Virtual High Performance Machining

FORUM AEROSPACE INNOVATION

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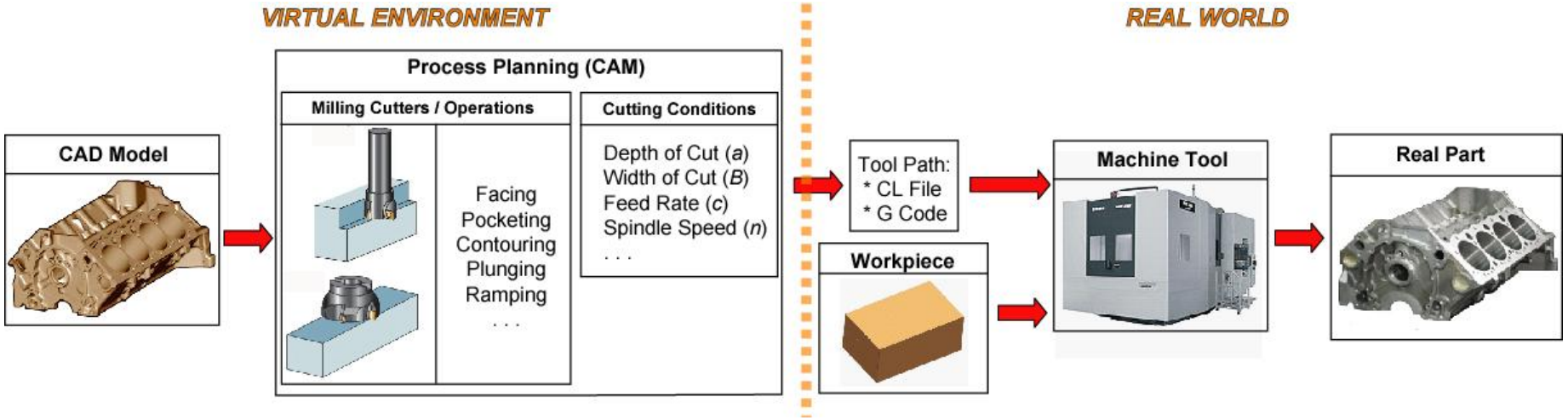
http://www.mal.mech.ubc.ca/

AERO MONTREAL 10 YEARS

Virtual Process Simulation/Optimization



- ***Machine the part correctly and cost effectively at the first trial***
- ***Replace the physical machining trials by the digital model of the machining operations and machine tools***

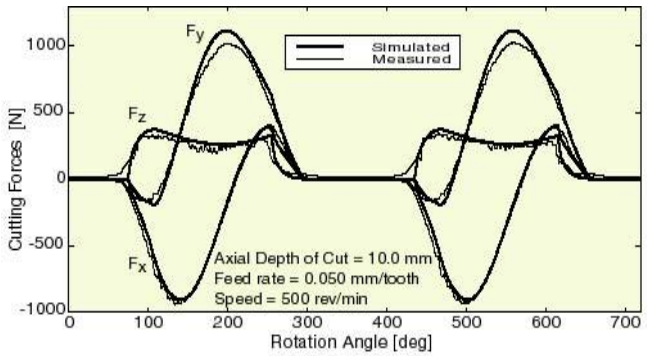
Virtual Machining Modules

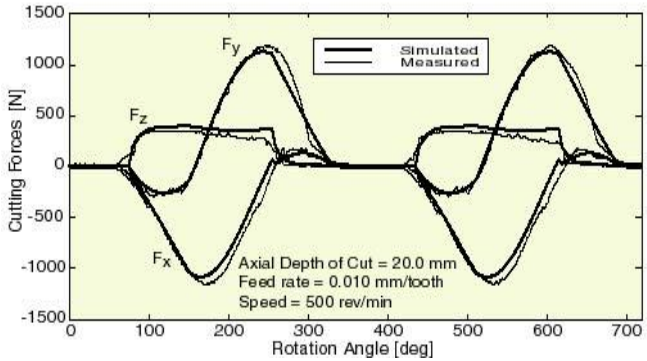
1. **Cutter Part Intersection Module (CAD/CAM)**
2. **Machining Process Mechanics & Dynamics Module (UBC-CUTPRO™ released in 2000)**
3. **Machine Tool Dynamics – Kinematics – Control (CNC) Modules (UBC-VIRTUAL CNC released in 2004)**

