By adopting CUTPRO advanced machining software, you will achieve the highest possible material removal rates, long tool and spindle life. You will be able to manufacture parts correctly at the very first trial with reduced production cost and machine down time. Developed at internationally acclaimed Manufacturing Automation Laboratory (MAL), CUTPRO provides high productivity solutions for the metal cutting world. MAL delivers strong technical and follow-up support to its customers, and our twenty strong research engineers add new technology modules to CUTPRO every six months.

Measure the machine, simulate the process and select the best cutting conditions with CUTPRO

Tap Test
the tool

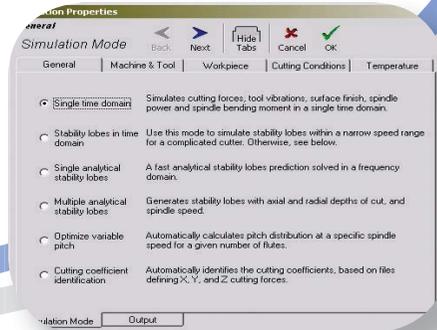
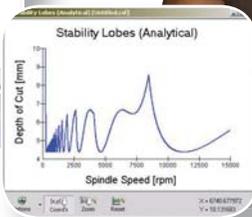
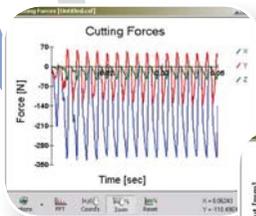


with
CUTPRO MaITF
Module

“CutPro provides the
best solution for
productivity!”



Optimize the
process with
CutPro



Shop-Pro is an integrated, shop version of CUTPRO which covers the entire measurement and optimization of machining operations.

Shop-Pro



Shop-Pro is a cost effective and practical chatter avoidance tool kit to achieve high speed - high performance machining within minutes.

Shop-Pro is an entry level, very effective, integrated machine tool testing and chatter vibration avoidance product. It can easily be used by machine tool operators and production engineers thanks to its built-in expert guidance and simple graphical user interface. Furthermore, users can migrate from Shop-Pro to the advanced CUTPRO as they gradually build their technological base while avoiding costly software and training investments.

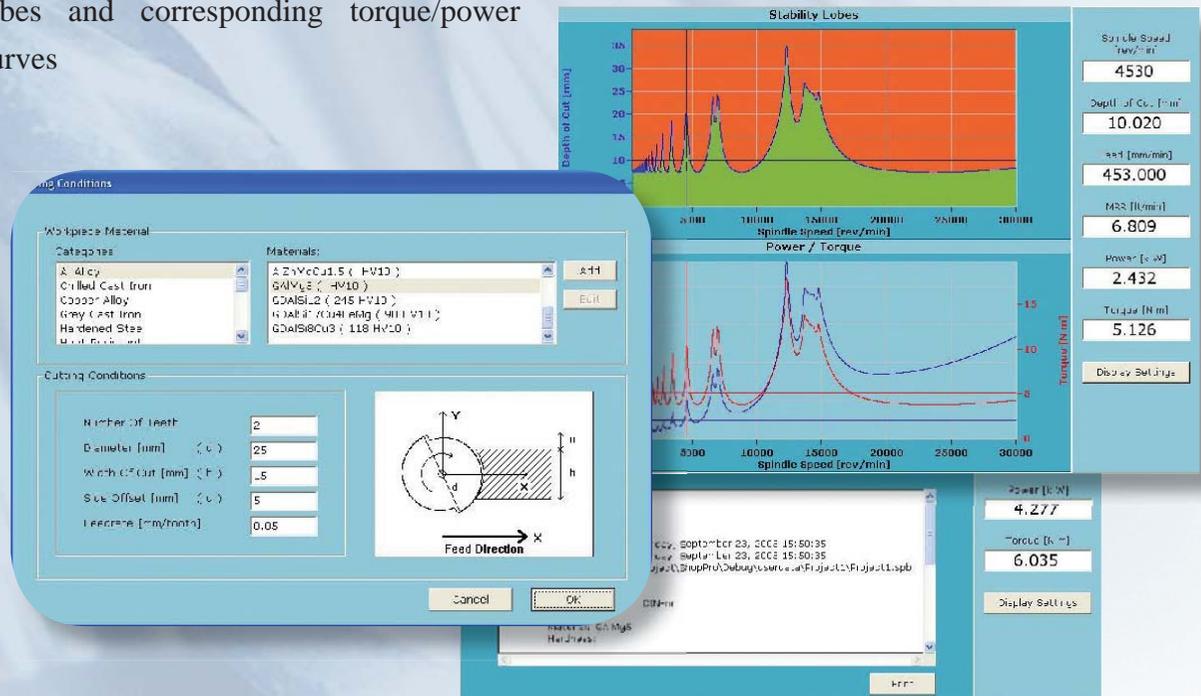
After a few minutes of tap testing, chatter vibration free spindle speeds and depth of cuts are found and the material removal rates are significantly increased. Shop-Pro's integrated expert system automatically diagnoses machining problems by reading your concerns, listening to the machining sound, and checking the specified cutting conditions.

