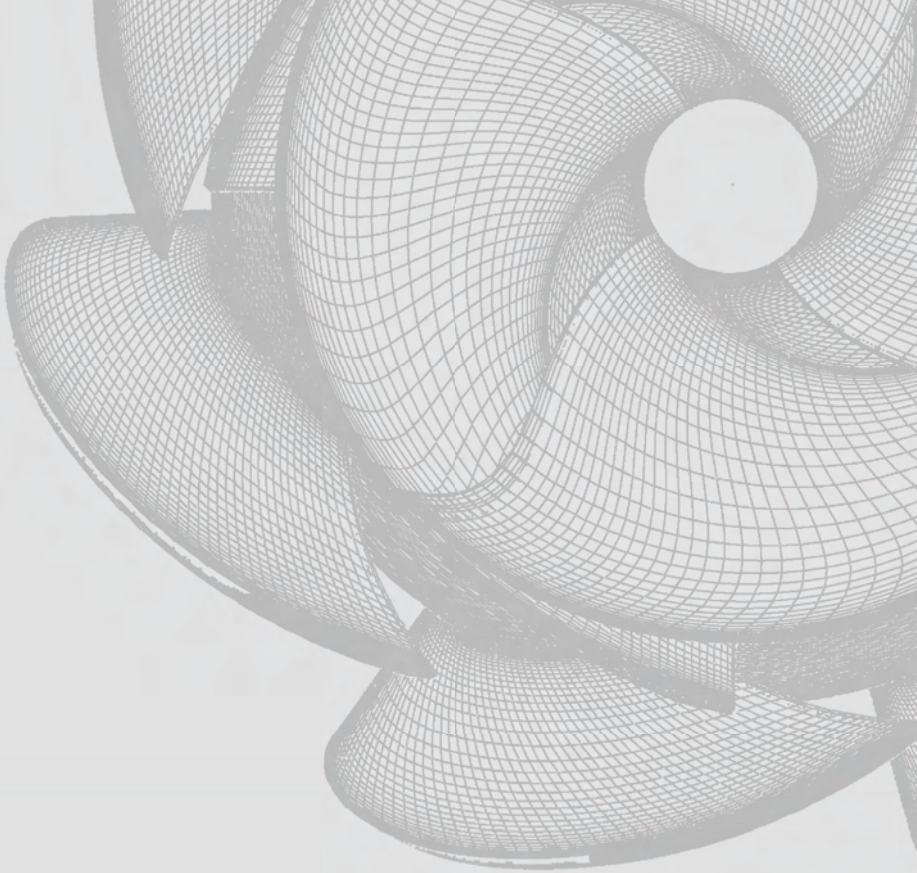


1

2

optima

pre

volute

shaper

cad

cfd

turbo designsuite

leading design for turbomachinery

Advanced Design Technology

About Us

We are a global leader in the development of advanced turbomachinery design methods, which help to shorten development time and also improve the performance of turbomachinery components.

Our aim is to put the designers in direct control of the aerodynamic design and to considerably shorten the design time and time to market for a range of turbomachinery products.

Our clients represent the leading companies in the aerospace, automotive, industrial, marine and power generation fields. They have achieved significant returns on investment, reduction in design times, higher performance and ease of know-how transfer between different design teams and projects.

We add value to your business

Aerodynamic design may represent only a small percentage of the total cost of bringing a turbomachine to market, but it can have a significant effect on your competitive position.

We can help deliver advanced aerodynamic design codes which put your designer in control of the blade design process; expert consultancy and design services in all areas of turbomachinery to supplement your in-house knowledge or a tailor made software solution to revolutionize your design system.

We understand your needs

We work closely with the largest companies in the automotive, aerospace, industrial, marine and power generation fields.

Our experience gives us unique insights into the demands of the globally competitive turbomachinery industry.

Our technology is unique

Our 3D inverse design technology is unique and has been extensively used in industrial design environments.

