AIRCRAFT STRESS SEQUENCE DEVELOPMENT A COMPLEX ENGINEERING PROCESS MADE SIMPLE

N95-19480

K.H. Schrader, D.G. Butts, W.A. Sparks
Structural Engineering Department
Southwest Research Institute
San Antonio, Texas

113064

Development of stress sequences for critical aircraft structure requires flight measured usage data, known aircraft loads, and established relationships between aircraft flight loads and structural stresses. Resulting cycle-by-cycle stress sequences can be directly usable for crack growth analysis and coupon spectra tests. Often, an expert in loads and spectra development manipulates the usage data into a typical sequence of representative flight conditions for which loads and stresses are calculated. For a fighter/trainer type aircraft, this effort is repeated many times for each of the fatigue critical locations (FCL) resulting in expenditure of numerous engineering hours.

The Aircraft Stress Sequence Computer Program (ACSTRSEQ), developed by Southwest Research Institute under contract to San Antonio Air Logistics Center, presents a unique approach for making complex technical computations in a simple, easy to use method. The program is written in Microsoft Visual Basic for the Microsoft Windows environment. This environment has become common among users of personal computers and offers a consistent user interface. The benefit of a common user interface is to reduce the time required for an individual to learn the operation of a program written for that environment.

The program was originally developed for the T-38 aircraft. Subsequently, capabilities for T-37, F-5A, F-5B, F-5E, and F-5F aircraft were added. Although, ACSTRSEQ performs many complex engineering computations, these complexities are not apparent to the user. The user is exposed to a number of choices such as aircraft type, FCL of interest, and type of stress sequence desired. To further simplify the process for the user, choices are made by a pointing device such as a mouse on either menu items or screen images of the aircraft structure of interest. Screen images are either photographic or schematic depending on the information or detail that is required at that point in the decision process. Various levels of information detail are available to the user depending on knowledge or experience level. Less experienced users can choose structural areas of interest from screen pictures of the wing, fuselage, and empennage. However, users experienced in aircraft structural considerations and program usage may select program options from textural menus. In addition, schematics are provided for each FCL which show the general orientation of the FCL as well as details such as fastener hole diameters and material thicknesses and other crack parameters. These structural details are required for the crack growth analysis procedures for which the stress sequences are produced.

Printed user and programmer documentation is provided with ACSTRSEQ and is also available as part of the program "help" facility. The on-line "help" capability, which includes the full text of the user/programmer logic manual, allows the user full access to information regarding all program aspects through the use of index, search, and hyper-text linking functions. Included

in this documentation are engineering considerations, equations, and brief tutorials on data sources and results applications. As such, the on-line documentation provides a basic level of training for the determination of aircraft loads, stresses, and stress sequences required for crack growth analyses and laboratory testing.

The Aircraft Stress Sequence Computer Program integrates large, cumbersome reference information with the complex techniques of stress sequence development in a graphical user interface (GUI) that is suitable for both novice users as well as engineers experienced in spectra development. The result is a tool which provides accurate and repeatable results in a timely fashion to meet the demands of continuous damage tolerance analyses and testing programs. The concepts exhibited by this computer program only begin to explore the possibilities of productivity gains which can be obtained with properly designed state-of-the-art software.

A reduced copy of the poster is shown in the following figure.

Aircraft Stress Sequence Development (ACSTRSEQ)

Kurt H. Schrader, Devin G. Butts, William A. Sparks; Southwest Research Institute, San Antonio, Texas

Introduction

State-of-the-art computer program which produces stress sequences for fighter/trainer aircraft. Program requires flight measured usage data as input and utilizes known aircraft loads and their relationships between structural stresses at fatigue critical locations. The program produces flight-by-flight, cycle-by-cycle stress sequences in a variety of formats for use in analytical crack growth analysis and laboratory testing. The ease of use and speed of the program allow for the development of critical stress sequences using minimum engineering time.

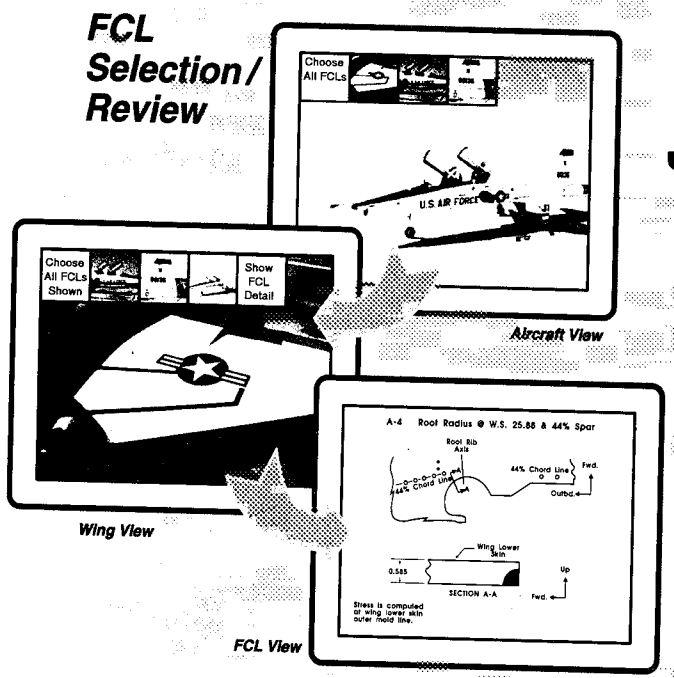
Benefits

- Rapid Stress Sequence Development
- Minimum Time Required to Learn Program
- Produce Repeatable and Consistent Results
- Easily Modify Mission Mix to Evaluate New Usage
- Productivity Increase

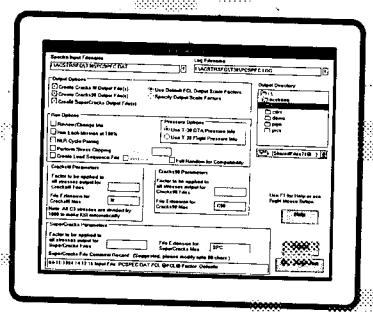
Features

- Graphical User Interface
- Multiple Output Formats
- Adaptable for Other A/C Types
- Multi-Tasking in Windows Environment
- Can Be Used by Experienced and Novice Users
- Combines Published Loads Data in One Source
- Embedded Engineering Tasks
  - Randomization of Usage Data
  - Conversion of Maneuver Data to Stresses

FCL Selection / Review



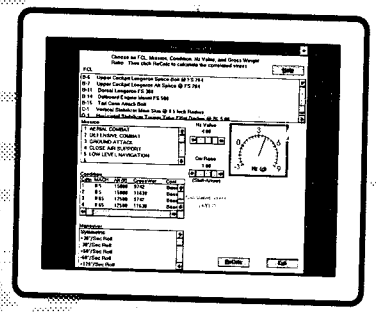
Run Parameters



- Input/Output
- Mission Mix
- Documentary Information

- Crack Growth Formats
  - Cracks III
  - Cracks 90
  - SuperCracks

Stress Calculator



- Compute Stress Due to a Single Maneuver
  - Determine maximum spectrum stress
  - Verify flight measured strains
- Parameter Sensitivity Studies
  - Flight condition
  - Maneuver type
  - Mission type
  - Vertical acceleration
  - Gross weight