STRUCTURAL ANALYSIS DEMONSTRATION OF CONSTITUTIVE AND LIFE MODELS

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The overall objective of this program is to demonstrate the applicability of NASA-developed advanced constitutive and life damage models for calculating cyclic structural response and crack initiation in selected components of reusable space propulsion systems. The computer model resulting from this program will enable the user to produce an accurate life prediction of hot gas path, life-limiting components of propulsion systems such as the space shuttle main engine (SSME). Program features include:

- Integration of Prior Developed Programs as Basic Approach

  Previously developed computer models addressing constitutive modeling and life damage will be combined in an advanced finite element analysis to generate a sophisticated baseline life prediction program.

- Test Verification of Synthesized Model

  A material data base will be established for the constitutive and life models parametrically involving temperature, strain range, strain rate, mean strain/stress, and dwell time. Structural problems will be run involving cyclic thermomechanical loading and multiaxial stress states. The structural assurance models will be verified for multiaxiality, cumulative damage, and damage mechanism interaction.

- Model Utilization With SSME Components

  The verified computer program will be used to accomplish the life predictions of three SSME critical components as evidence of the model functionality.

Three engine components will be chosen for analysis. Only one of these components has been selected to date - a blade from the high pressure turbopump presently used in the SSME and shown in figure 1. The analysis will be carried out using the properties of PWA 1480, the proposed material for the next generation of blades. Other candidates for the program are a redesigned blade and a nonrotating component. An analysis of these components will be carried out by using properties of appropriate materials that are of a quite different class than the highly anisotropic, single crystal structure of the PWA 1480. This will allow the analysis to test the selected constitutive and life models for quite different microstructures and symmetry classes.

The constitutive model selected for analysis of the anisotropic PWA 1480 is the Stouffer-Dame model. However, the Walker model will be examined to some extent. For the isotropic materials, the model developed by Ramaswamy will be employed, although others may be evaluated depending on data requirements and

what is available. Various damage models will also be investigated, namely continuous damage, hysteresis energy, and strainrange partitioning.

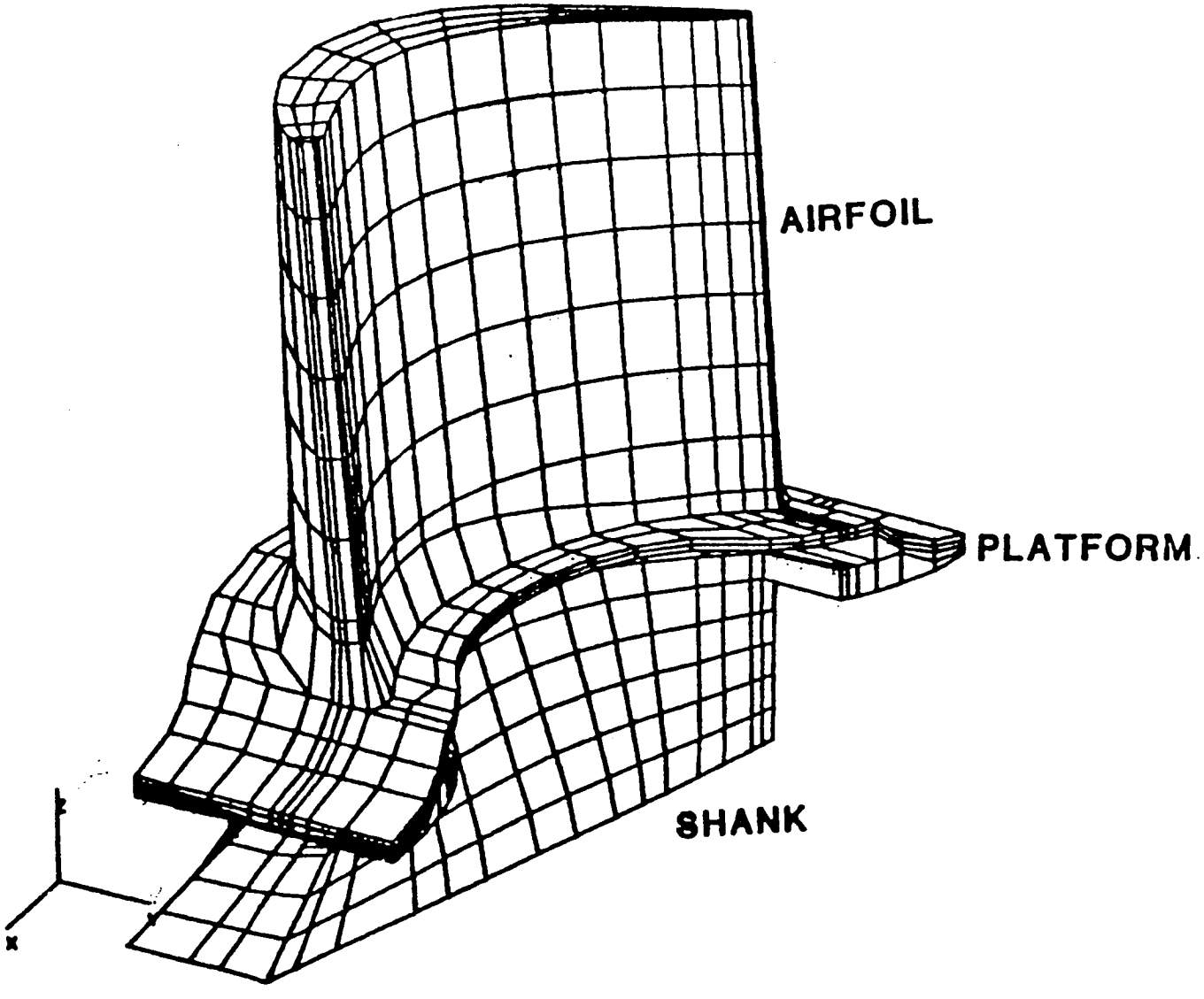

Figure 1.