DATA REDUCTION, MANAGEMENT, AND ANALYSIS SOFTWARE FOR CID

Charles W. Davis
System Development Corporation
Hampton, Virginia

NASA/FAA Government/Industry CID Workshop
NASA Langley Research Center
April 10, 1985

OVERVIEW OF DATA REDUCTION SYSTEM

In an overview of the Data Reduction System, one must look at 3 major steps. First, the raw data tapes were selected from the onboard recorders. These tapes should provide the best quality data for the data reduction software system. These tapes contained 352 channels of data, plus the monitor channels recorded in 8 bit Pulse Coded Modulation (PCM) words. The next step consists of transcribing the PCM tapes from 8 bit serial digital data to 8 bit parallel digital data. This puts the data in the correct format for processing. The transcription process was accomplished here at LaRC in the Central Data Transcription Facility (CDTF). The last step in this 3 step process is to process the data through the reduction system (reference 1) developed for the Impact Dynamic Research Facility in the early part of 1980.

- PCM tapes (on board recorders)
  - 352 channels plus monitor channels
  - 8 bit words
- Digital transcription (central data transcription facility at LaRC)
  - Convert raw data from 8 bit serial digital data to parallel digital data
  - Conversions done for prefires and in flight data
- Data reduction processing system for experimental and analytical data
  - Developed for impact dynamics research facility

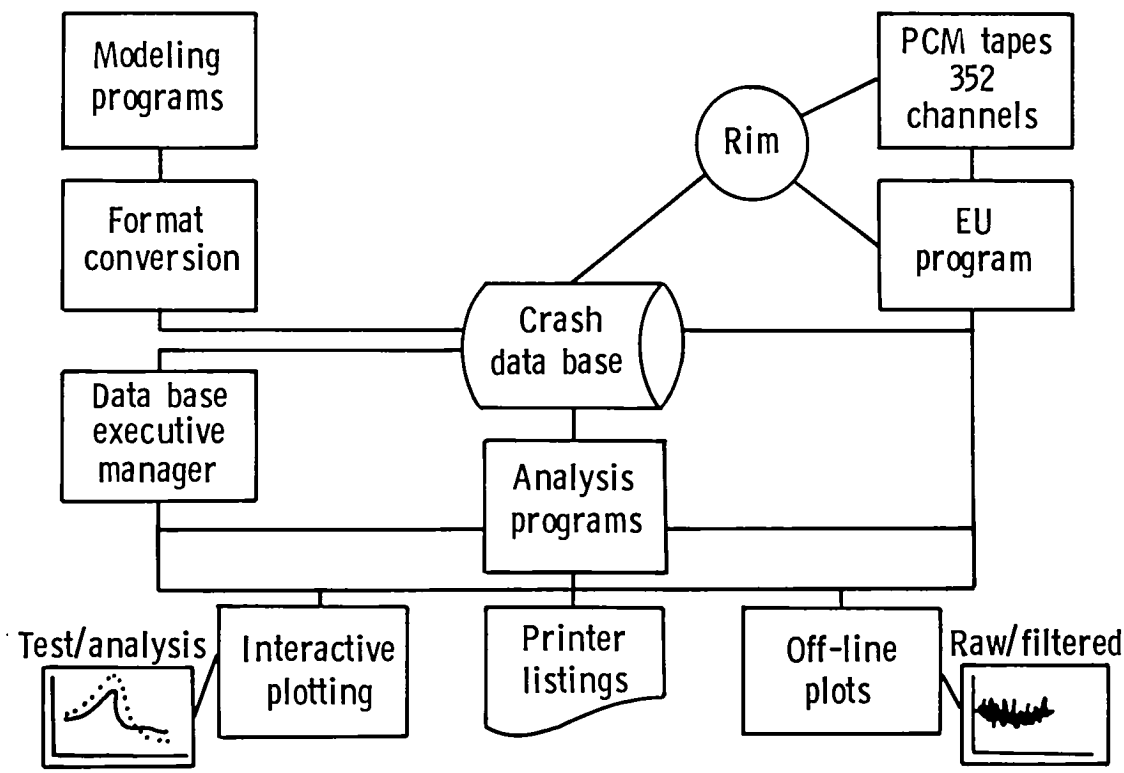
DATA REDUCTION PROCESSING SYSTEM DESIGN CRITERIA

In the design phase of the Data Reduction Processing System certain criteria were set forth to insure the processing system would be simple, fast, and give accurate results. The criteria set forth were: Program units perform one and ONLY one function. Each unit must be able to have interaction between any other program units. This makes multi program unit processing and job stepping possible. Program unit processing is order independent. Using these criteria the System was easy to design and implement, also making any modification to the processing system simplier. Before the new data reduction system was implemented it was taking approximately five weeks for turnaround, under the new system the same data can be processed in approximately one week. This means a 80 percent saving in time and personnel.

