

## Recent Consulting Projects By Ron Aungier

- Designed very small high speed centrifugal compressor and radial-inflow turbine stages for a new gas turbine power generating product.
- Designed basic centrifugal compressor stage configurations for an advanced nine-stage compressor to operate on hydrogen. Detailed aerodynamic design of the first stage was completed and validated by a CFD evaluation conducted by an independent consultant. Constraints imposed by structural integrity are quite severe.
- Completed preliminary designs of four centrifugal compressor stages for a propylene refrigerant compressor rerate for a European manufacturer of industrial compressors. Very complex designs with high flow coefficients and very limited available axial space.
- Witnessed a series of centrifugal compressor shop performance acceptance tests on behalf of the end user at the supplier's facility.
- Conducted on-site training seminars for two companies that have licensed the *CompAero* aerodynamic design and analysis system to instruct staff members in the effective application of the software to centrifugal compressors.
- Supplied aerodynamic design services to a manufacturer of integral-g geared centrifugal compressors to develop a new multistage product line -- from preliminary definition of the product line configuration through detailed aerodynamic design of the compressor stages required. Detailed aerodynamic design of three of the stages required is completed.
- Provided preliminary aerodynamic designs for four radial-inflow turbine stages for a client developing a new solar energy product. Detailed aerodynamic designs of three of the impellers required were also completed and an existing turbocharger impeller was qualified for initial use in the fourth stage.
- Converted *CompAero* software system programs *SIZE*, *CENCOM* and *RKMOD* to command-line (stand-alone) versions for direct execution from a new compressor selection/application software system under development by a major aftermarket supplier of compressor rerates and revamps. The purpose is to provide sufficient design and performance information for quotation of additional or replacement stages in the compressor.
- Conducted a complete aerodynamic performance evaluation of commercially available centrifugal compressor stages for a major compressor manufacturer planning to employ those stages in a new product application.
- Consulted for a customer of Ron's former employer to assist both parties in evaluating and resolving certain client concerns and reservations relative to an active compressor rerate quotation.
- Completed the detailed aerodynamic design of 22 centrifugal compressor stages to rerate a high-pressure multiple section centrifugal compressor for a major aftermarket supplier of compressor rerates and revamps. The client is also a licensed user of the *CompAero* aerodynamic design and analysis system, including the source code.
- Completed a rerate study on a 6 stage, 2 section centrifugal compressor for another major aftermarket supplier of turbomachinery rerates and revamps for quotation to

the end user. The purpose is to increase the flow capacity by 20% at the same head and using the same driver.

- Troubleshooting analysis conducted on a turbocharger incapable of meeting engine design operating conditions due to excessive surging. Reconfigured the turbocharger for additional surge margin and to improve the match with the engine. That resolved the problem.
- Developed conceptual designs of alternative radial-inflow expander configurations for various operating conditions and alternate refrigerant working fluids, including sufficient performance analysis and internal flow analysis to confirm the feasibility of accomplishing detailed designs capable of meeting the client's proposed applications.
- Preliminary designs of an axial fan for fuel cell application using the axial-flow compressor portion of the *CompAero* system. Project was continued by Ron's client (a licensed user of his software).
- Provided extensive compressor and turbine performance analysis and compressor-turbine matching calculations for several turbocharger sizes to support the design improvement activities of a major turbocharger supplier.
- Completed an aerodynamic redesign of the centrifugal compressor and radial-inflow turbine of a high specific speed turbocharger to extend its capacity to higher mass flows to match specific engine operating conditions.
- Conducted troubleshooting analyses of a modified turbocharger having marginal performance at the intended engine matching conditions. Showed that a turbine efficiency level beyond any reasonable expectation would be necessary to obtain the power increase desired by the client. Identified turbine modifications capable of a substantial power improvement considered to be quite likely to meet the guarantee operating conditions. Project continued by the turbocharger supplier (a licensed user of the *CompAero* and *TurbAero* software).
- Completed an independent aerodynamic design audit of a two-stage power turbine under development by a major turbomachinery manufacturer. The audit confirmed that the current design should achieve near-optimum efficiency levels. Performed a follow-on conceptual redesign to quantify modest efficiency gains considered to be achievable.
- Conducted an aerodynamic performance analysis on a single-stage utility axial-flow steam turbine, predicting a significant shortfall in power relative to the guarantee. Results from a subsequent field performance test were in close agreement with the prediction.
- Conducted a two-day (on-site) centrifugal compressor aerodynamic design & analysis training seminar for a major industrial turbomachinery supplier and licensed user of the *CompAero* software system. Training included activity ranging from application work (preliminary design and performance estimates) through detailed stage design. Subsequently worked directly with the designer for several days at my home-office to assist with the company's first application of *CompAero* to a multistage industrial centrifugal compressor rerate.
- Conducted an aerodynamic performance analysis of a two-stage refrigeration compressor that experienced a major mechanical failure after its conversion from refrigerant R-12 to R-134a. The results showed that unstable compressor operation is to be expected at the intended operating condition. Review of the expected

performance map supplied to the end user by the manufacturer also supports that conclusion. Recommended obtaining a compressor rerate to reselect both stages with sufficient stable operating range for the intended application. Suggested alternate vendors who should be capable of providing the rerate, while confirming compatibility with the overall chiller system.

- Accomplished a centrifugal compressor rerate to extend the operating range of a popular turbocharger model to a different engine application.