Our key staff are well known internationally and have made significant contributions to all areas of turbomachinery design.

TURBOdesign Suite is a unique solution for the preliminary design, detailed 3D blade design, analysis and optimisation of all turbomachinery components. Application of the 3D inverse design resulted in breakthrough designs across all turbomachinery components.

Search for Advanced Design Technology on

TURBOdesign Suite

TURBOdesign1 is an aero/hydro-dynamic design software for turbomachinery blades based on a 3D inverse design method for all types of turbomachinery.

TURBOdesign2 is a 3D Transonic Viscous Inverse Design Code developed for transonic axial fans, compressors & turbines used in aero-engines & gas turbines.

TURBOdesign Optima is an integrated automatic optimization platform for the design of turbomachinery blades.

TURBOdesign Pre is a 1D sizing code for the preliminary design of turbomachinery components providing initial geometrical and performance estimates for the full stage design.

TURBOdesign Volute is a design code based on a 2D inverse design methodology allowing designers to account for circumferential variation of inlet flow angle.

TURBOdesign Shaper optimizes complex geometries with respect to given targets, such as total pressure loss and velocity uniformity.

TURBOdesign CAD is developed to considerably speed up the blade design process & integration with existing design environments.

TURBOdesign CFD is a fast and robust CFD solver developed for the application to compressible and incompressible turbomachinery flows.

Engineering Services

ADT Engineering Services team is composed of highly skilled turbomachinery design and analysis engineers ready to support and complement your design needs. Whether you need a complete study, from conception to final design for manufacturing, or are facing challenging multi-point / multi-objective design objectives, our team will be able to support your requirements by application of our proprietary technology and unique design know-how.

We are experts in:

- ✔ Aerodynamic design of all types of turbomachines: pumps, axial turbine and compressors, centrifugal compressors, radial turbines, hydraulic turbines, low speed to transonic fans, torque converters.
- ✔ Computational fluid dynamics code development and analysis.
- ✔ Design of Experiments and Automatic optimization methodology (e.g Simplex, Simulated annealing, Genetic algorithm and Tabu search).
- ✔ FEA for stress and vibration analysis.
- ✔ Acoustics and noise modelling.
- ✔ Experimental and measurement techniques for aerodynamic and noise measurements.

- We have access to our own proprietary advanced design and analysis methods which enable ADT engineers to complete relatively complicated turbomachinery design or analysis tasks in surprisingly short periods of time.
- We understand our clients needs thoroughly which comes only with experience.
- We offer superior project management skills, with one point of contact from concept to complete engineering solution.

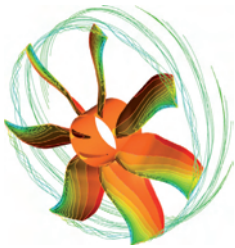
Types of Consultancy Services

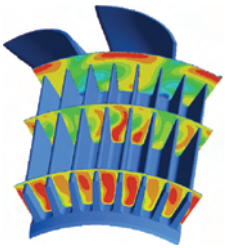
- Aerodynamic Design
- Re-design Services
- Complete Design Services
- CFD Analysis
- Finite Element Structural Analysis
- Aeroacoustic Modelling
- Aeroelastic Design & Analysis
- Automatic Optimization

Design Consultancies

Aerodynamic and Aero-Acoustic Design Optimization of Axial, Mixed-Flow and Centrifugal / Radial Fans

ADT has considerable experience in the design, analysis and optimization of axial fans including automotive, IT cooling, refrigeration and air conditioning systems.
Our expertise includes successful, real world tested designs for world leading fans & blowers manufacturers.



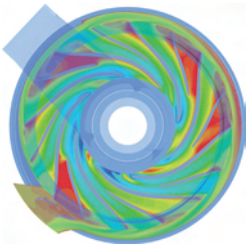


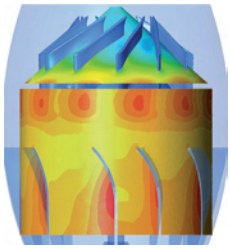
Design of Cooling Fan

TURBOdesign1 was used to design the fan impeller. At the client request, various configurations were explored, which included changes to the meridional geometry, tip clearance and number of blades. With TURBOdesign1 and 3D Inverse Design method these changes can be done in a matter of minutes maintaining the required fan performance, hence considerably speeding up early phases of the design process.