1+2+3 = Integrated Virtual Machining System

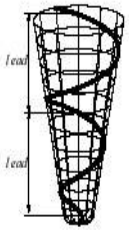
(UBC-VMS – MACHPRO released in June 2011)

Tool design for the application





Taper Helical Ball End Mill - Ti_6Al_4V

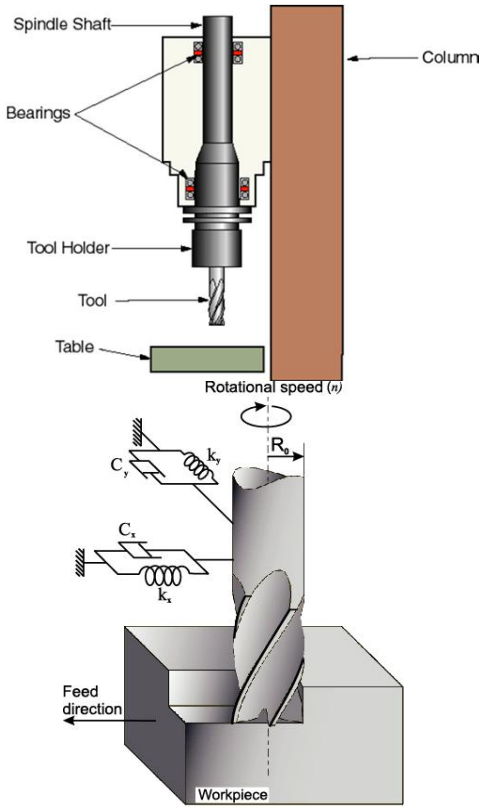


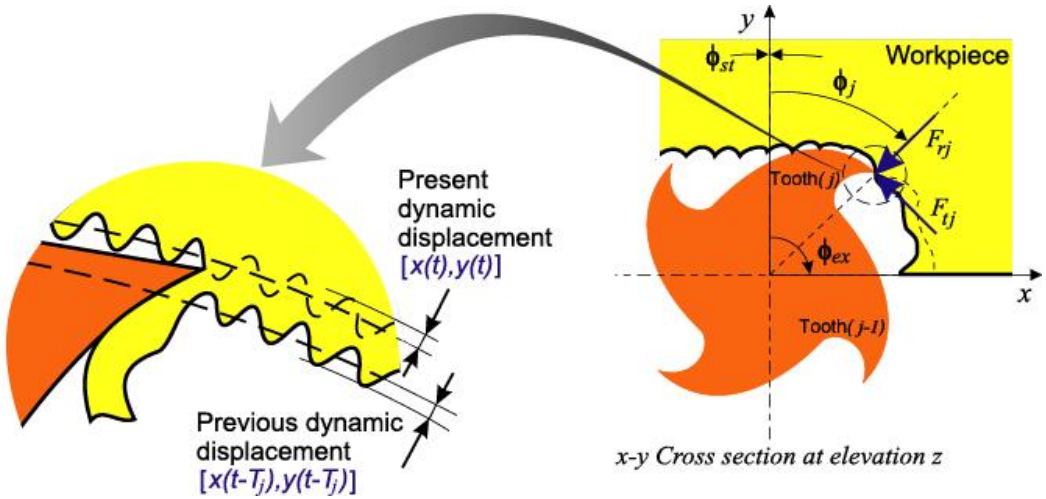
Cycle Time Reduction: 62%

Surface roughness improved by 8.4 fold

Impeller Milling
UBC + P&WC NSERC Chair

Machine tool vibrations



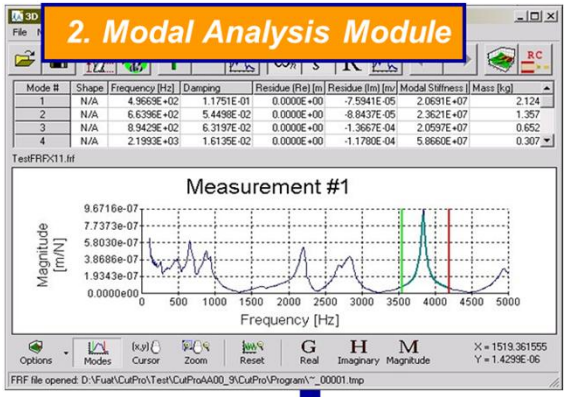


Optimal NC Programming

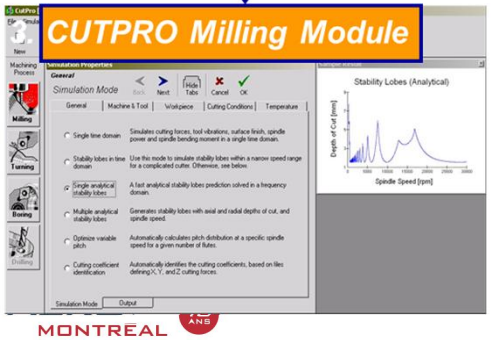
1. TF Measurement & MALTF