Shop-Pro has the following four steps to achieve trouble free, high material removal rates :

- Cutter and material type selection by the user
- Voice-guided, quick tap testing of machine tools with an impact hammer
- Graphical output displays chatter stability lobes and corresponding torque/power curves

- Expert system diagnoses and avoids chatter, tool setting and tolerance violation errors
- Compatible with our CUTPRO advanced machining simulation software

Shop-Pro can be learned and applied in minutes to achieve high material removal rates in shops.



Advanced Milling Process Module



Predicts and optimizes milling operations with any cutter and insert geometry for higher material removal rates.

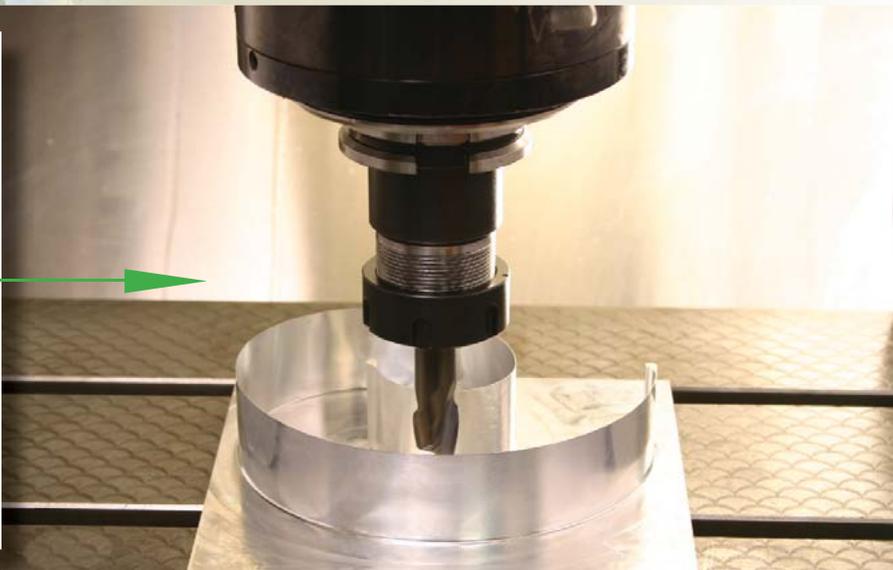
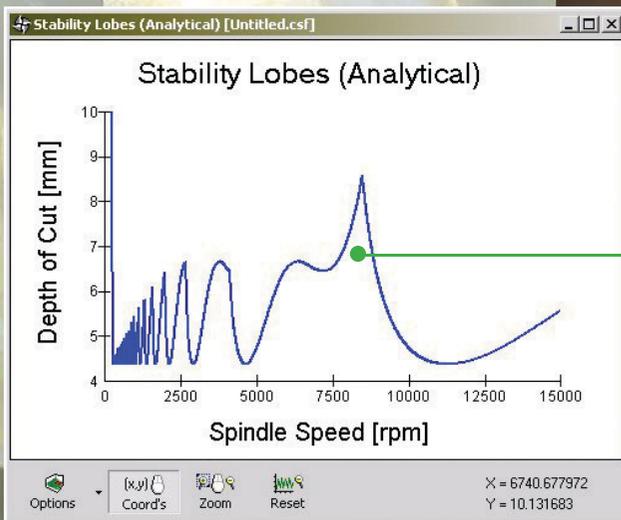
Milling Module Features:

- Predicts forces, power, torque and vibrations for user specified cutting conditions, cutter geometry, workpiece material, workpiece and machine tool structures
 - Predicts surface form errors caused by feed marks, tool setting errors, deflections of tool and part
 - Allows virtual design and machining performance testing of complex cutter shapes, machine tools and spindles
 - Designs, tunes and simulates the performance of variable pitch - variable helix, and serrated cutters for machining thermal resistant alloys
 - Designs and simulates the performance of user defined indexable cutters, ball end mills, plunge mills, and solid end mills with varying geometry along the flutes
 - Simulates stability lobes, forces, power and torque for multiple cutting conditions.
- Simulates the stability lobes and predicts the most optimum depth of cuts, feed and spindle speeds for chatter vibration free high performance machining

- Has simplified integrated modal analysis module to identify stiffness, damping and natural frequencies of the machine tool and the workpiece accurately
- Allows the inclusion of machine tool and part flexibilities in the simulations
- Accepts dynamic parameters of the machine tool and workpiece manually or in various

industry standard formats created in CUTPRO or other commercial modal analysis software packages

- Has over 110 materials in the data base with an automated user material identification and data base entry mechanism.
- Has user friendly graphical interface with wizard guidance.