Unique Motor Mounted Radial Cooling Fan with Splitter Blades and Collector Volute

The client, a manufacturer of electric motors, required a unique and innovative fan to extract heat from the motor rotor. ADT has designed a unique radial fan sitting in an extremely constrained space able to deliver the heat extraction, pressure and volume flow targets. This unique fan features a tight inlet, radial fan with splitter blades and a collector volute.



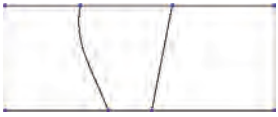


Design of a High Speed Fan and Support Guides for Lower Noise and Improved Pressure Rise

ADT has been involved in the redesign and optimization of a unique radial / mixed-flow fan including support guides for reduced noise. Particularly challenging of this project were the strict geometrical constraints, manufacturing requirements and acoustic targets for the assembled system.

What is 3D Inverse Design?

3D Inverse Design is a unique approach to blade design where designers specify the desired flow conditions and the 3D blade shape is generated automatically to satisfy these specified flow distributions.

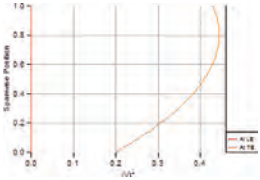


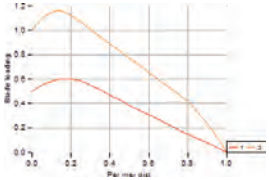
Define Meridional Shape:

The code supports all types of fan configurations from including axial, mixed-flow and radial / centrifugal fans for both rotors and stators.

Impose Spanwise Work Distribution:

In TURBOdesign1 users can specify the desired Spanwise distribution at LE and TE ensuring that every design made respects the required pressure rise at given design point. The code supports all types of work distributions such as free-vortex, forced-vortex or controlled-vortex.



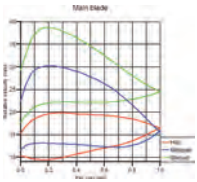


Optimise Streamwise Loadings:

An essential design parameters of a fan blade is the streamwise loading which distributes the work from Hub to Tip of the blade. TURBOdesign1 allows users to prescribe the three-dimensional work distribution providing superior control over the aerodynamic and aero-acoustic performance of the blade.

Visualise 3D Plots:

Within 30 seconds TURBOdesign1 will generate a full 3D blade shape and provide immediate performance data for designers to review. Designers can perform tens of design iterations before even running one CFD analysis.



Flow Visualisation and Performance Parameters:

The detailed 3D and Line Plots along with pre-defined performance parameters allow designers to carefully optimise the fan geometry and aerodynamic performance. Available data include 3D surface pressure and velocities along with validated loss models for aerodynamic performance such as tip-leakage losses, diffusion ratio and profile losses.

Fan Industrial Consortium

Design of high efficiency and low noise axial propeller fans:

The Fan Noise Consortium, a large industrial effort with 16 industrial sponsors and 4 universities, supported by the Japanese Society of Mechanical Engineers (JSME), aimed to establish guidelines for systematic design of high efficiency and low noise axial propeller fans for air conditioning, domestic appliances, refrigeration and IT cooling. These propeller fans are characterised by the relatively low speed, from a few hundred and up to 3,500 rpm, typical of these blades is the noise generated by the tip leakage flow from one blade hitting the following one and generating noise, a typical example of such complex flow field is illustrated in Figure 1.

The consortium included investigations of 22 different blade designs, 14 of which were manufactured and have been subject of detailed aerodynamic and aero-acoustic investigation in 3D CFD and anechoic chamber. The work performed resulted in development of design guidelines for systematic design of high efficiency and low noise fans, the guidelines featured optimal spanwise distribution of work and streamwise blade loading.

