We are pleased to report that all of the planned contractual and grant research programs in the fatigue and fracture discipline of the HOST Project are now in place. Many are producing important new results. These results and detailed aspects of the individual efforts will be conveyed by the responsible technical principal investigators in Session IVa scheduled for the last afternoon of this workshop. At this point I would like to give a brief overview of the status of the fatigue and fracture programs.

The programs involve the development of appropriate analytic material behavioral models for cyclic stress-strain-temperature-time/cyclic crack initiation, and cyclic crack propagation. It was convenient to divide the research efforts into two camps, depending upon the nominally isotropic or anisotropic mechanical response of the materials. Five industrial contracts with three different research organizations, three university grants, and two in-house programs round out the overall effort.

Figures 1 to 6 provide a block flow diagram of the activities within the various programs. I will address these figures one by one, but the reader is encouraged to study the individual contributions for more specific details.

I do want to emphasize the underlying thrust of these programs: the development and verification of WORKABLE engineering methods for the calculation, in advance of service, of the local cyclic stress-strain response at the critical life governing location in hot section components, and the resultant cyclic crack initiation and crack growth lifetimes.
FATIGUE & FRACTURE ... IT'S ROLE IN HOST

GOAL: DEVELOP AND VERIFY ANALYTIC ENGINEERING MODELS THAT CAN BE USED ON A ROUTINE DESIGN BASIS FOR THE PREDICTION OF CYCLIC STRESS-STRAIN-TEMPERATURE-TIME RESPONSE (i.e., CONSTITUTIVE RESPONSE) AND FATIGUE CRACK INITIATION AND PROPAGATION LIFETIMES OF TURBINE ENGINE HOT SECTION COMPONENTS MADE OF ISOTROPIC OR ANISOTROPIC ALLOYS

PROGRAM INTEGRATION

PROGRAM ELEMENTS:

- CONSTITUTIVE MODELING - ISOTROPIC — (48 mos)
- LIFE PREDICTION - ISOTROPIC — (60 mos)
- CRACK PROPAGATION - ISOTROPIC — (48 mos)
- LIFE PREDICTION & CONSTITUTIVE MODELING - ANISOTROPIC — (60 mos)
- IN-HOUSE ACTIVITIES — (60 mos)

Figure 1

CONSTITUTIVE MODELING—ISOTROPIC MATERIAL
SOUTHWEST RESEARCH, LINDBOM; AND GENERAL ELECTRIC, LAFLEN

SCREEN CONSTITUTIVE MODELS
EVALUATE BEST MODELS
IMPLEMENT IN FE CODE
EVALUATE MULTIAXIAL MODES
BENCHMARK NOTCH EXPERIMENTS
DEMONSTRATION OF MODEL

PROPERTY EVALUATION PROCEDURES
REFINEMENT OF MODEL
ALTERNATE MATERIAL

Figure 2

CS-84-3928

CS-84-3928
LIFE PREDICTION - ISOTROPIC MATERIAL
PRATT AND WHITNEY, MORENO

evaluate
best models
for creep-fatigue

optional

screen
life-prediction
methods

thermal
mechanical
module

multiaxial
module

cumulative
damage
module

mean
stress
module

environmental
attack module

coatings
module

integrated
life-prediction
model

verification
on
base alloy system

alternate alloy
system evaluation

CS-84-3932

Figure 3

CRACK PROPAGATION—ISOTROPIC MATERIAL
GENERAL ELECTRIC, LAFLW; AND SYRACUSE, LIU

screen
specimen
config.

screen
CMOD/CTOD
methods

screen
path-independent
integrals

reversed
loading
module

thermal
gradient
module

TMF
propagation
module

time independent
crack propagation prediction methodology

time dependent
crack propagation prediction methodology

verify using
high temperature engine alloy

CS-84-3931

Figure 4
LIFE PREDICTION & CONSTITUTIVE MODELING
- ANISOTROPIC MATERIAL
PRATT AND WHITNEY, SWANSON

THEORETICAL MODEL DEVELOPMENT
U OF CIN, STOUFFER
U OF CT, JORDAN

SCREEN ALLOYS AND MODELS

COATING, TMF, MULTIAXIAL MODULES

PRELIMINARY EVALUATION OF MODELS

FULL EVALUATION ON COATED SINGLE XTAL ALLOY SYSTEM

ALTERNATE COATED SINGLE XTAL ALLOY SYSTEM EVALUATION

BASE PROGRAM

UPGRADE FATIGUE LABORATORY
- HOST/SATELLITE COMPUTER SYSTEM
- EXPANDED HYDRAULIC SYSTEM
- EXPANDED TEST CELL AREA
- CENTRALIZED CONTROL ROOM
- TENSION/TORSION BIAXIAL FATIGUE MACHINES
- HCF/LCF MACHINES FOR CUMULATIVE DAMAGE
- TMF MACHINE

SINGLE CRYSTAL/COATING THERMAL MECHANICAL FATIGUE PROGRAM
- PWA 1480 BARE AND COATED
- STAND ALONE COATING
- TROIKA EFFORT
- FUNDAMENTAL APPROACH TO UNDERSTANDING OF CYCLIC FLOW AND CRACKING BEHAVIOR OF COMPLEX ALLOY/COATING SYSTEM

Figure 5

IN-HOUSE ACTIVITIES

Figure 6