- Program unit performs one function
- Interaction between program units
- Multi program unit processing
- Independent processing order
- Simple, fast, and accurate results

DATA REDUCTION PROCESSING SYSTEM

This is the flowchart showing the Data Reduction Processing System. The flow from the top right shows the experimental data. The Raw Data PCM Tapes goes into the engineering units (EU) program. A listing of the calibrations was obtained from RIM database. These calibrations were applied to the raw data generating EU data. The output from the EU program is placed in the database. The flow from the top left shows the analytical data. This data is run through a modeling programs and the output goes through a format conversion programs to be put in the correct format before being placed in the database. The database can be accessed by the database executive program or any of the analysis programs. See reference 2 for information about the filter or analysis routines. By accessing the database the user can obtain listings, off-line plots, or interactive plots. The database is in a Time History Interface Tape (TIFT) format. This is a CDC internal binary code accessed by unformatted Reads and Writes.



SYSTEM INTERFACE ROUTINES

At present there are two system interface routines available for accessing the database. The first type converts analytical data, like output from the Dynamic Crash Analysis of Structures (DYCAST) program, into the TIFT format so it can be placed into the database. The second type converts the TIFT format into ASCII data for transmittal use. The ASCII data can be blocked at either 80 or 120 characters per record. The disadvantage to the ASCII format is its size. One 1600 BPI, TIFT formatted tape will produce five 1600 BPI, ASCII formatted tapes.

- Analytical data (dynamic crash analysis of structures)
  - Converts analytical modeling data to TIFT format
- Transmittal data (FAA)

  Converts TIFT formatted data to ASCII
  - 80 character blocking
  - 120 character blocking
- Ratio factor
  - 1 TIFT (1600 BPI tape)

    to
  - 5 ASCII (1600 BPI tapes)

ENGINEERING UNITS PROGRAM

The Engineering Units (EU) program, simply reads the digitized data from the tapes obtained from the onboard recorders, and applies the calibration and prefires to each channel. For the B720 CID test the EU program had to deal with 3 different sampling rates. The mainframe data was recorded at 1000 SPS, the subframe data was recorded at 500 SPS, and the voltage monitor channels were recorded at 100 SPS. The prefires or ambient conditions were recorded on the runway just prior to take-off. This would provide the best possible prefire conditions. The output from the EU program is in TIFT format so it can go directly into the database. During the processing of engineering units data the program also does a integration calculation on the accelerometers to produce velocities.

(PCM)

- On board tapes (352 data channels plus monitors
- Sample rates (1000 SPS, 500 SPS, 100 SPS)
- On board tapes digitalized
- Prefires and calibrations applied to raw data
- Engineering units output in TIFT format
- Integration calculations

The database executive program was designed to access the TIFT-formatted database. The database executive performs several functions, such as selecting a smaller subset by channels from the larger database, selecting a smaller time subset from a larger database, and performing some limited mathematical calculations on the data during the transfer function. The executive program was designed to run interactively. During execution it is capable of determining sample rate, number of channels, number of records, and the time segment (start and stop times).

(STRIPPR)

- **Selects channels** from larger data base (order independent)
- **Selects time segments** from larger data base
- **Performs limited calculations**
- Summarizes channel information per file
  - Sample rate
  - Number of channels
  - Number of records
  - Time segment