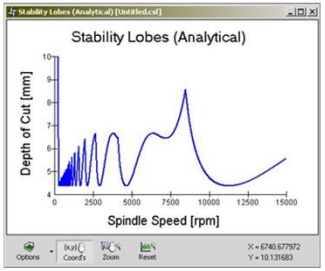
Prediction of torque, power, force, stability lobes, vibrations,..

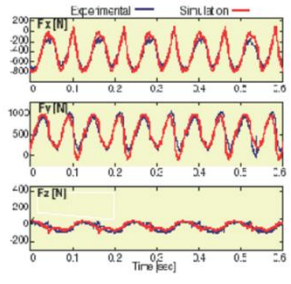
2. Modal Analysis Module



CUTPRO Milling Module

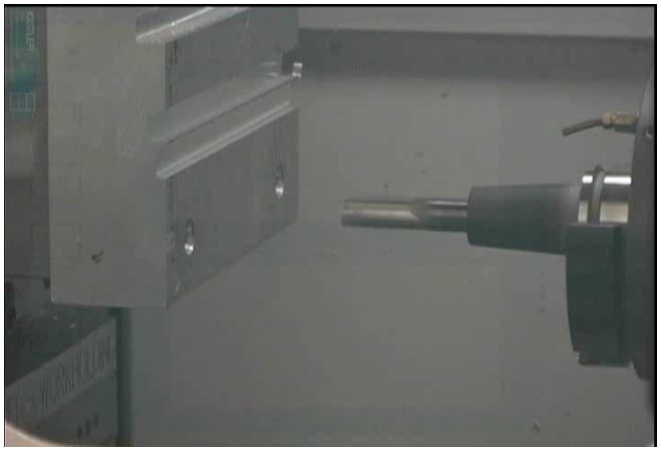




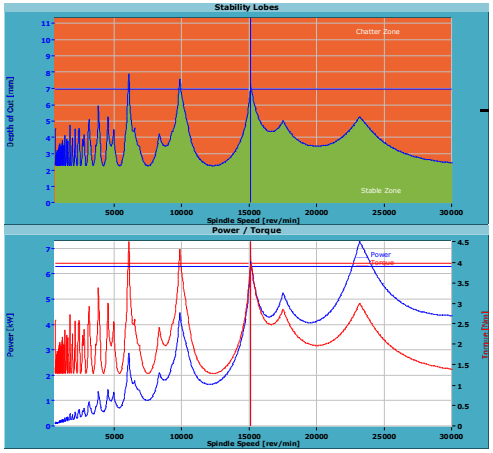


Gives most productive, chatter free cutting conditions to NC Programmer

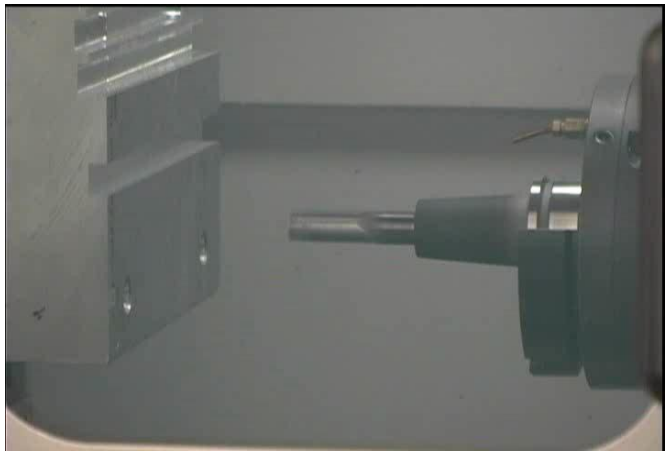
Chatter avoidance



Chatter at 12500 rev/min



Select green zone



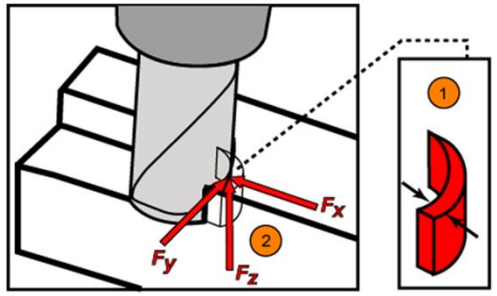
Higher productivity at 15000 rev/min. No chatter.

