

Webinar Description

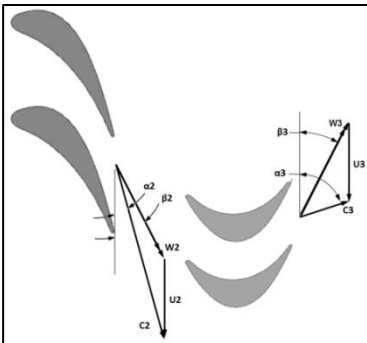
The turbine design seminar/webinar has been structured to build technical comprehension in steps, beginning with a basic review of aero/thermo fundamentals and advancing through more in-depth turbine design and analysis material. This schedule covers important material for both beginners and advanced attendees. Course material has been collected from 40 years of turbine design practice and assembled into a valuable resource of presentation material. Worked problems and quizzes are also used to reinforce essential material. This training can provide attendees with answers to their turbine aero/thermo design and analysis questions as well as an opportunity to discuss specific technical concerns.

Days 1 & 2 – details on page 2

The first two days of training provide a solid introduction into turbine aero/thermo design and analysis methods for relatively new engineers to the field. The presentation material also serves as a good technical refresher for the more experienced turbine engineer.

This part of the program will enable you to:

- Evaluate and prioritize the key factors affecting a turbine's performance level
- Work through the basic relations involved in properly sizing a flow path for good efficiency
- Decide important blade manufacturing tolerances
- Consider key stress & vibration failure criteria
- Step through the complete process of stage sizing, performance analysis & detailed blade design
- Scale designs for other operating conditions or for different frame sizes.
- Examine blade profile design methods and follow a step-by-step software demo of airfoil construction



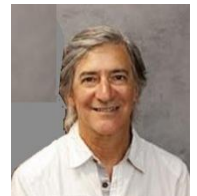
Days 3 & 4 – details on pages 2 & 3

Days 3, 4 & 5 (1/2 day) offer more in-depth material on special topics important to turbine aero/thermo design:

- Special considerations for multi-stage turbines, wetness & erosion, axial thrust calculations.
- Sizing strategies are illustrated by software demos for multi-stage turbines
- Comparison of design techniques for three stage types: Curtis, High-Pressure, Low-Pressure
- Analysis of supersonic nozzles and blades
- Exhaust diffusers, hood losses and design
- Testing and instrumentation
- Hand Calculation Method for Stage Sizing
- Transfer of axial turbine skills to radial turbines and learn how to design radial components
- Wrapup session to summarize key takeaways

Presenter

John Perera is a specialist in turbine design and analysis and has been consulting as PerAero Turbine Designs since 2007. His experience began at Ebara Elliott Energy where he advanced through engineering R&D responsibilities to become the technical lead for aero development of steam turbines, turbochargers and hot gas expanders. John continued broadening his experience as the Associate Director of Turbine Aerodynamics at Concepts NREC where he added design expertise for turbopumps, waste heat recovery expanders and microturbines. He also provided turbine design seminars and software training worldwide for university students and turbomachinery engineers.



Since 2007, PerAero Turbine Designs has consulted for more than twenty turbomachinery companies on:

- Turbine aero/thermo design and analysis for new power generation products and aftermarket repairs
- Rerates and redesigns of existing equipment
- Software development, training webinars/seminars

Day 1

1) Turbine Applications & Construction Features

- Turbine Applications & Cycles
- Steam Turbine Constructions
- Aero & Mechanical Components

2) Fundamentals of the Expansion Process

- Fluid Properties / Mollier Chart
- Available Energy versus Used Energy
- Velocity Triangles & Energy Conversion
- Choked Flow

3) Basic Considerations in Stage Design

- Stage Loading & Velocity Ratio
- Impulse versus Reaction
- Nozzle and Blade Losses
- Stage Parasitic Losses

4) Steam Path Sizing & Scaling Methods

- Specific Speed / Specific Diameter
- Flow Factor / Loading Coefficient
- Radius Ratio / Aspect Ratio
- Scaling Methods

