BENEFITS OF AN EXPERT SYSTEM

The **Automated Design Expert System** has been designed to assist the engine designer in solving complex multi-variable, multi-goal problems. Key elements of the Expert System that provide this capability include:

- A choice of user-interfaces that meet the needs of both experienced and novice users:
  - A detailed **Knowledge Engineering Interface** where experienced users can clearly define the Automated Engine Design process. The interface allows precise tailoring of the experiment for each particular application.
  - A simplified **Application Specific Interface** where the novice user has limited control over the Automated Engine Design process. The interface allows only the objective of predefined experiments to be modified.
- Reusable **Objectives** and **Strategies**. The Objective precisely defines the desired performance goals of the engine design. Each goal may be assigned a relative weighting that will be used to decide the optimum design. The Strategy precisely defines the methodology by which the problem may be solved, included the engine parameters that can be modified in an effort to meet the objective. Both can be applied to any engine design with the click of a mouse button.
- A **Knowledge Base** that acts as a central repository for all design objectives and strategies. The Knowledge Base can be organized in such a way that the most beneficial objectives and strategies can be easily located and applied to any design problem.
- A shared, centralized **database** in which the accumulated knowledge and expertise of every engineer is stored. This expertise can be reapplied to any engine design problem irrespective of personnel or project changes.
- A dedicated **Inference Engine** that guarantees a repeatable design process. The inference engine employs a rigorous design space exploration process that diligently searches the space for multiple, alternative solutions to each particular problem.

> An **Expert System** is a computer program that simulates the judgment and behavior of a human or an organization that has expert knowledge and experience in a particular field. Typically, such a system contains a knowledge base containing accumulated experience and a set of rules for applying the knowledge base to each particular situation that is described to the program.

As a result, the **Automated Design Expert System** can significantly decrease the amount of manual design iteration that is traditionally associated with engine performance prediction. In the engine cycle simulation paradigm, the expert user applies his skill, judgment and experience to improve the engine design by a laborious, repetitive process of iterative change and analysis, as shown in Figure 1. This process has many pitfalls, including:

- It is difficult to repeat if the project specifications and requirements are changed.
- It is difficult to apply on each new project, as the methodology exists only in the users head.
- Other users in the organization cannot leverage the knowledge and expertise that is gained by the design exercise.
- It lacks a rigorous approach to problem solving, and relies totally on the diligence of the individual user. In an environment where multiple parameters interact with one another to produce the optimum response, it is highly unlikely that this design process will yield the best design possible.

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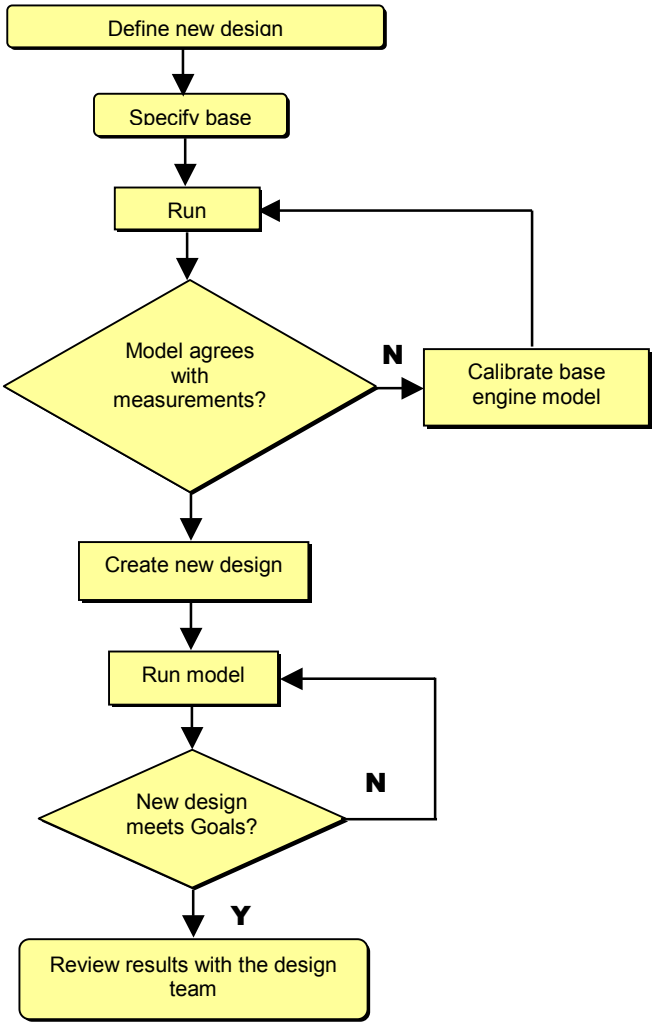

Fig 1: Traditional Simulation-based Design Process

In the **Automated Design Expert System** paradigm, the user has a powerful tool that addresses these pitfalls. The exact methodology by which the problem is solved is stored within the database, allowing the process to be easily repeated if the project requirements change. This shared resource allows other users to assess the benefit of reusing each methodology on their individual design problem. As a result, the knowledge and expertise of all users is easily transferred from one design problem to the next. The new design process is shown in Figure 2.

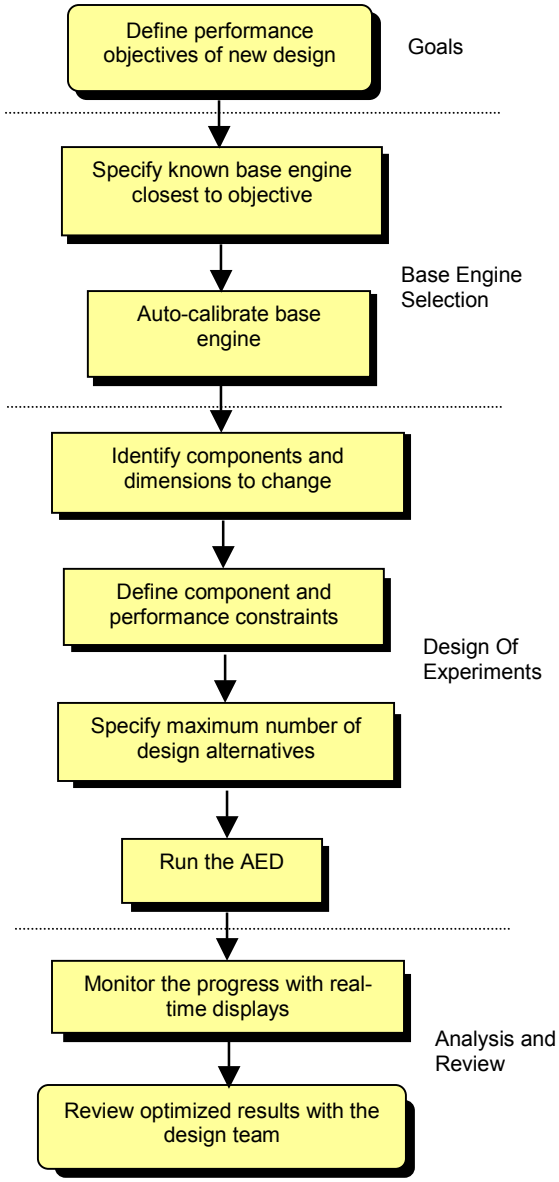

Fig 2: Simulation-based Automated Design process

The **Automated Design Expert System** encompasses embedded algorithms for rigorous design space analysis. This engine designer is now able to specify complex, multi-variable problem that would have been previous impractical. The interdependencies between engine parameters that inherently influence engine operation can be directly assessed and utilized for improved ending design.