These guidelines are considered generally valid for similar applications and irrespective of fan size, designers can directly apply these findings and guidelines in ADT's 3D Inverse Design software TURBOdesign1. With this unique approach designers can directly control the aerodynamic and acoustic behaviour of the blade subject to specific desired flow features which results in higher efficiency and lower noise blade designs.

A Broadband noise model was also developed during the consortium for application to Steady State CFD analysis and implemented in TURBOdesign CFD, ADT's 3D Viscuos CFD code.

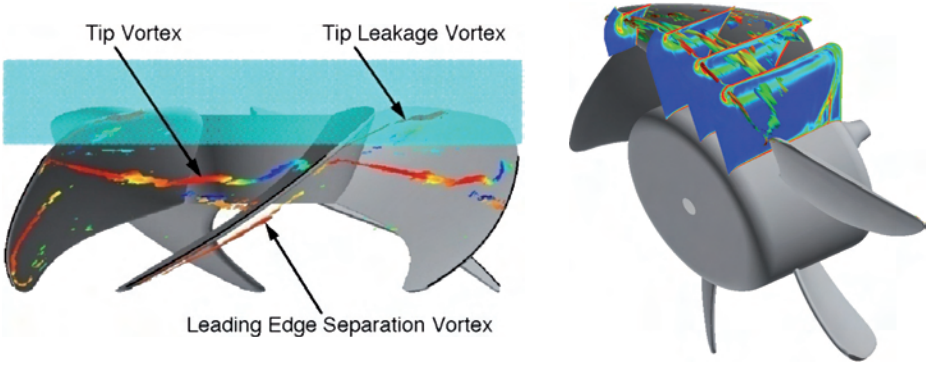


Figure 1. *Typical sources of aerodynamic noise in low speed axial propeller fans (Left) and visualisation of tip leakage flow from one blade hitting the following one (Right).*

Reference: FEDESM2009-78454

Reducing Fan Noise

Broadband Noise

It is important for design engineers to understand the dominating noise for each application before starting design activities aimed at reducing the fan noise.

Generally for axial propellers fans with relativity low speed (ie. few hundreds to few thousand rpm) the dominating source of noise is the Broadband noise which is caused by blade to blade tip vortex interaction.

During the Fan Noise Consortium ADT developed a Broadband noise model that is integrated within TURBOdesign CFD to provide a fairly accurate, computationally fast and affordable indicative values for Broadband noise.

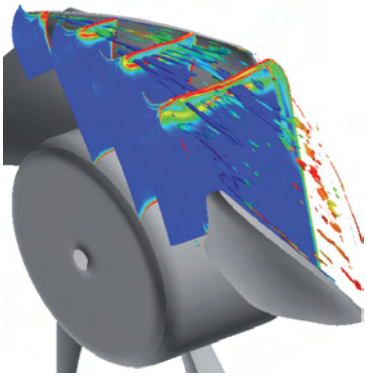
The key advantages of this model are the availability of indicative data from Steady State 3D CFD data to provide an estimate of the aero-acoustic performance. Typically designers can assess the improvements in noise performance with every CFD run within 15 minutes.

Tonal Noise

For IT Servers and Telecoms cooling units, where fans are characterised by requirements for higher pressure and rotational speeds in the range of 10,000 to 20,000 rpm Tonal noise generally becomes the dominant noise generation factor.

ADT has developed and implemented in TURBOdesign1 a Tonal Noise model that relates 3D blade surface pressure and velocities to provide relatively accurate noise emission data with every design created by the software.

TURBOdesign1 is computationally very fast with each design taking around 30 seconds on a low end workstation, it is then extremely helpful for designers to evaluate and rank different designs before even running any CFD, this approach allows engineers to evaluate the geometry, the aerodynamic and aero/acoustic behaviour exponentially faster than traditional conventional design and analysis methods.