High Perfromance Machining of Aircraft Parts

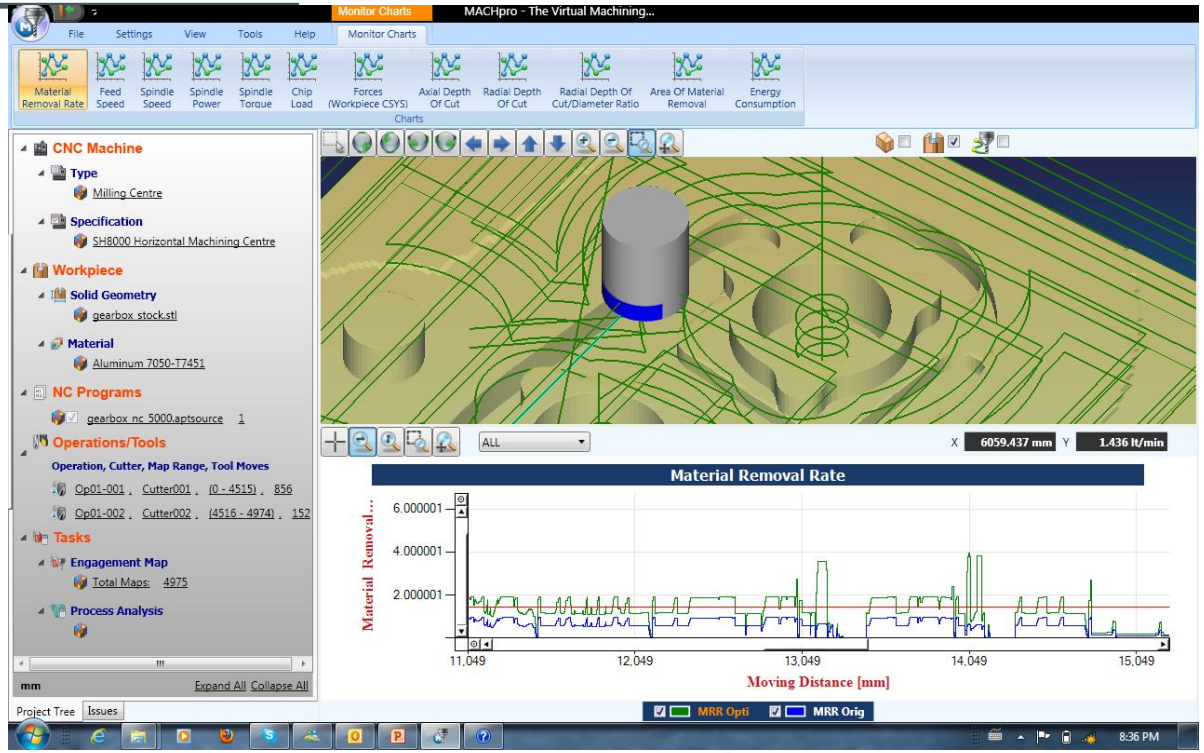
- 90% of the material is machined from solid blocks
- Any mistake leads to scrap of costly part
- Any reduction in machining time leads to major savings