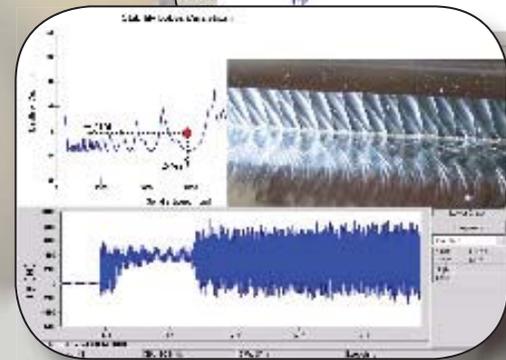
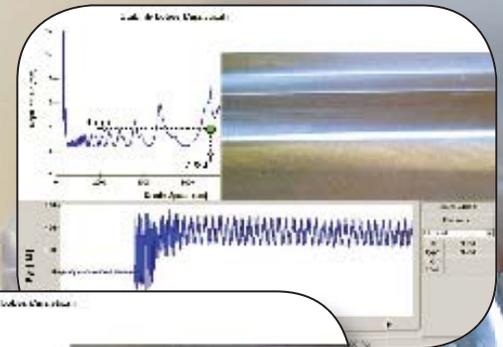
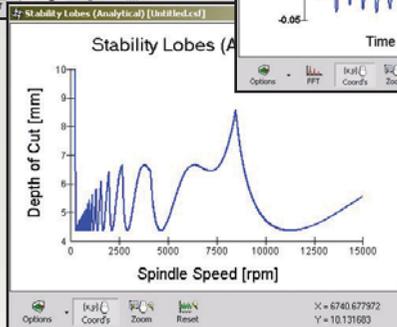
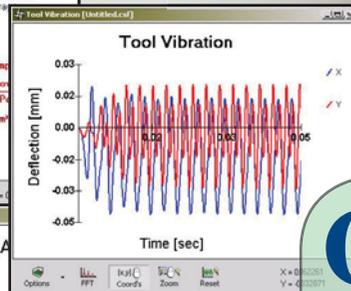
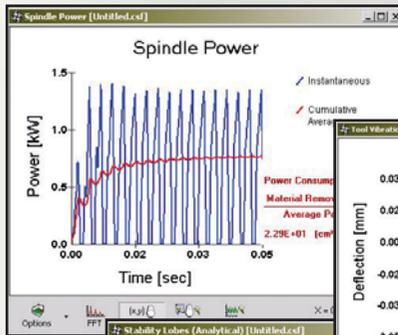
Milling Process Module (Continued)

In only a few minutes of simplified tap testing and simulation, you will be able to significantly increase the material removal

rates while reducing the scrap rates, eliminating vibration marks, and prolonging both tool and spindle life.

INPUT BY THE USER:

Tool Geometry, FRF (tap test) of the machine tool, workpiece material and cutter engagement

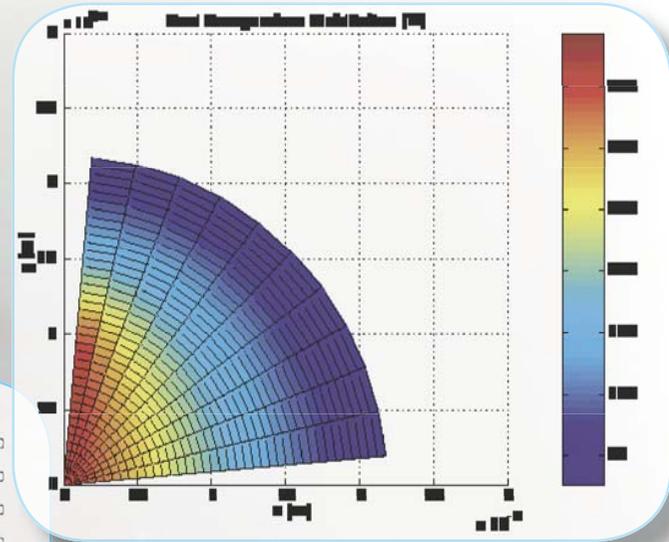
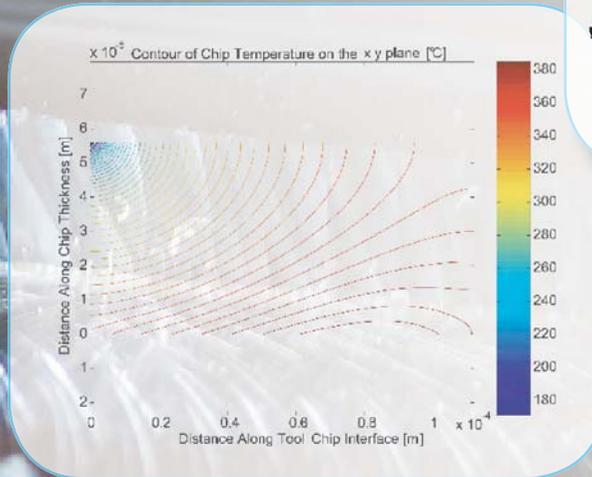


OUTPUT FROM CUTPRO:

Chatter free speed, depth and width of cuts, i.e. the stability lobes. Cutting forces in three directions, torque, power, tool/part vibrations, chip thickness, surface finish, optimum variable pitch angles.

