FINE™/Design3D

Technical Specification

NUMECA, a new wave in fluid dynamics

NUMECA INTERNATIONAL

A fully integrated suite of turbomachinery design and optimization tools combining:

- **AUTOBLADE™** : Parametric Blade and Channel Modeler
- **DESIGN3D™** : Turbomachinery 3D Design and Optimization code
- **FINE™ GUI** : Interactive Graphic User Interface

Hardware requirements

(recommended for full capabilities):

- Standard equipments: monitor, keyboard, mouse
- CD-Rom drive
- 3-button mouse
- 24-bit color graphics and 1280x1240 pixel resolution monitor
- Mandatory ethernet card for a node-locked license on LINUX.
- RAM minimum requirement: 256 Mb >512 Mb recommended (for 1 million points)
- Swap space: 3 times of RAM size
- Hard disk storage capacity depends on project types and number of points; 100 Mb space is needed to store mesh and solution files of a 1-million-points project

Main Features:

- Multi working points optimization
- Multi-stages rotating machinery
- Process progression monitoring
- Seamless integration with NUMECA's FINE/Turbo CFD suite or with other CFD packages

Computer platforms:

- SGI
- SUN
- DEC Alpha
- Pentium/Athlon (WindowsNT, 2000, XP)
- HP
- IBM
- Linux

Database generation

- Generation of a database of similar geometries required by the optimization process
- Database contains the geometrical parameters of all blade geometries, and the CFD results obtained successively on all generated geometries
- Coupling between the AutoBlade™ blade modeler and a CFD suite using a simple Graphical User Interface
- Fully automatic process with no user intervention
- Easy setting up of variation range of all parameters
- The system randomly modifies the values of the geometrical parameters

Optimisation Technology

- General optimization platform featuring
  - Local techniques, based on gradients
  - Global technique, based on genetic algorithms
- Optimization process uses an approximate model instead of the Navier/Stokes solver, allowing an efficient use of genetic algorithms
- Very fast approximate model, based on an artificial neural network
- Neural network predicts an approximate value of the CFD results for any combination of the geometrical parameters, making use of the results included in the database
- Multi objective optimization handled by integrating all objectives and constraints into one single objective function

Optimization

- Multi-stages
- Multi working points
- Robust numerical optimization algorithm
- Maximal/unlimited required number of function evaluations thanks to ANN
- Multi disciplinary constraints: aerodynamic, mechanical, manufacturing…
- User defined weighting function for each constraint reflecting the user design priority

Solution Monitoring

- *Design Convergence History*: the convergence of the design process comparing optimization result and CFD result
- *Optimizer Convergence History:* the convergence of the inner optimisation algorithm coupled to the approximate model:
  - Evolution of objective function
  - Evolution of penalty
  - Evolution of a variable

FINE™ GUI

Interactive Graphic User Interface

- Simple user-friendly POINT & CLICK graphical user interface (GUI) :
  - mouse-driven
  - context-sensitive
  - intuitive and fast to learn interaction
- Easy-to-use object-oriented interface with :
  - pulldown menus
  - pullright menus
  - dialogue boxes
  - keyboard input areas
- Selection of graphical entities by :
  - mouse picking or
  - keyboard entries
- View buttons operations for geometry and quantity representations in any perspective, with immediate visual feedback
- Multi-windows environment
- Task management

Fully Integrated Design and Optimization Suite For Revolutionary Blade Design

AutoBlade™

Technical Specification

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Applications:

- Compressors (axial or radial)
- Turbines (axial or radial)
- Fans
- Pumps
- Inducers
- Blowers
- Turbochargers
- Return channels
- Torque converter

Design mode:

- **Channels:**
  - Endwalls:
    - Bezier curve
    - Cubic B-Spline
    - Composite Line-Bezier-line
    - User-defined
  - Meridional stream surfaces:
    - Planar
    - Cylindrical
    - Conical
    - Hub to shroud interpolation
  - Parameterized stream surfaces spanwise locations

- **Blades:**
  - 2D section:
    - Camberline:
      - Bezier curve
      - Cubic B-Spline curve
      - Second order Bezier curve
    - Thickness distribution
    - Independent pressure and suction sides
    - Leading edge and trailing edge shapes:
      - Rounded
      - Blunt
  - 3D blade generation:
    - Stacking point of 2D sections:
      - Leading edge
      - Trailing edge
      - Center of gravity
      - Maximum thickness
      - Center of channel
    - User-defined number of primary 2D sections,
    - Spanwise interpolation of additional 2D sections,
    - Meridional spanwise locations:
      - Sweep law:
        - Second order Bezier curve
        - Composite Bezier - line - Bezier curve
      - Leading and trailing edges traces:
        - Second order Bezier curve (symmetric)
        - Third order Bezier curve
    - Tangential spanwise locations (lean law):
      - Second order Bezier curve,
      - Composite Bezier-line-Bezier curve

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- **Splitters:**
  - Up to ten splitters per channel
  - Camber line inherited from the main blade camber line
  - Optional refinement of camber lines
  - Parameterized splitters locations
  - Suction and pressure sides built following the same method as the main blade:
    - Camber curve type
    - Construction mode
    - Edges
  - Specific number and values of the splitters parameters

- **Technological effects:**
  - Trailing edge filing
  - Blade cut-off

Geometrical Analysis mode·

- Blade channel width distribution
- Blades:
  - Thickness
  - Curvature
  - Angle distributions
- Throat area
- Unguided turning angle
- Moment of inertia of 2D sections
- Area of 2D sections
- Leading edge wedge angle
- Leading and trailing edges sweep and lean distributions

Pre-defined templates for various rotating machinery·

- Axial turbine and compressor
- Centrifugal compressors
- Pumps
- Blowers
- Fans

Parametric Blades and Channels Modeler

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