Use of the SCIRun PSE for Coupled Fluid-Structure Analysis

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Objectives

- To investigate the use of PSE for tightly coupled fluid-structure control analysis of aerospace vehicles

Background

- To Date Multidiscipline Software Are Developed As Monolithic Pieces To Work In "Off-line" Mode
  - Not Suitable For Changing Computing Environments
  - Less Suitable To Absorb New Discipline Modules
  - Not Designed For GRID Environment
- Use Of Problem Solving Environments (PSE) To Address Above Issues Has Started

The SCIRun PSE

- SCIRun- developed by the University of Utah's Scientific Computing and Imaging Department
- A software package that provides users with a set of tools to solve problems modularly
- Attempts to allow users to add custom tools to augment the tools already supplied in the package

Projects Done with SCIRun

- BioPSE – extends capabilities of SCIRun by including modules that are geared toward bioeletric field problems
- Uintah – derivative of SCIRun that targets large scale simulations on distributed memory supercomputers
- C-SAFE – simulate propagation of fire

Research Procedures

- Installation
- Module Development
- Time Testing

Installation

- SCIRun requires pre-installed software packages

- Xerces – parses XML
- Tcl/Tk – required for GUI
- Python – scripts for installing SCIRun
- MPICH – optional fordistributed computing

Installation Problems on NAS

- Xerces – Number of command line arguments in the installation script exceeded the allowable number of command line arguments on an SGI

Module Development

- MyFieldReader
  - Developed to gain understanding of SCIRun disk I/O and user interface
  - Built upon the provided SCIRun FieldReader module
  - Extended the fuctions in FieldReader to allow reading of other data formats such as FieldView
  - Data selection available from the GUI of MyFieldReader

Module Development (cont.)

- Tri2d
  - 2D Structures solver program written in FORTRAN
    - Computes the stresses of a 2D surface when a load is applied from a given direction
  - Tri2d(SCIRun) uses a system call to run the FORTRAN written executable
  - The executable receives data from SCIRun's I/O
  - The executable then outputs the data back into SCIRun
  - Tri2d(SCIRun) also generated the 2D grid as part of the input

Module Development (cont.)

- Tri2d's GUI (graphical user interface)
  - Written in TCL script
  - Allows the user to input data
  - Provides users with the ability to monitor the convergence through each iteration
  - Allows users to input the grid resolution
    - Changing the total number of nodes in the generated surface grid

Module Development (cont.)

- Arc2d
  - Arc2d is a flow solver program written in FORTRAN that computes the fluid flow over a solid 2d surface
  - Arc2d (SCIRun) uses the ARC2D(FORTRAN) executable
    - Receives and sends data through SCIRun's I/O

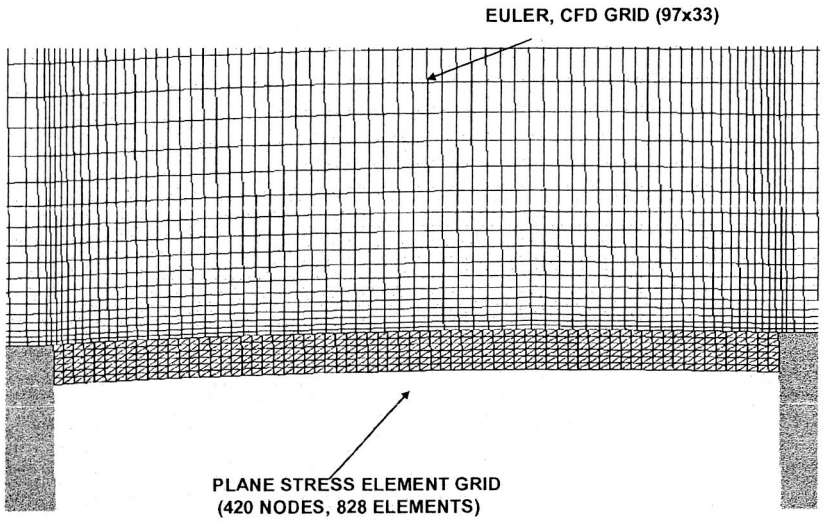
Module Development (cont.)