Temperature Module:

Temperature is the main concern in machining thermal resistant materials such as titanium and nickel-based alloys. The cutting edge chipping and the rate of tool wear greatly depend on the tool-chip interface temperature.



CUTPRO Temperature Module predicts tool and chip temperature fields in turning and milling processes. The user can optimize the feed, width of cut and spindle speed to maintain the tool temperature under 900 Celsius for Carbide and 1200 Celsius for CBN tools. When combined with chatter stability prediction, optimal spindle speeds, feeds and depth of cuts are achieved in machining Titanium, Nickel and high strength alloys.

Boring and Turning Process Module

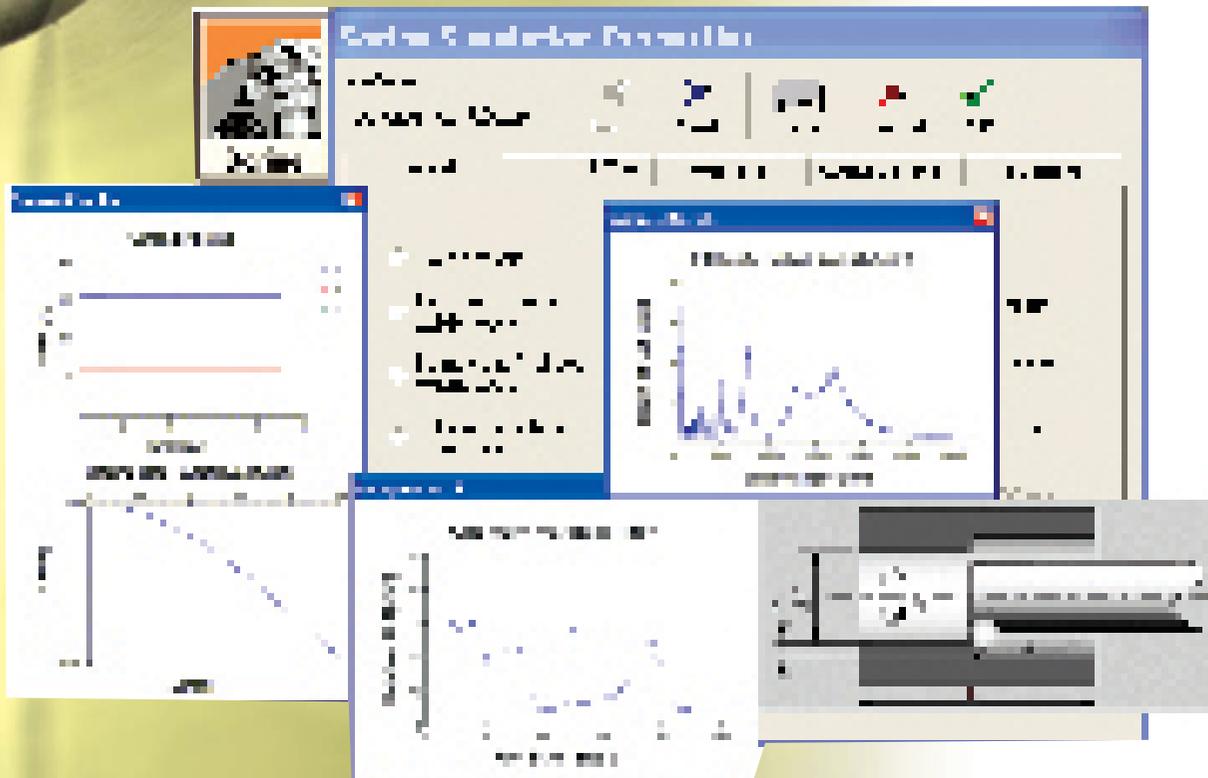


Boring and turning modules predict torque, power, force, and chatter vibration free spindle speeds and depth of cuts.

- Predicts forces, power and torque for given cutting conditions, cutter geometry and workpiece material.
- Simulates stability lobes for single point and multiple-inserted boring heads, and predicts the most optimum depth of cut & spindle speed for chatter free machining operations.
- Designs and simulates the performance of variable pitch boring heads tuned to a specific workpiece material and machine tool spindle.
- Shares the same extensive work material data base used in Milling Module.