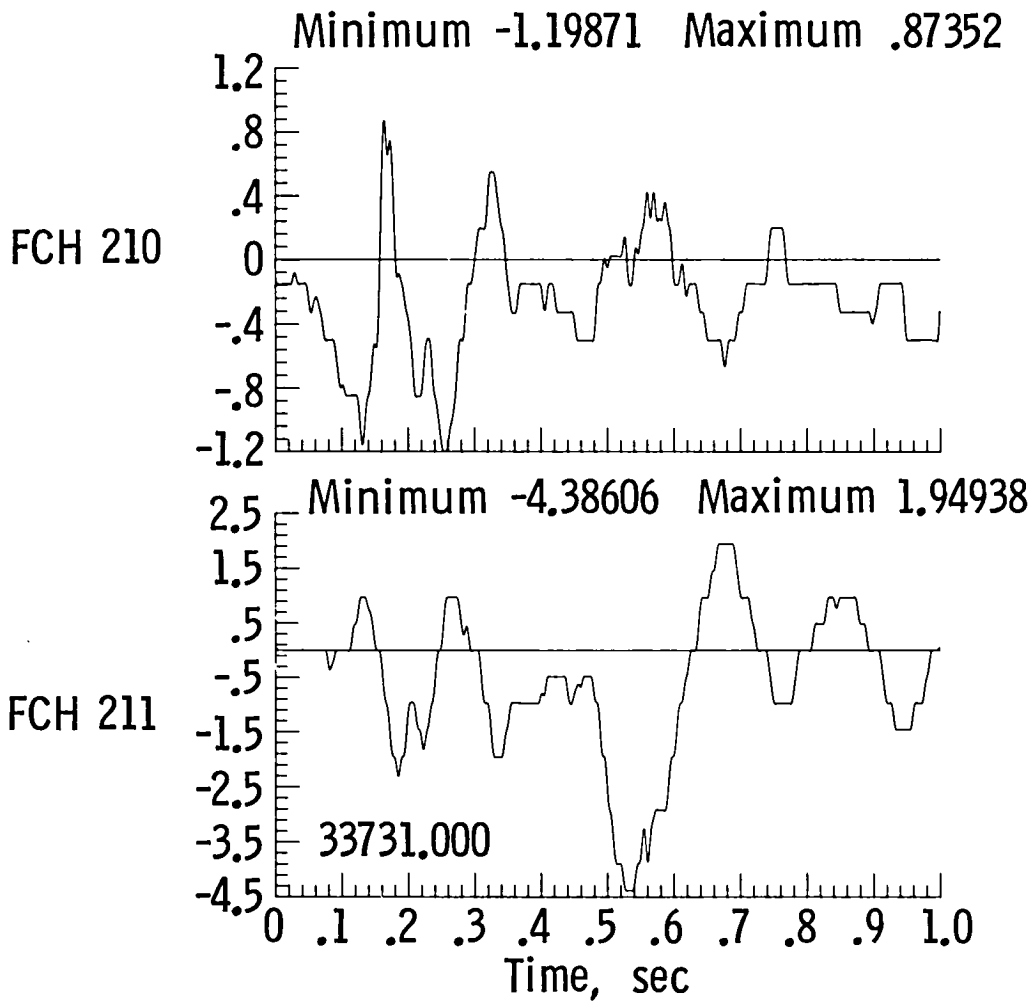
QUICK LOOK PLOTS

The varian fanfold quick look plotting program was designed for quick look working plots. This program has no input directives, it simply reads the database, determines the scales, and plots the data. The graphic output is on page size electrostatic paper processed on an off-line plotting device available at the computer center at LaRC.

- Quick look - working plots
- No input directives
- Page size graphic output (electrostatic)

QUICK LOOK EXAMPLE

Below is an example of the graphic output from the quick look plotting program.



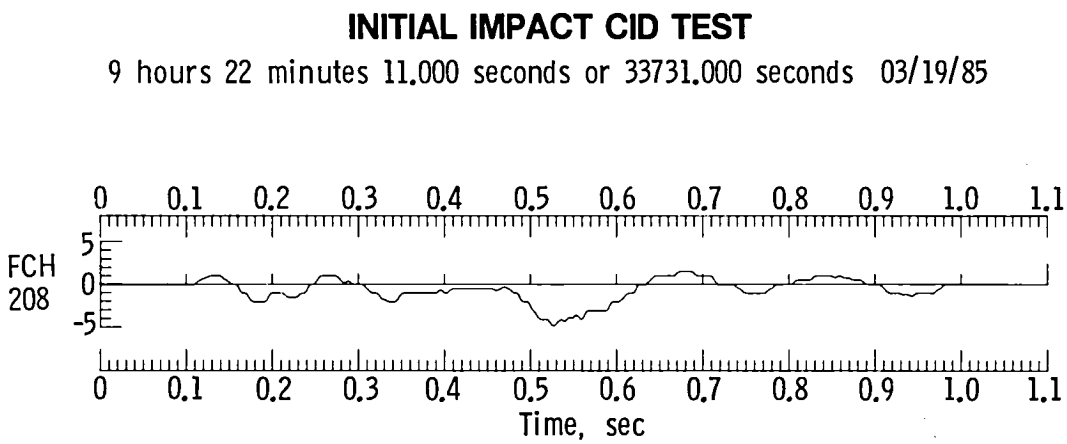
CALCOMP PLOTTING PROGRAM

The calcomp plotting program was designed for final report quality plots. This program permits the user to input the title and scales per inch for each channel. By having the channels plotted on the same scale it allows for a quick and easy comparison of different channels. The graphic output is on either 30 inch or 10 inch paper. The paper color can range from white to several selected grid patterns in red, blue or green.