- Arc2dtoTri2d
  - Serves as an interface between Arc2d and Tri2d by distributing the pressure values in the output of Arc2d
  - A mapping of data from Arc2d to Tri2d

Module Testing Framework

- Framework is setup in a loop to allow for multiple iterations

CLOSE-UP VIEW OF CFD AND CSM GRIDS



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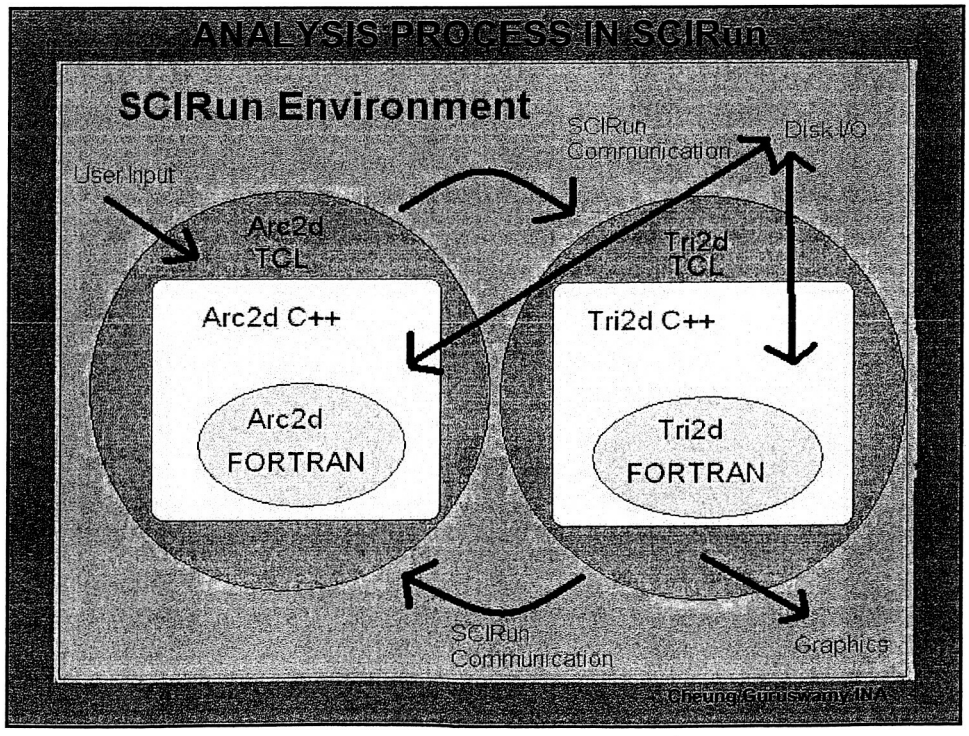
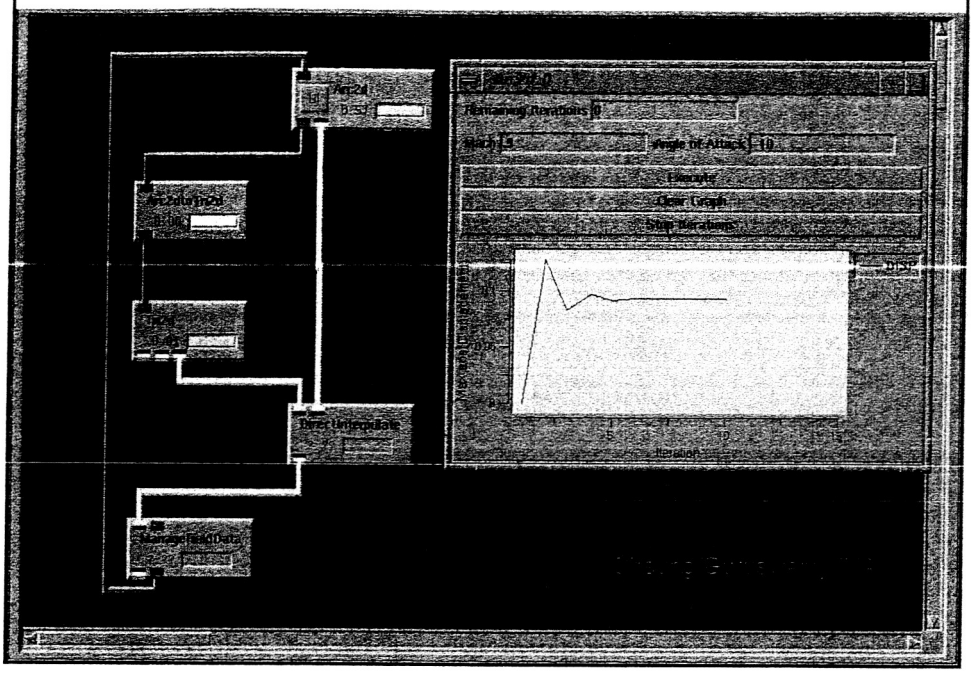
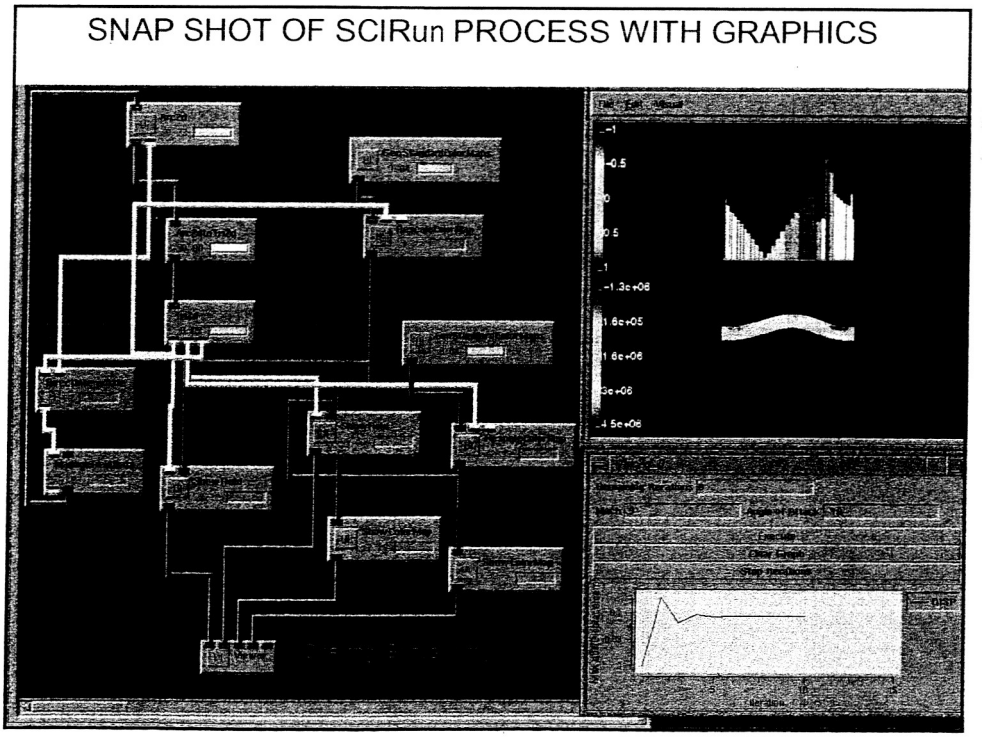