INPUT BY THE USER:

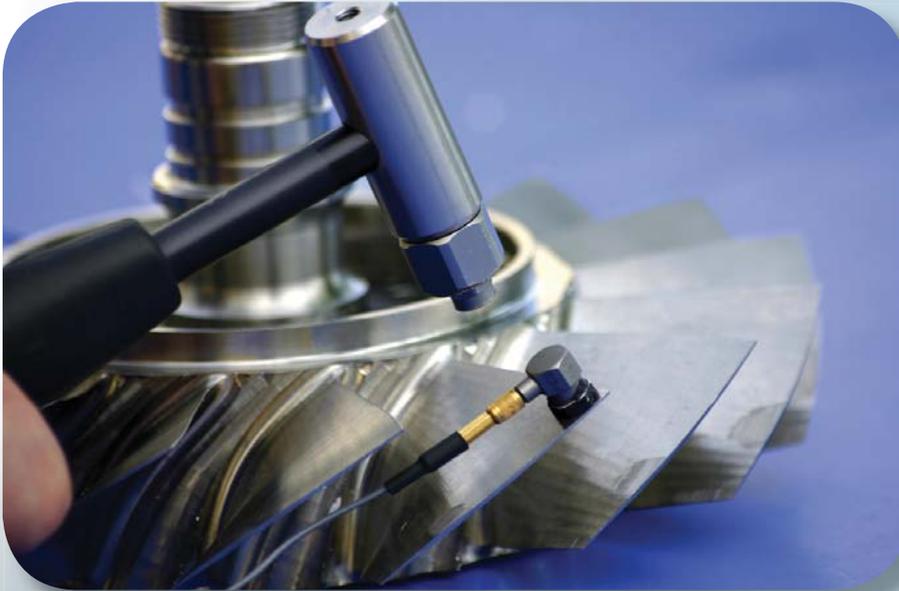
Tool Geometry Parameters, FRF (Frequency Response Function-tap test) of the machine tool, workpiece material



OUTPUT FROM CUTPRO:

Stability lobes, cutting forces in three directions, torque, power, optimum pitch angles, tool deflection

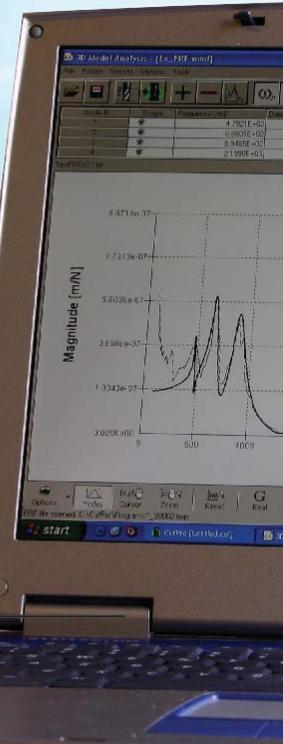
Modal Analysis Software



With CUTPRO Modal Analysis Module, you will be able to identify stiffness, damping, natural frequency, mode shapes and weak tool and fixture connections in just a few minutes.

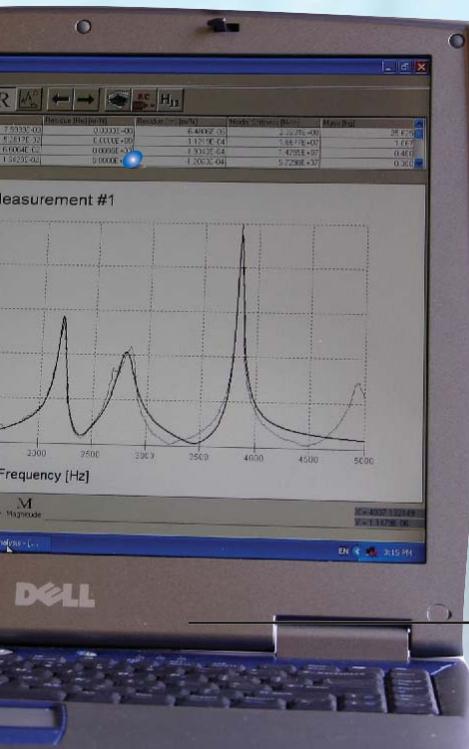
CUTPRO Modal Analysis Module is user friendly and easy-to-use. It automatically and accurately identifies the structural dynamic parameters of a machine set-up from Frequency Response Function (FRF) measurements. The accurate identification of machine and part parameters is crucial in predicting chatter vibration free cutting conditions and in identifying weak joints in the machine tool - fixture assembly.

