In the design of mechanical components, numerical simulations and experimental methods are commonly used for
design creation (or modification) and design optimization. However, a major challenge of using simulation and
experimental methods is that they are time-consuming and often cost-prohibitive for the designer. In addition, the
simultaneous interactions between aerodynamic, thermodynamic and mechanical integrity objectives for a particular
component or set of components are difficult to accurately characterize, even with the existing simulation tools and
experimental methods. The current research and practice of using numerical simulations and experimental methods do
little to address the simultaneous "satisficing" of multiple and often conflicting design objectives that influence the
performance and geometry of a component. This is particularly the case for gas turbine systems that involve a large
number of complex components with complicated geometries.

Numerous experimental and numerical studies have demonstrated success in generating effective designs for
mechanical components; however, their focus has been primarily on optimizing a single design objective based on a
limited set of design variables and associated values. In this research, a multiobjective design optimization framework to
solve a set of user-specified design objective functions for mechanical components is proposed. The framework
integrates a numerical simulation and a nature-inspired optimization procedure that iteratively perturbs a set of design
variables eventually converging to a set of tradeoff design solutions. In this research, a gas turbine engine system is
used as the test application for the proposed framework. More specifically, the optimization of the gas turbine blade
internal cooling channel configuration is performed. This test application is quite relevant as gas turbine engines serve a
critical role in the design of the next-generation power generation facilities around the world. Furthermore, turbine
blades require better cooling techniques to increase their cooling effectiveness to cope with the increase in engine
operating temperatures extending the useful life of the blades.

The performance of the proposed framework is evaluated via a computational study, where a set of common, real-world
design objectives and a set of design variables that directly influence the set of objectives are considered. Specifically,
three objectives are considered in this study: (1) cooling channel heat transfer coefficient, which measures the rate of
heat transfer and the goal is to maximize this value; (2) cooling channel air pressure drop, where the goal is to minimize
this value; and (3) cooling channel geometry, specifically the cooling channel cavity area, where the goal is to maximize
this value. These objectives, which are conflicting, directly influence the cooling effectiveness of a gas turbine blade and
the material usage in its design. The computational results show the proposed optimization framework is able to
generate, evaluate and identify thousands of competitive tradeoff designs in a fraction of the time that it would take
designers using the traditional simulation tools and experimental methods commonly used for mechanical component
design generation. This is a significant step beyond the current research and applications of design optimization to gas
turbine blades, specifically, and to mechanical components, in general.

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The public is welcome to attend.