- Report quality plots
- Input directives scale/inch, title
- Graphic output 30 inch paper - black ink

CALCOMP PLOTTING EXAMPLE

Below is an example of the graphic output from the Calcomp plotting program.



SYSTEM DEVELOPMENT CORPORATION INTERACTIVE GRAPHIC SYSTEM

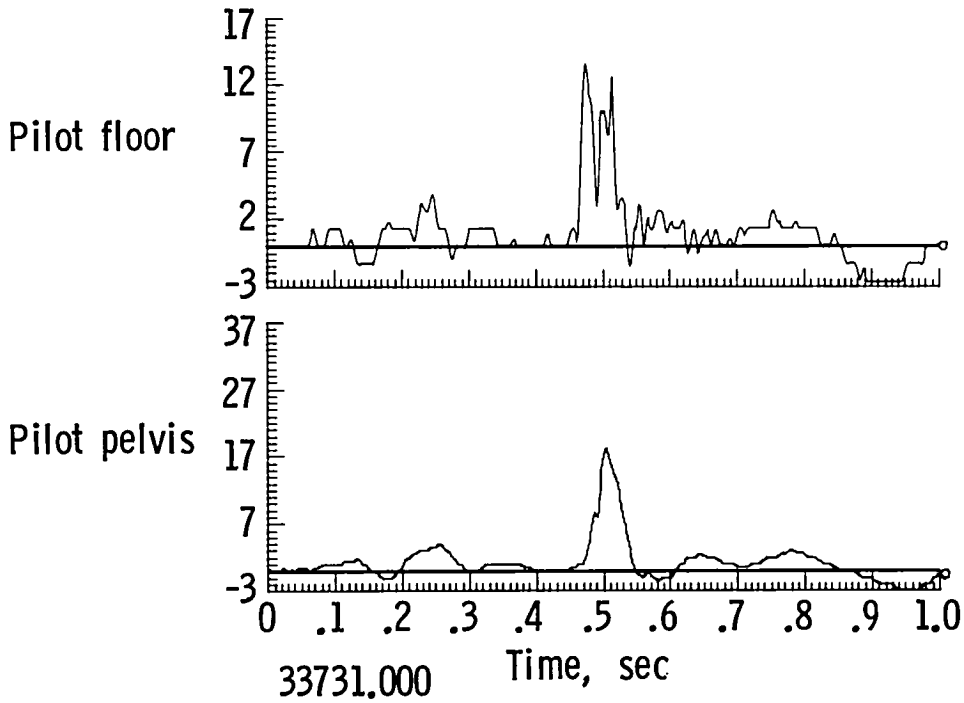
System Development Corporation Interactive Graphic System (SDCIGS) was developed primarily for interactive analysis and displaying of experimental and analytical data. SDCIGS was designed to handle multiple curves on one set of axes. These curves can be from the same test, different tests, analytical vs. experimental data, filter vs. raw data, or any combination the user chooses. SDCIGS also gives the user the option of splitting the screen and displaying data on 1 to 4 sets of independent axes. The multiple curve feature also works in the split screen mode. SDCIGS is great for designing graphic output for publications or reports. The graphic output is mainly an interactive device but the program writes an intermediate file which can be routed to off-line plotting devices.

(SDCIGS)

- Developed for interactive graphics support
- Plot related data on same frame
  - Same test
  - Different test
  - Experimental vs. analytical
  - Raw vs. filtered
- Graphic output - interactive or routed to NASA off-line plotting devices
- Great tool for designing final plots

