In the power generation sector, more specifically, the gas turbine industry, competition has forced the lead time-to-market for product advancements to be more important than ever. For design engineers, this means that product design iterations and final product development must be completed within both critical time windows and budgetary constraints. Therefore, two areas that have received significant attention in the research and in practice are: (1) rapid prototyping technology development, and (2) rapid prototyping technology selection.

Rapid prototyping technology selection is the focus of this research. In practice, selecting the rapid prototyping method that is acceptable for a specific design application is a daunting task. With technological advancements in both rapid prototyping and conventional machining methods, it is difficult for both a novice design engineer as well as an experienced design engineer to decide not only what rapid prototyping method could be applicable, but also if a rapid prototyping method would even be advantageous over a more conventional machining method and where in the manufacturing process any of these processes would be utilized.

This research proposes an expert system that assists a design engineer through the decision process relating to the investment casting of a superalloy gas turbine engine component. Investment casting is one of the oldest manufacturing processes, and it is a well-known technique for the production of many superalloy gas turbine parts such as gas turbine blades and vanes. In fact, investment-cast turbine blades remain the state of the art in gas turbine blade design. The proposed automated expert system allows the engineer to effectively assess rapid prototyping opportunities for desired gas turbine blade application. The system serves as a starting point in presenting an engineer with commercially-available state-of-the-art rapid prototyping options, brief explanations of each option and the advantages and disadvantages of each option. It is not intended to suggest an optimal solution as there is not only one unique answer. For instance, cost and time factors vary depending upon the individual needs of a company at any particular time as well as existing strategic partnerships with particular foundries and vendors.

The performance of the proposed expert system is assessed using two real-world case studies. The first case study shows how the expert system can advise the design engineer when suggesting rapid manufacturing in place of investment casting. The second case study shows how rapid prototyping can be used for creating blade patterns for use within the investment casting process. The results from these case studies are telling in that their implementations potentially result in an 82 to 94% reduction in blade design decision lead time and a 92 to 97% cost savings.