SNAP SHOT OF SCIRun PROCESS



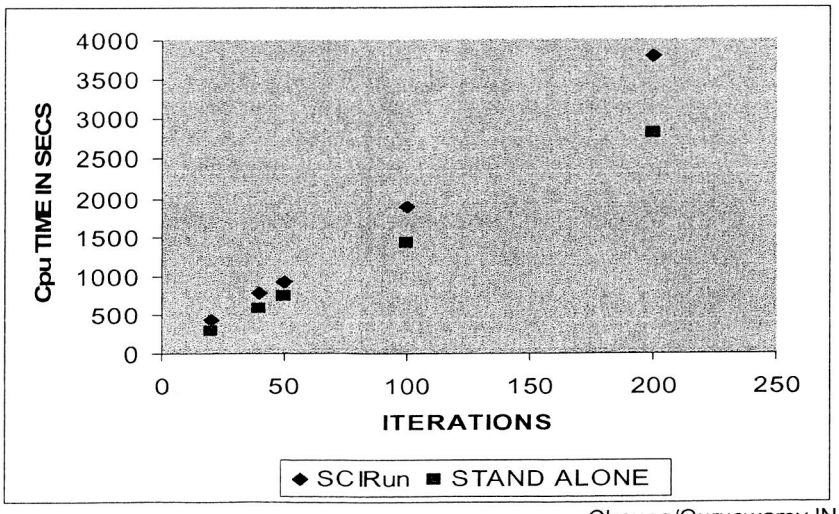
SNAP SHOT OF SCIRun PROCESS WITH GRAPHICS



Time Testing of SCIRun

- System used for time testing
  - SGI-Octane – 250 MHz R10000, 512 Mbytes RAM
- The SCIRun framework used for testing
  - The same as described in a previous slide
- Compared to the Independent Solver
  - Independent Solver – Completely written in C++
  - Runs the Fortran Programs completely independent of SCIRun
  - Allows for determining the extra overheard required by SCIRun

COMPUTATIONAL EFFICIENCY



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Time Test Results

- SCIRun requires about 30% more time to run compared to the Independent Solver
- Increased CPU time in SCIRun due to extra overhead cost of transfering data with SCIRun's I/O

Problems Encountered

- Problems running through iterations-looping
  - In larger iteration test cases (over 200 total iterations), the SCIRun modules would lock up
- Autoexecute ability in some of SCIRun's supplied modules
  - Modules would automatically execute the entire framework in some cases out of user control

Conclusions

- SCIRun package provides a great deal of modules that can be incorporated into user created frameworks
- Provides ease of use for users
- SCIRun's extra overhead hinders it's ability to compute larger or more complex problems
- Limitation on number of iterations

Future Studies

- The use of PETSc to create a Problem Solving Environment
- The use of multiple processors in Problem Solving Environments
- Incorporation of other graphics packages to help visualize data as it is being computed