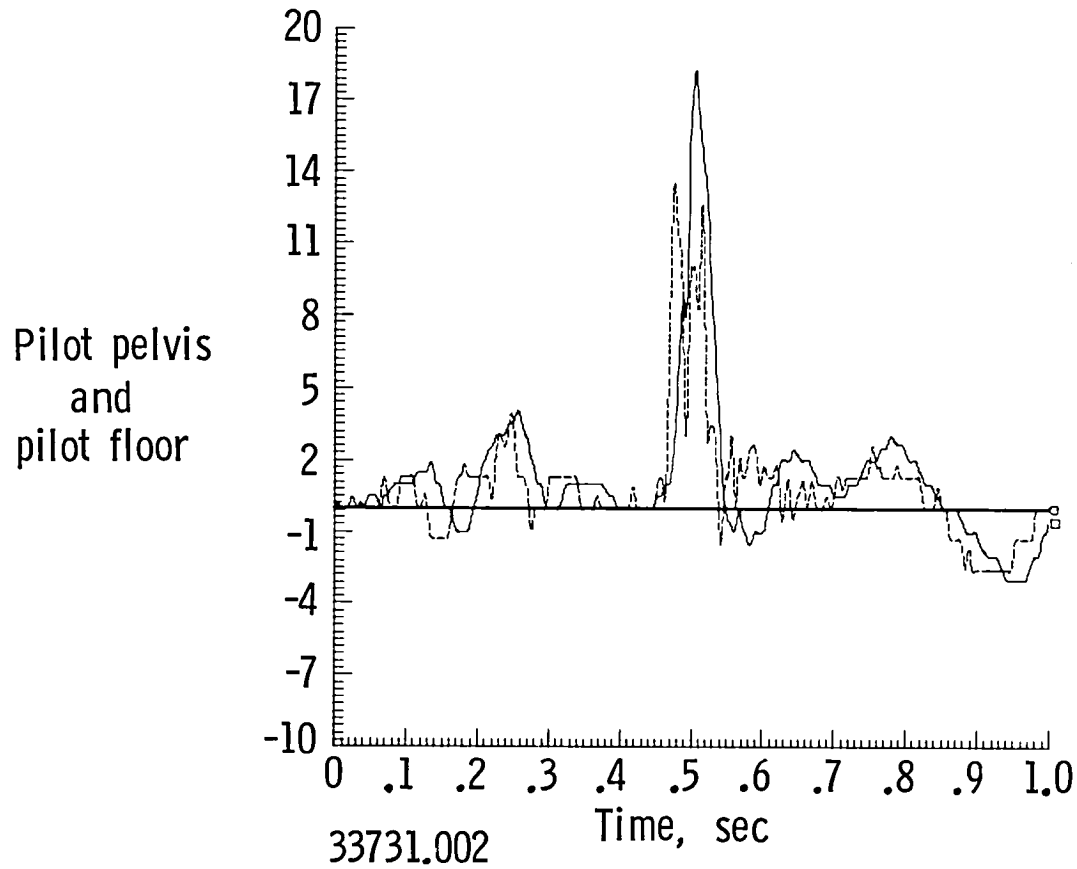
SDCIGS EXAMPLE 1

An example of SDCIGS graphic output comparing two related channels of information in the split screen mode is shown below.



