Concepts NREC

The Experts in Turbomachinery

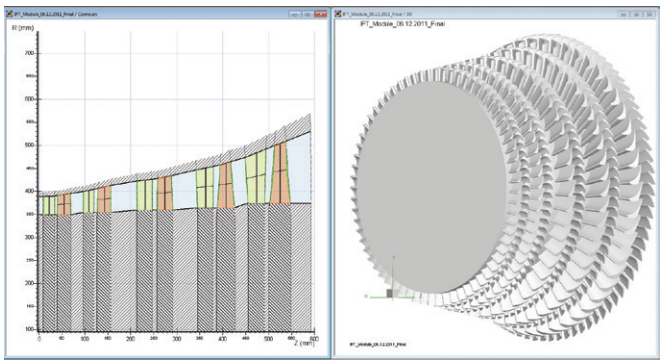
Case Study

Full Steam Ahead for Technology Transfer Partnership

Triveni Turbine Ltd. and Concepts NREC Partner for New Steam Turbine Module

Triveni, Engineering & Industries Ltd, India's largest supplier of steam turbines, has been working with Concepts NREC to bring to market an innovative three-stage, low pressure (LP) blade module with exit diffuser for its industrial steam turbine product range.

Based in Bangalore, the Turbine Business Group (Triveni Turbine Ltd – TTL) of Triveni was the first steam turbine manufacturer in India to get ISO 9001:2000 and ISO 14001 accreditations. The company has grown to become a major player in the steam turbine industry since being launched in 1968. Today they supply more than 80 turbines a year and command a 70% share of the Indian market while engineering every product to customer requirements.



Collaborative development of three-stage LP Module.

Triveni started its own product development program more than a decade ago, with the extension of the range completed in phases – from 6 MW initially, through 8 MW and 15 MW, to 30 MW. The company now has models offering specifications up to 140 bar pressure and 565°C, with a strategic target to develop further higher pressure, temperature models by 2014. A critical component in these developments has been the LP blade module, which is where Concepts NREC came in as consultants for research and development.

Dr. Louis Larosiliere, Director of Aero/Hydro Design Engineering at Concepts NREC, takes up the story: "Initially we were asked to audit an existing design from the perspective of aerodynamic performance and steam path optimization, and suggest potential improvements," he explains. "From this engagement we came up with a collaborative plan for the three-stage LP module."

Selected Triveni engineers took up residence at Concepts NREC's Vermont facility in the USA for a number of weeks. Using Concepts NREC's Agile Engineering Design System® (AEDS) software, and under the guidance and supervision of Concepts NREC staff, the Triveni representatives were instructed on how to execute the aerodynamic and aeromechanic aspects of the LP module. While the

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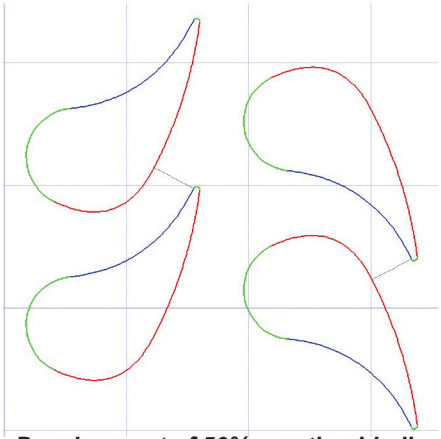
AEDS software is an excellent tool for facilitating such projects, Triveni also wanted to benefit from Concepts NREC's methods and design practices, tapping into the company's knowledge, experience, and refined techniques.

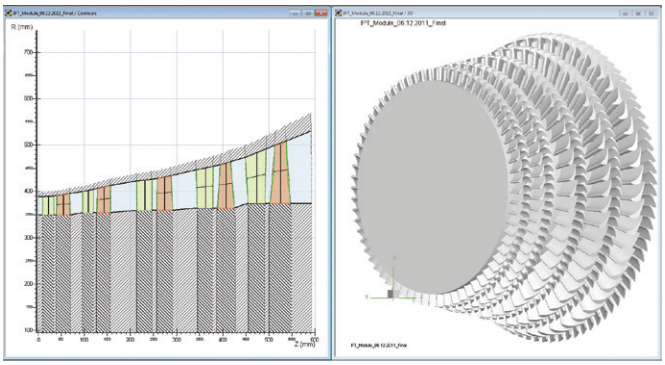
When the 600-employee company extended its range up to 15 MW turbine manufacturing back in 2002, it had to look at issues such as component redundancies and safety factors. New designs emerged for parts, including the rotor, casing, blade path, and nozzle chest. The company was effectively "learning on the job", which is when it decided to create a separate R&D department. Today, Triveni employs approx. 60 engineers in R&D functions.