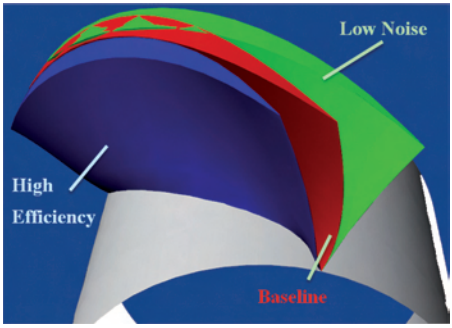


Figure 2. *Redesigned by TURBOdesign1, fan was found to be 4 points more efficient and 3 dB lower in noise.*

Zangeneh, M; De Maillard, M; (2012) Fan 2012 Book of Abstracts: International Conference on Fan Noise, Technology & Numerical Methods.

Reference: FEDESM2009-78454

Automatic Optimization

Coupling of 3D Inverse Design and Automatic Optimization

The design guidelines described above are generally valid and relatively straight forward to implement in any design system at low computational costs, however requirements may exist for particular applications where the fan is required to provide high efficiency and low noise at multiple operating conditions and speeds.

Manual design iterations achieve such complex design targets, however more and more frequently designers tend to rely on automatic optimization to help them explore the design space and achieve breakthrough designs.

ADT has developed a complete design, analysis and optimization environment to help satisfy stringent requirements for high efficiency and low noise at multiple operating conditions via development of TURBOdesign Optima.

There are a variety of optimization algorithms that can be used for such activities, however all these methods tend to rely heavily on the quantity and quality of the design input parameters, practically the 3D blade geometrical definition in a parameterized way. The blade parameterization implemented in TURBOdesign1 is particularly favourable to automatic optimization leading to considerable advantages.

First of all the 3D Inverse Design approach ensures that all designs satisfy the required work input coefficient (or Pressure Rise) at the specified design conditions.

Secondly, rather than representing the blade shape geometrically, TURBOdesign1 uses a blade loading definition that allows, with as few as 4-5 design parameters, coverage of a design space equivalent to in excess of 30 geometrical design parameters. This unique approach can save hundreds of hours of computational costs.

Finally, at the end of the optimization process, designers have access to much more than a single optimized geometry, the optimization results are expressed in the form of an optimal blade loading configuration that can be used over and over in similar fans, irrespective of size and flow conditions.

The blade design, analysis and optimization methods highlighted are computationally affordable and aimed at improving designers' capabilities to explore larger areas of the design space without longer product development times and costs. The solution is cost effective and affordable for the majority of fans and blowers manufacturers regardless of the intended product as all types of rotating and stationary blades for axial, mixed-flow and radial or centrifugal configurations can be designed within TURBOdesign Suite.

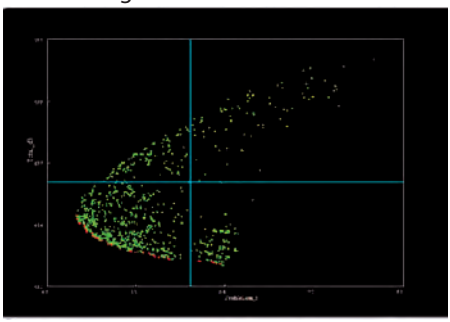
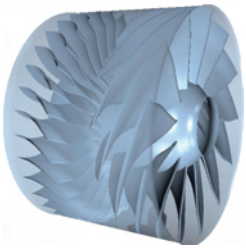


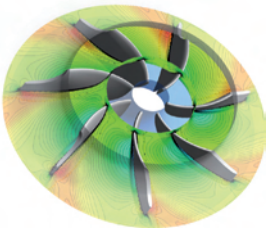
Figure 3. *With MOGA optimization designers can run 1,600 designs in just a couple of hours on a mid-range workstation. The process highlights scope for optimization in reducing fan noise and improving fan efficency*

Case Studies

Developing Unique Cooling Fans in Less Time at Low Cost



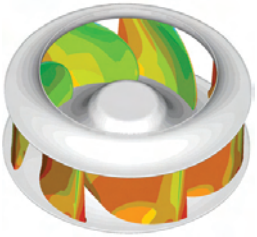
The use of the ADT's TURBOdesign1 made it possible to design an entirely new cooling fan from scratch starting only from design requirements. In the process, the company was able to eliminate the costs of using outside consultants and reduce the lead time for new turbomachinery designs of this type and produce their own designs inhouse that are best suited to their application needs.



