

1. SUMMARY

In this lecture, engine simulation technology is discussed. It is intended to provide an overview of the continuous system simulation process as it has been applied in the gas turbine engine industry. The topics include : devices employed in simulation, numerical and programming methods used; high-level languages, applications toward which the simulation process is directed, organizational requirements, and future trends predicted by the current practice. Subsequent lectures will focus more directly on specific aspects of the engine simulation process, namely, transient engine simulation practice, nonlinear equation solvers and simulation systems and software.

2. INTRODUCTION

First, let me introduce myself. I've been involved in gas turbine engine simulation since 1960 when I helped to develop transient heat transfer models for the nuclear aircraft engine project. I was employed at Pratt and Whitney for over twenty years where I designed and developed transient engine simulations of most of Pratt and Whitney's engine products. I was responsible for the transient aspects of Pratt and Whitney's State-Of-The-Art Performance Program (SOAPP), as well as its nonlinear solver. This was one of the first generalized engine simulation system and is still used in all transient and steady state performance analysis tasks. While at Pratt and Whitney, I also managed NASA programs dealing with high frequency and real time modeling advances.

Since leaving Pratt and Whitney to found my consulting practice, I have served Pratt and Whitney, Textron Lycoming, AlliedSignal (Garrett) Engine and Auxiliary Power Divisions, Allison Gas Turbine Division and Sverdrup Technologies in a variety of roles, from "pure" consulting to simulation system design and implementation. My practice combines application-specific system requirements definition with program design, documentation, code preparation, validation testing, quality assurance and training.

I am currently in the fourth year of my work on the Integrated Modeling and Analysis of Gas-turbine Engines (IMAGE) program, a large-scale nonlinear simulation system that I designed and developed for AlliedSignal's Auxiliary Power Division. IMAGE's user interface allows the definition of the engine's flow field and mechanical connections, as well as equations describing the operation of control systems and auxiliary sub-systems. IMAGE is used in both steady-state performance analysis and in various transient applications, notably starting studies. It includes access to an optimization facility controlled by user input. It also serves as the source of programs delivered to Allied's customers in support of marketing and support efforts.

As for the subject matter of this lecture series, "Gas Turbine Engine Transient Behavior", I am pleased to have the opportunity to speak to you on the subject of "Engine Simulation Technology". This lecture is intended to provide an overview of the process by which the concepts and models produced through the efforts of my engineering and scien-