Process Optimization Constraints

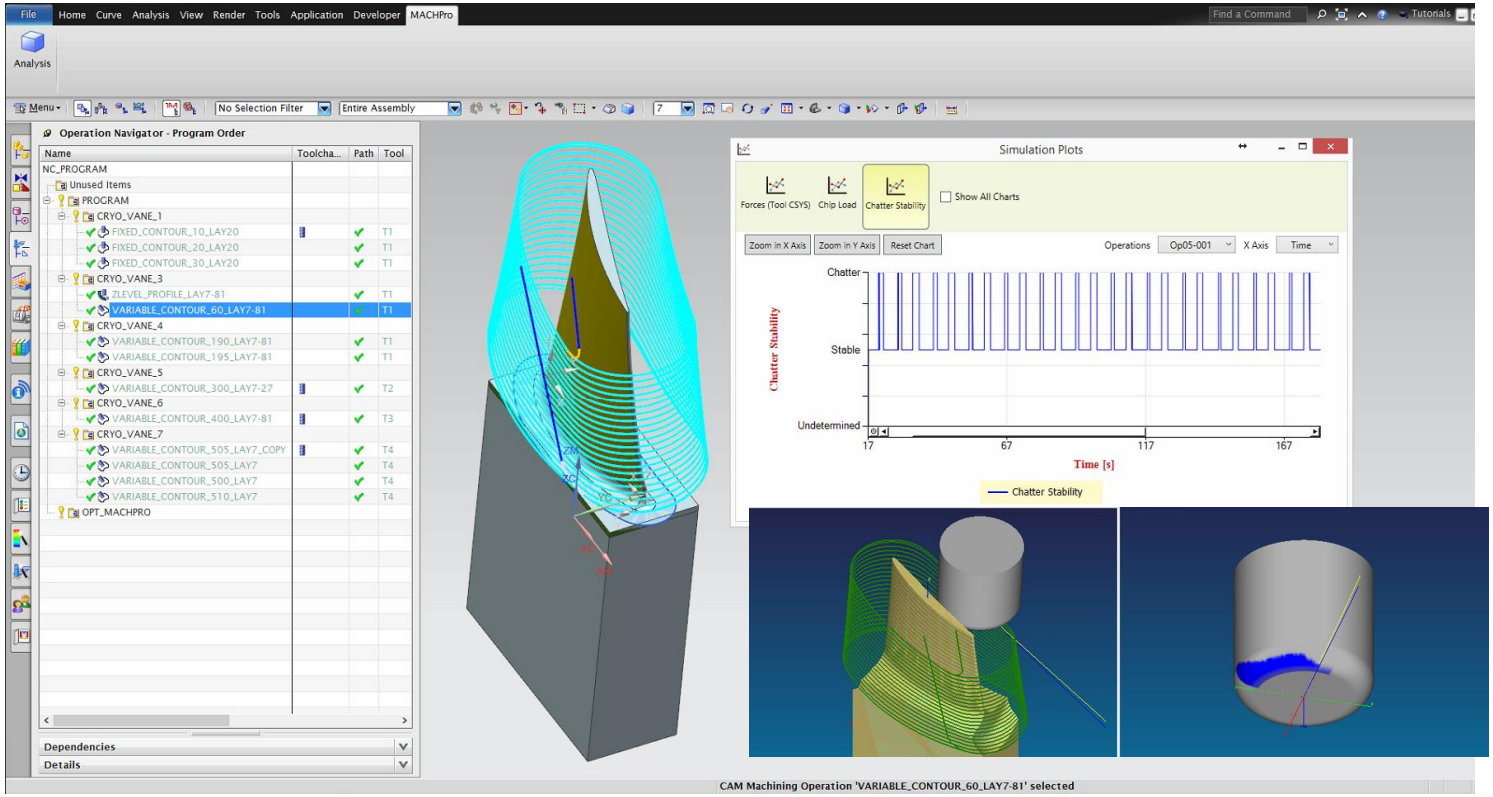
1. **Chip Load**
   - *Maintain desired feed per tooth despite varying workpiece geometry during machining*
2. **Cutting Forces**
   - *Avoid excessive cutting forces on the tool*
3. **Moment on Spindle Bearings**
   - *Avoid spindle bearing failure due to excessive loading*
4. **Static Tool Deflection**
   - *Control dimensional/form error on the part*
   - *Avoid tool breakage*
5. **Surface Speed**
   - *Obtain uniform surface finish*
   - *Extend tool life*



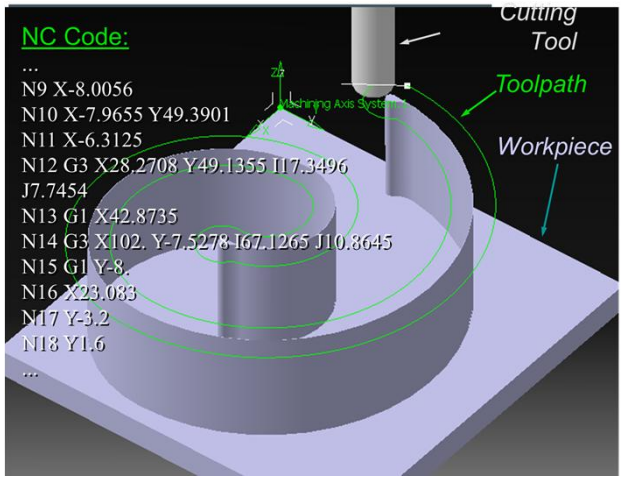
MACHPRO: UBC's Virtual Machining Process Simulation and Optimization Platform