Day 3

9) Multi-Stage Turbines

- Special Considerations
- Stage Carryover Energy
- Part Load Operation, Wetness & Erosion
- Axial Thrust Calculations
- Supercritical Turbines

10) Multi-Stage Sizing Demo

- **Aeolus** Steam Path Sizing with Demo
- **Aeolus** Performance Analysis with Demo

11) Specific Stage Designs: Curtis, HP & LP

- Curtis Stage Characteristics & Components
- HP Stage Advanced Designs
- LP Stage Considerations & Advanced Designs

12) Supersonic Stages

- Expanding Nozzles
- Supersonic Blades

Day 2

5) Blade Mechanical Design & Manufacturing

- Blade Stress & Vibration Basics
- Failure Criteria & Evaluation Diagrams
- Manufacturing Considerations & Tolerances

6) Nozzle & Blade Loss Analysis

- Profile Loss Component
- Secondary & Leakage Loss Components
- Deviation Angle

7) Turbine Design Cycle Steps

- Important Considerations
- Overview of Design Cycle Steps
- Preliminary Design – Meanline (1D) Analysis
- Detailed Design – Throughflow (2D) Analysis
- Blade Profile Geometry
- Application Curves

8) Blade Profile Design & 3D Stacking

- Profile Design Goals
- Radial Equilibrium & Advanced Stacking Methods
- Profile Construction Demo/Evaluating Loadings

Day 4

13) Diffusers & Exhaust Hoods

- Pressure Recovery with Diffusers
- Exhaust Losses & Hood Design

14) Testing & Instrumentation

- Flow & Power Measurement
- Instrumentation & Uncertainties
- Performance Mapping & Correction Curves

15) Hand Calculation Method for Stage Sizing

- Hand Calculation Steps
- Example Worked Problem

16) Summary of Key Material Presented

- Energy Transfer, Power & Efficiency
- Stage Reaction
- Blade Losses & Leakages
- Blade Profile Design
- Blade Stress & Vibration

Day 5 (1/2 day)

17) Introduction to Radial Turbine Design

- Component Descriptions
- Comparisons with Mixed Flow & Axial Turbines
- Sizing & Design Goals
- Preliminary Design Software Demo

18) Detail Design of Radial Turbine Components

- Loss Calculations, Volute Design
- Nozzle Design + Demo
- Impeller & Diffuser Design + Demo

Seminar Options and Costs

Interested attendees can receive a free evaluation copy of the Aeolus design & analysis system used to demonstrate basic principles and design strategies during the training.

In-House Seminars

The Turbine Design Seminar is offered as a convenient and cost-effective in-house training course at your company site (actual cost depends on site location).

- 2-Day Seminar: \$5,500 to \$6,800
- 3-Day Seminar: \$6,400 to \$8,100
- 4½-Day Seminar: \$7,700 to \$9,600

These costs are all inclusive and include three copies of all presentation material (about 700 informative slides for the complete 4½ day seminar). Additional copies of the presentation material are available for \$100, \$125, or \$150 each (2, 3, or 4½ day).

One copy of the reference book is also provided:

Turbine Aerodynamics: Axial-Flow and Radial-Inflow Turbine Design and Analysis by R. H. Aungier

Webinars - at lower cost, webinars are a convenient way to schedule sessions and include remote attendees.

Registration Details

- Each seminar day runs from 9:00am to 4:30pm and is divided into 4 sessions with time allocated for Q&A, worked problems, quizzes & lunch.
- Webinar sessions are usually distributed over several weeks at the convenience of the attendees.
- A 25% pre-payment is billed prior to the scheduled seminar or webinar start date with remaining balance due 30 days after completion.
- Cancellations receive a full refund for notices received at least 2 weeks prior to seminar start date. For late cancellations, the 25% pre-payment fee will be retained for application to a future PerAero seminar or consulting service.
- Contact John Perera at jperera@peraero.com to discuss seminar/webinar details and options.