Arc'Teryx - Design of Innovative Radial Fan for Avalanche Airbag Rescue System

ADT has designed a unique and innovative radial fan capable of inflating a backpack avalanche airbag system in less than 3 seconds. This unique design features high pressure and volume flow with minimal inflation time. Particular attention was given to manufacturability of the product for injection moulding system.

Coupling TURBOdesign1 with Automatic Optimization as Ebm-Papst to Design Efficient and Low Cost Fans



"Our experience shows the TURBOdesign1 can reduce development / design time, improve efficiency and reduce noise of fan blades" says Katrin Bohl, Engineer R&D Aerodynamics, "The design process with TURBOdesign1 being very fast, thousands of designs can be carried out overnight, allowing even optimizations with more than 20 input variables."

To see our full range of case studies visit:
www.adtechnology.co.uk/fans-blowers-case-studies

Case Studies

Daikin Industries Improves HVAC Fan Efficiencies Using TURBOdesign1

Toru Iwata, Researcher, Daikin Industries, Environmental Technology Laboratory says "With TURBOdesign1, Daikin was able to take the efficiency of its air conditioning fan designs to higher levels, without it, we would not have been able to design these new fans."

Soler & Palau Develops New Fan Design in Less Time Using TURBOdesign1

Josep Salvans, CFD Engineer, Soler & Palau said "For us, the main benefit from TURBOdesign1 is that it will help in reducing design times, not only in the aerodynamic design stage but also in the noise and structural validation stage."

TURBOdesign1, an Efficient Design Tool for the Development of Compact Fan Guide Vanes

The possibility to generate different designs in a fast and robust way makes TURBOdesign1 an integral part of the work flow for designing multi-row fans with guide vanes at Ebm-papst St. Georgen. "After using TD1 for numerous years, we now consider it our standard design tool for radial, diagonal ans axial fans".

To see our full range of case studies visit:
www.adtechnology.co.uk/fans-blowers-case-studies

Engineering Services

ADT Engineering Services team supplies turnkey turbomachinery design, analysis and optimization services to leading turbomachinery manufacturers in aerospace, automotive, industrial, marine and power generation industries.

Some of our recent projects include:

- Multi-disciplinary Design Optimization of Radial Inflow and Mixed-Flow Turbines for Heavy Duty Turbochargers
- Redesign of a Sirocco Blower and Volute Stage for Automotive HVAC
- Conceptual and Detailed Design of Gas Turbine and Compressor Stages for Automotive Range Extender
- Design of a Novel High Speed, Low Weight Automotive Axial Cooling Fan
- Optimization of a Turbocharger Centrifugal Compressor Stage for Wider Operaing Range and Higher Efficiency
- Design Optimization of a Transonic Axial Compressor for Power Generation
- Preliminary and Detailed Design of Very Low Head Axial Hydraulic Turbines
- Design and Optimization of a Series of Axial Drilling Turbines
- Development of a Wide Range Compressor Stage for Fuel Cell Applications
- Optimization of a Double Inlet Suction Volute to a Multistage Pump
- Aerodynamic and Aero-acoustic Design Optimizaion of High Speed Contra-rotating CPU Cooling Fans
- Multi-point and Multi-objective Optimization of a Centrifugal Compressor Stage for Large Tonage Refrigeration
- Preliminary and Detailed Design of a Hydraulic Turbocharger for Reverse Osmosis Applications

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