CUTPRO Modal Analysis software uses advanced vibration engineering algorithms to identify the modal parameters accurately. The modal parameters are then automatically accepted by CUTPRO Milling, Turning, Boring and Drilling Modules for the simulation of machining vibrations.



Modal Analysis features:

- Easy to use in shops without advanced vibration expertise
- Accurately predicts natural frequency, damping ratio, residues, modal stiffness and mass from FRF measurements of the tool and workpiece
- Predicts the FRF of very flexible, difficult to measure tools from impact tests
- Predicts and displays one and two dimensional mode shapes and modal parameters Animates mode shapes



- Allows structural coupling of tool-holders and tool to existing spindles stored in the data base
 - Automatically tunes the tool length to create stability lobes at the desired speed range
 - Accepts the measurement data in acceleration or displacement units
 - Accepts both Metric or Imperial units
 - Accepts FRF measurement files in MALTF, ASCII, HP SDF, and UFF file formats
 - Has a built-in report generator with graphical results
- Receptance Coupling feature predicts FRF at the tool tip from the measurement of the tool holder and spindle assembly

MALTF: Impact Modal (TAP) Testing Software



With shop friendly MALTF, you can tap test the machine and fixtures in a few minutes.

MAL Inc. offers inexpensive, easy-to-use tap testing software that is as powerful as the costly and difficult to use packages on the market. Tap testing with an impact hammer is considered to be an art, and the accuracy may be critically dependant on the skill of the user. After years of practical and scientific experience, and collecting feedback from CUTPRO users in the industry, we have designed MALTF with built-in scientific expertise and artificial intelligence. The expert

system inspects the quality of the measurement and provides voice-guided instructions to the user.

MALTF features:

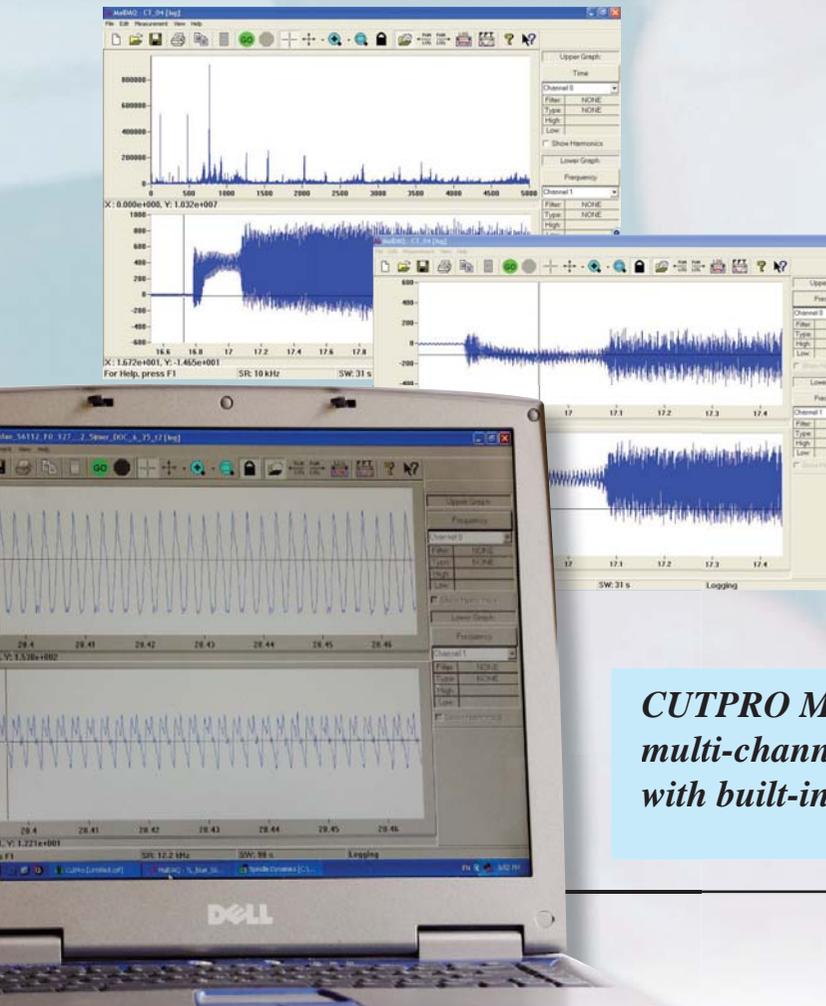
- Has a very user friendly graphical user interface
- Allows simultaneous testing at multiple measurement points
- Supports impact force and shakers as exciters and accelerometer, velocity and displacement sensors as vibration output devices
- Has a built in expert measurement quality control system with voice feedback
- Displays time history, power spectrum and coherence of the measurements
- Displays Magnitude & Phase, Real & Imaginary parts of the measured FRFs
- Stores the FRF data in binary or standard ASCII formats.
- Has a built-in engineering report generation system with graphical results

MALDAQ: Data Acquisition Software

Machining process data such as force, acceleration, torque, power and sound pressure are used for the diagnosis of machining operations. CUTPRO offers highly versatile PC-based data acquisition software (MALDAQ). With CUTPRO MALDAQ, an entire machining operation data can be collected, and the problematic locations on the part can also be tracked.

