

# Elliott Engineered Solutions' Analytical Capabilities

A turbomachinery rerate or modification might be a simple redesign of a nozzle ring or a comprehensive review of a unit's mechanical limits and the replacement of all the aerodynamic components. Elliott Engineered Solutions expertly evaluates rotating equipment from any manufacturer and designs efficient, reliable solutions to maintain, enhance, and extend the equipment's operating capabilities.

An engineering study is often necessary to determine how rotating equipment should be modified. We review design specifications, drawings, instruction manuals, overhaul history, and service reports to ensure a full understanding a machine's history of operation and maintenance. We determine which features of the machine should be re-engineered and which can remain unchanged. A thorough mechanical and aerodynamic evaluation can include performance and efficiency analysis, flow-path definition, material analysis, rotor dynamics analysis, finite element analysis (FEA), and gas analysis. Elliott knows what it takes to keep your turbomachinery performance high and your maintenance costs low.

## Reverse Engineering

Using portable, coordinate measuring machines (CMM), Elliott engineers can precisely map the geometry of equipment from any manufacturer. Using CMM tools to record internal component geometry during service outages, we can offer recommendations for the redesign, rerate, or reliability upgrade of internal components. If operating machinery cannot be dismantled for measurement and evaluation, we can map the installation footprint and provide a replacement "drop-in" unit with upgraded internal components. This is a timely and cost-effective way to meet changes in production requirements or provide spare components for your rotating equipment.



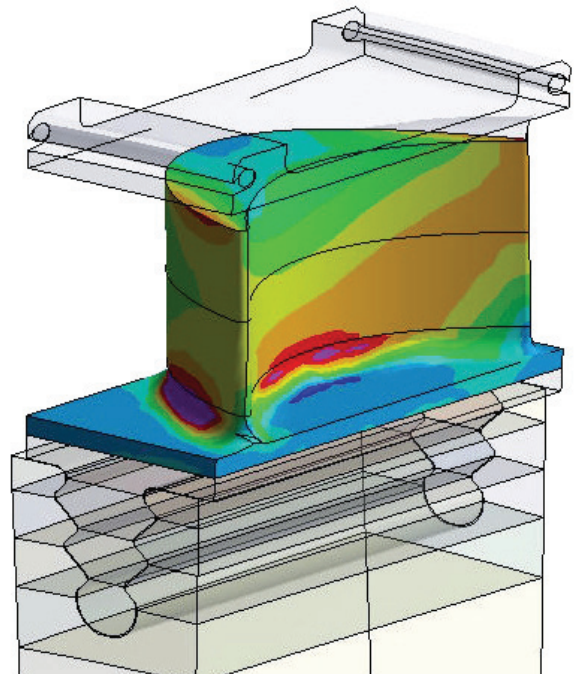
*Reverse engineering of a non-Elliott steam turbine rotor using CMM.*

## Advanced Engineering Studies

Using solid modeling techniques, computational fluid dynamics (CFD), finite element analysis (FEA), and internal performance and rotor dynamic software, Elliott engineers develop design solutions that use the latest materials, aerodynamic designs, and reliability advancements to meet or exceed new application requirements. Engineering studies can also evaluate equipment for increased output, revised operating conditions, or extended-life requirements.

## Site Audits

Elliott consulting engineers perform site audits to offer an objective analysis of the condition of equipment from any manufacturer. Site audits target cost-effective equipment upgrades for improved reliability, peak efficiency, and ease of maintenance. Typical audits consider site utility costs, equipment operating histories, potential upgrades, and include a detailed report with improvement recommendations and value analysis.



*Finite element analysis of turbine bucket airfoil.*

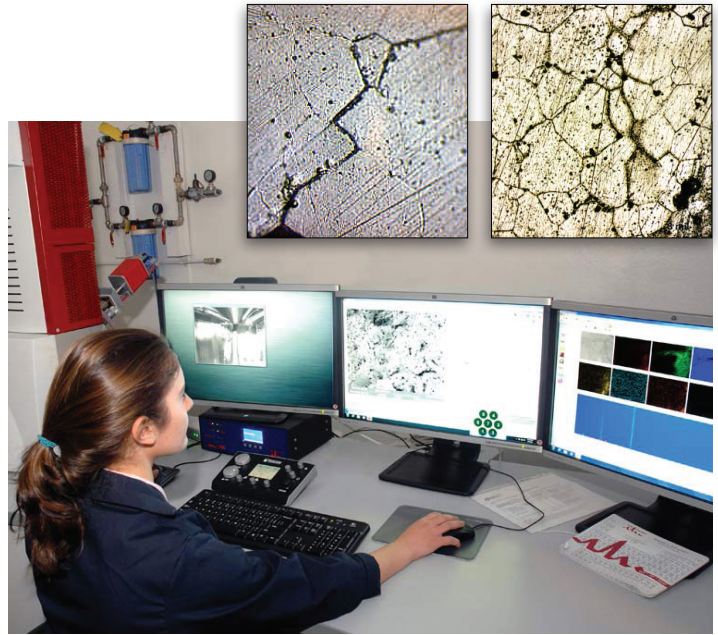
## Remaining Life Assessment

Elliott conducts remaining life assessment evaluations using metallurgical and fracture-mechanics methodologies. These techniques predict the remaining operating life of components and structural elements that have been in service for an extended period of time. Life assessment is an important tool for scheduling replacement and avoiding premature scrapping of parts.

## Elliott Engineered Solutions

Elliott Engineered Solutions has one focus – to help turbomachinery operators obtain the highest value from their critical rotating equipment. Elliott has more than 100 years of experience in engineering, manufacturing, repairing, and modifying all types of turbomachinery. Elliott Engineered Solutions specializes in the following areas:

- ♦ Modifications and rerates of turbomachinery to increase the operational life and value of your investment by optimizing performance and reducing downtime.
- ♦ Reverse engineering and comprehensive analytical studies such as lateral and torsional rotor analysis, root-cause failure analysis, mechanical evaluation analysis, finite element analysis (FEA), and aerodynamic analysis.
- ♦ Onsite audits to evaluate turbomachinery efficiency and determine potential reliability improvements to maximize your return on existing equipment.
- ♦ Reapplication of previously owned equipment for emergency installation or cost-effective replacement.
- ♦ Equipment configuration designs to precisely fit existing footprints.



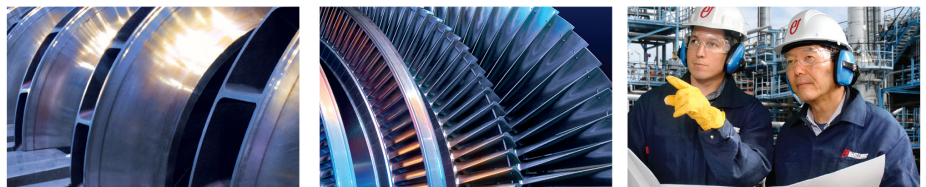
Materials Engineer performing microstructure analysis.



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C O M P R E S S O R S ■ T U R B I N E S ■ G L O B A L S E R V I C E