"We have product experience and system knowledge, and substantial operation expertise in different do-main areas," says Arun Mote, CEO of TTL, and a graduate of the prestigious Indian Institute of Technology. "We also have dedicated people associated with Concepts NREC for product development as a part of the collaborative development plan. Concepts NREC has taught us in new development areas such as aerodynamics and lifting analysis. With our niche and Concepts NREC's expertise, the collaborative model of development provides the best option for success. Today, our validation processes are completed by Concepts NREC, largely for the purposes of development speed and cost reduction."



Development of 50% reaction blading cascade for HP turbine.

The state-of-the-art LP blade module is a showcase success of the partnership between Triveni and Concepts NREC. It features advanced aerodynamic features, while optimized solidity, loading and reactions have resulted in the highest efficiency among existing modules. Furthermore, the blades were designed to be freestanding, which has eased manufacturing costs and assembly.



Development of intermediate pressure (IP) twisted stages design.

Triveni has a history of overcoming de-sign and manufacturing challenges, with over 2000 working turbines in the field. Ultimately, the Concepts NREC collaboration only serves to boost its progress as an organization making the transition to the global stage. Currently, only 15% of sales are from export, but this is growing, and one day Triveni expects its exports to outstrip domestic sales.

International orders are gaining ground as the wider turbine industry becomes more familiar with Triveni and its collaboration with technology/knowledge partners such as Concepts NREC.

Many other projects have been completed since the LP blade module. For instance, Triveni had traditionally been using impulse stages for high pressure (HP) steam turbines deployed in various industrial applications. However, to enhance the efficiency of the HP part of the steam turbine, they wanted to develop reaction blading technology. Triveni used Concepts NREC's AEDS software to develop a universal 50% reaction profile, which can be used in the first few stages, and then can be developed based on geometrical progression for various size applications. The advanced design features an identical blade profile for both stator and rotor blades, as well as simplified and similar root and shroud attachments for stator and rotor.

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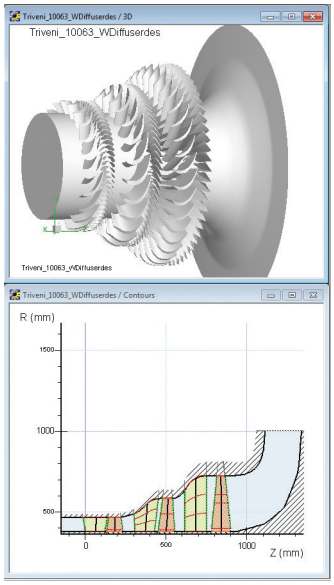
Furthermore, a blunt leading edge profile offers less sensitivity to incidence. Concepts NREC validated the development process and made suggestions that could potentially boost efficiency.

"The ongoing collaboration is a great example of how technology transfer partnerships can work," says Dr. Larosiliere. "While Triveni had most elements of Agile Engineering Design System beforehand, the knowledge and experience of design required to optimize its use was miss-ing. Following the residency at Concepts NREC and subsequent engagement, Triveni now has two engineers well versed in designing steam paths for LP turbines, for example."

Another project, the performance evaluation of LP steam turbines for an air-cooled condenser application (rather than traditional water-cooled), demonstrates this newly acquired knowledge. To work under the higher exhaust pressures for such applications, Triveni engineers made the necessary modifications based on the thermal and structural requirements of the LP blades. Concepts NREC carried out independent CFD analyses for various operating conditions and validated the modification, as well as provided advice on efficiency and a diffuser modification.



Re-analysis of high pressure ration LP Module.

"We have learned a lot from Concepts NREC while interacting on various projects. There is always a good amount of technology exchange," says Mr. Mote. "This will continue, with Triveni doing domain work supplemented by expert advice from Concepts NREC, whose software will remain core to our business model. We believe strongly that our R&D is up-to-date with tools that provide a competitive edge. Moving forward, we will continue to update these software tools and our skill set. I want my engineers to expand their horizons and have the confidence to take risks in charting new areas."

The future is extremely bright for Triveni. Not only is further development planned for its own turbine range, but they now offer industrial turbines from 30-100 MW via a joint venture with GE. This range is being manufactured by Triveni and sold globally through GE (sold by Triveni in India). Two orders for GE Triveni turbines have already been received, and manufacturing is in progress

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