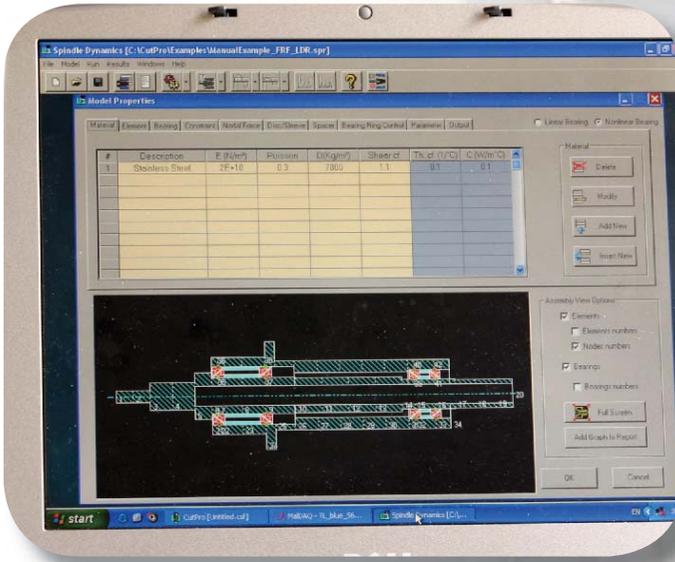
MALDAQ features.

- Very friendly graphical user interface
- Collects up to 8 channels of sensor data simultaneously
- Logs and streams data to the hard disk until the hard disk is full
- Displays real-time data
- FFT analysis of data windows to identify vibration frequencies and tool run outs
- A variety of digital filtering options
- Stores data in binary or ASCII text formats
- Data can be scaled into any measurement unit
- Can be used with Laptops or desktop PCs.
- Compatible with Win 95/98/Me/NT/2000/XP



CUTPRO MALDAQ is an easy to use multi-channel data acquisition program with built-in signal analysis features.

SpindlePro - Spindle Analysis Module



SpindlePro is an advanced engineering software for the optimization and virtual testing of spindles at the design stage.

SPINDLEPRO is a linear – nonlinear finite element software used to analyze and optimize spindles during design stage or to troubleshoot existing ones.

SPINDLEPRO features:

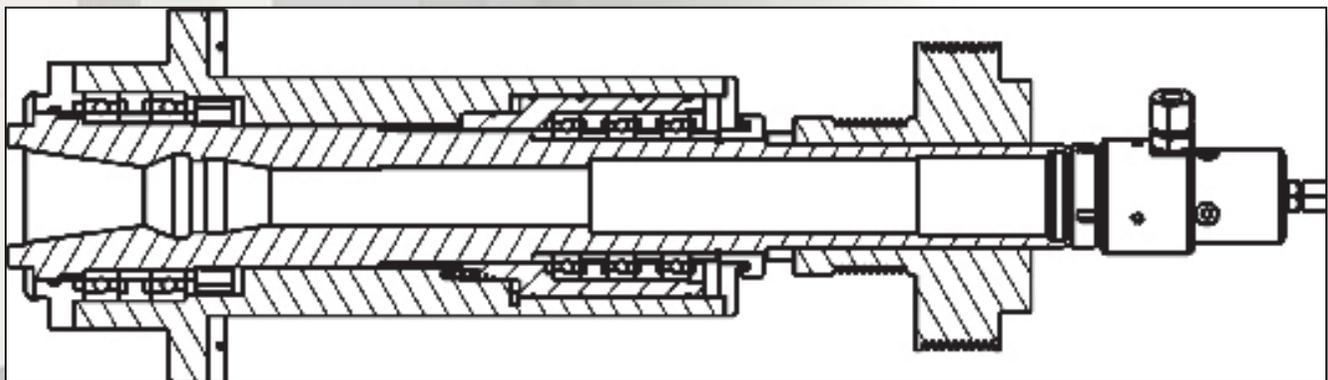
- Has a user friendly graphical interface
- Predicts deflection at any location on the spindle, contact loads and moments at the bearings, and housing supports under any load or cutting forces
- Has damped and undamped modal analysis.
- Predicts Frequency Response Function (FRF) at any location on the spindle and cutting tool
- Predicted FRFs can be used for the chatter stability of the spindle in cutting various materials with selected cutter geometry.
- Considers the influence of the preload and speed dependent Gyroscopic and Centrifugal spindle speed on the bearing stiffness

- Predicts history of dynamic contact forces acting on the bearing balls under cutting loads
- Displays the spindle deformation, mode shapes, bearing stiffness, contact forces, time history of the displacement, velocity and acceleration.
- Has a built-in engineering report generator with graphical results

S **SPINDLEPRO** has an **EXPERT SPINDLE DESIGN SYSTEM (ESDS)** feature. **ESDS** is based on the efficient utilization of the past design experience, the laws of machine design, and the mechanics and dynamics of metal cutting. The

expert system leads to the automatic generation of the spindle configuration which includes the drive shaft, motor, lubrication style, transmission mechanism, bearing types and tool holder style. The bearing locations are optimized to ensure chatter vibration free cutting conditions.