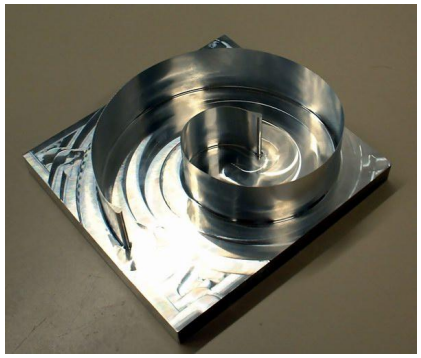


Embedded to NX CAM System

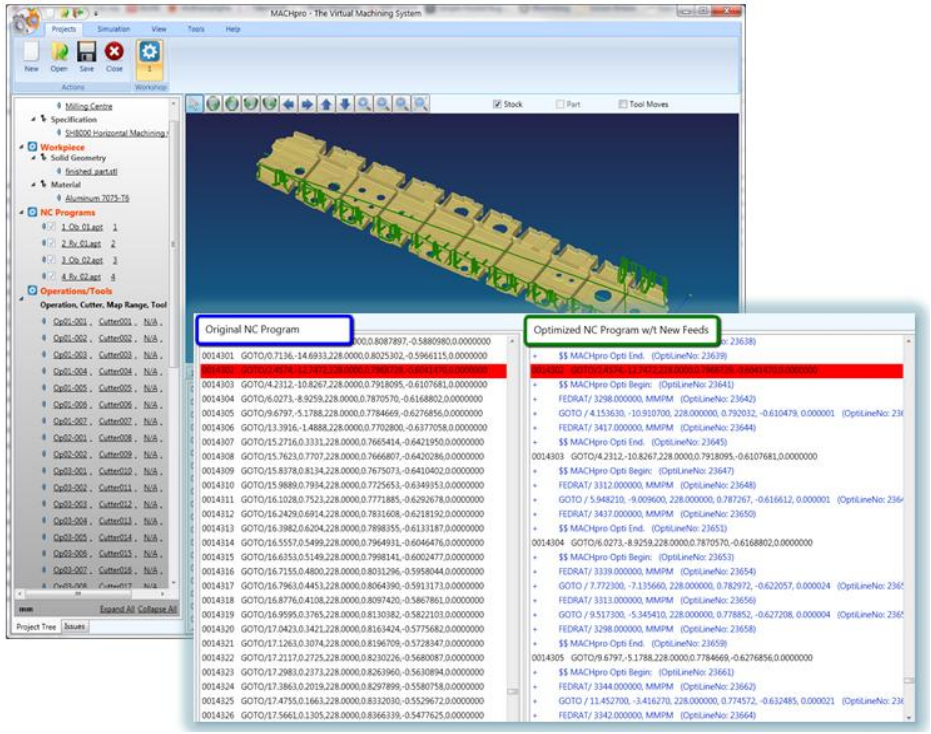


Virtual to real machining





Virtual Machining of Aerospace Parts



STATOR BLADE FOR A STEAM TURBINE Material: Stainless Steel	MACHpro Productivity Improvement
Blade Roughing – Stage 1	↑ 39%
Blade Roughing – Stage 2	↑ 31%
Blade Roughing – Stage 3	↑ 14%
Semi Finishing – Stage 1	↑ 72%
Semi Finishing – Stage 2	↑ 48%
Overall Productivity Improvement	↑ 57%

Impeller Milling UBC + P&WC NSERC Chair

Cycle Time Reduction: 62%

Surface roughness improved by 8.4 fold

Sample users of our technology

Research Partnership with Global Aerospace Industry

- Major aerospace companies use our machining process simulation and optimization tool box

  (P&WC, P&WA USA, Boeing, Bombardier, ASCO, Embraer, Airbus, GKN, MHI, IHI, Aikoku, Kawasaki, Irkutsk, TAI, TEI, Snecma, AIDC.)
- UBC trains their manufacturing engineers to understand the engineering principles.
- Aero industry raises new problems when they use UBC technology. New problems are brought as research projects to UBC.
- After solving the problem, we integrate the solution to our software and provide it to the industry.

Technology Transfer from MAL Inc.

- Train manufacturing engineers of the company in one week long course at UBC
- Select an existing aerospace part with high machining time and cost with the company.
- Re-engineer the machining using our Virtual Machining Technology with the manufacturing engineer designated by the company.
- We train the engineer step by step while planning the part machining together.
- We let the company to compare the new and existing methods, and they make their decision with a low cost trial and training.