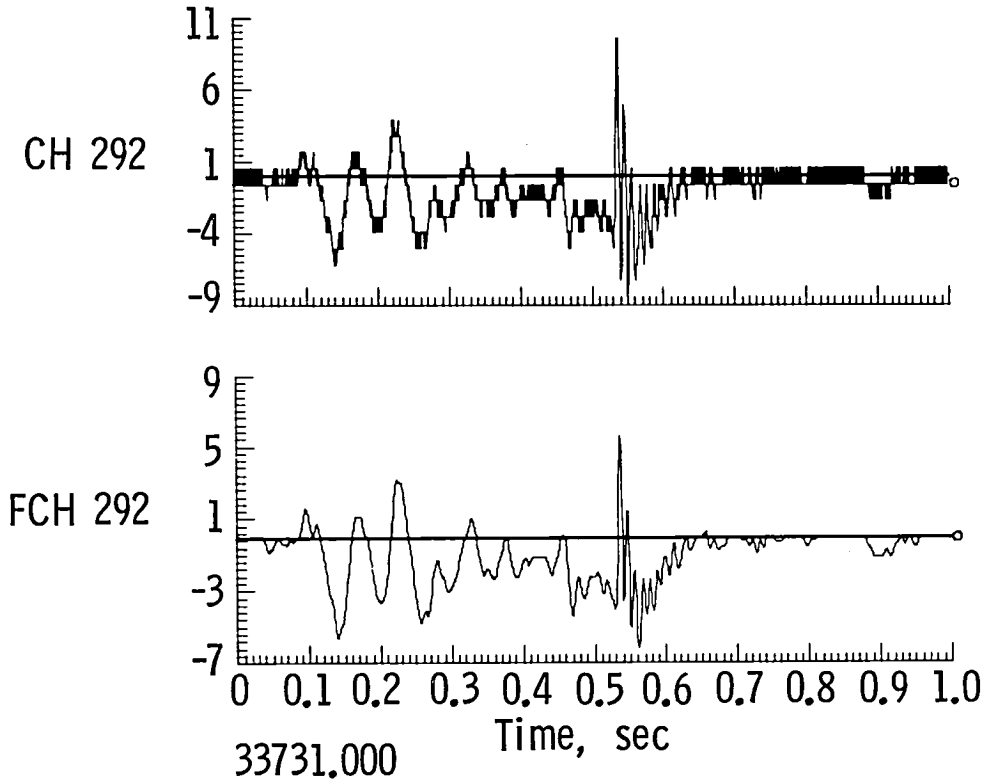
SDCIGS EXAMPLE 2

An example of SDCIGS graphic output comparing two related channels of information on the same axes appears below.



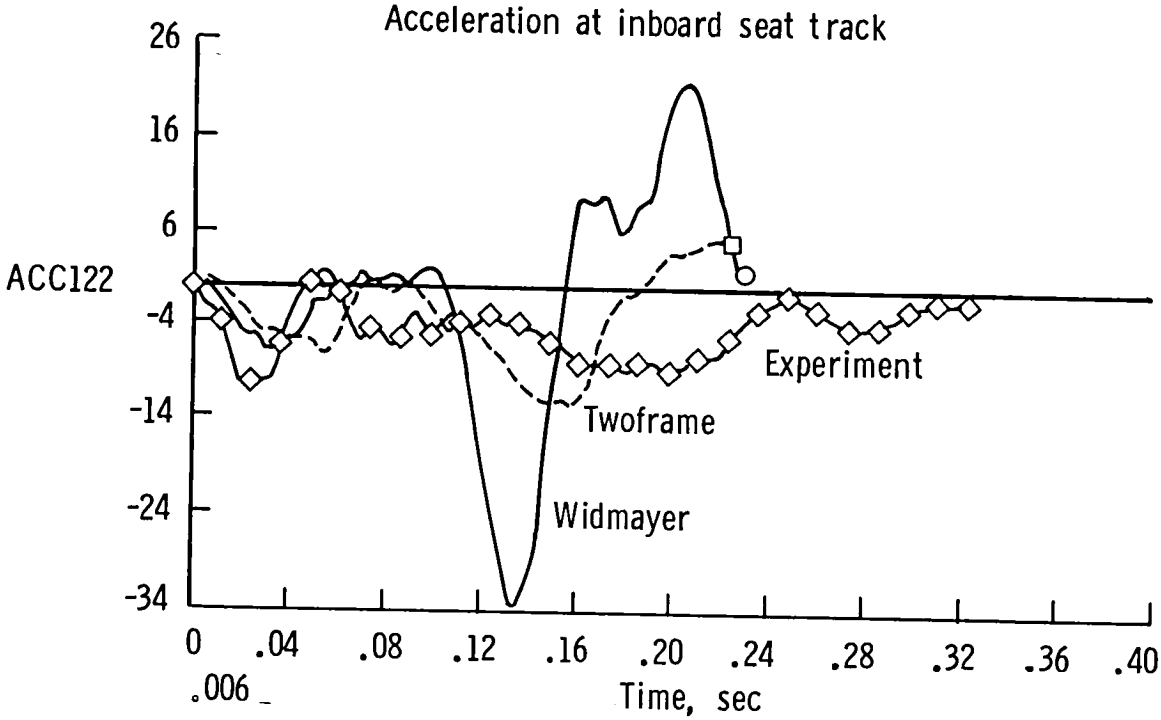
SDCIGS EXAMPLE 3

An example of SDCIGS graphic output comparing raw data vs. filter data in the split screen mode is shown here.



SDCIGS EXAMPLE 4

An example of SDCIGS graphic output comparing one experimental trace vs. two analytical traces is shown below.



REFERENCES

1. Davis, Charles W.: Impact Dynamic Research Processing Guide for Experimental and Analytical Data. NASA Contractor Report 172499, 1984.

2. Fasanella, E. L.: Digital Filtering and Acceleration Pulse Interpretation. Full-Scale Transport Controlled Impact Demonstration, NASA CP-2395, 1986, pp. 103-123.