SPINDLEPRO is a user friendly, and most advanced spindle selection and engineering design tool for spindle builders. **SPINDLEPRO** is also an excellent tool for end users of the machine tools for optimal selection of best spindle configuration for a family of machining operations in a company.



Virtual CNC Module



CUTPRO Virtual CNC Module allows the design and performance analysis of multi-axis CNC machines to achieve maximum positioning accuracy at high feed speeds.

CUTPRO Virtual CNC provides a comprehensive design and simulation environment for CNC engineers, end users and educators. MAL has developed a comprehensive, open, modular and reconfigurable CNC system

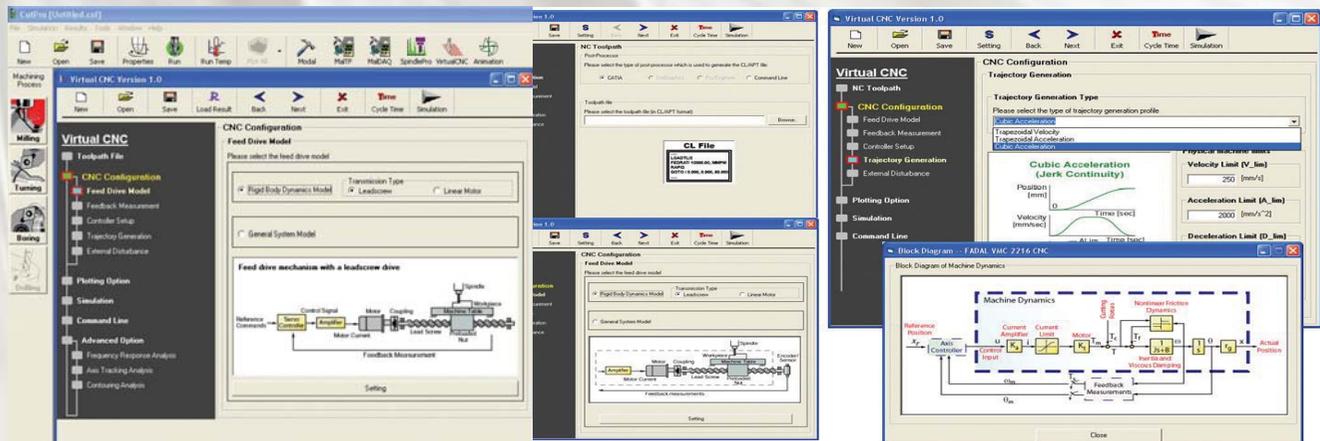
which has been tested on a number of multi-axis machines in well-known research laboratories. CUTPRO Virtual CNC is the replica of our real time CNC system which controls the virtual model of user defined machines.

Virtual CNC Module is suitable for the rapid prototyping of CNC configurations, the performance testing of machine elements such as motors, ball screws, sensors, amplifiers and metal cutting conditions.

Virtual CNC Features:

- Allows rapid design and testing of multi-axis CNC systems ready to be implemented on real machines
- Allows the selection of trajectory generation style, axis control type, amplifier settings, position (encoder), velocity (tacho-generator) and acceleration feedback sensors and their resolutions

- Displays both command and predicted tool paths by the CNC; indicates tolerance violation locations along the tool path
- Automatically tunes linear and nonlinear axis controllers
- Has P, PI, PID, Pole Placement, Sliding Mode Control Algorithms with Feed Forward friction compensation
- Predicts actual cycle times by accurately calculating the feed variations caused by the control law, acceleration and deceleration
- Allows testing the performance of different control laws, friction fields, motors, sensors, ball screws, linear motors and trajectory generation algorithms under cutting loads and vibrations
- Provides time and frequency domain response of individual drives as well as testing the CNC on ISO standard test workpieces such as diamonds and circles
- Handles up to 5 Axis machine tool drives and has a built-in Finite Element Model of drive mechanisms
- Accepts standard APT/CL files and processes them like a real CNC
- Predicts position, velocity, acceleration, torque, current, tracking and contouring error along the tool path
- Automatically inserts micro splines at sharp corners to minimize tolerance violation



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