The Focus

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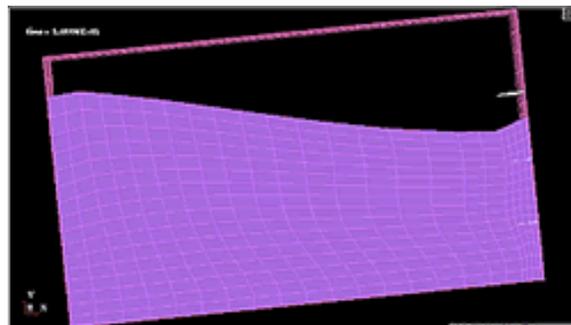A Publication for ANSYS Users

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Fluid Solid Interaction

Modeling Spilt Milk

- The Multiphysics capability of ANSYS is crucial to industries where more than one physics type is involved. This occurs in many combinations, but we will look at the specific case of Fluid / Structure Interaction.
- Sometimes you can not answer your design questions with single-physics modeling.
  - When interaction between physics is strong, ANSYS Multiphysics capability is of great value.
    1. Fluid flow deflects structure
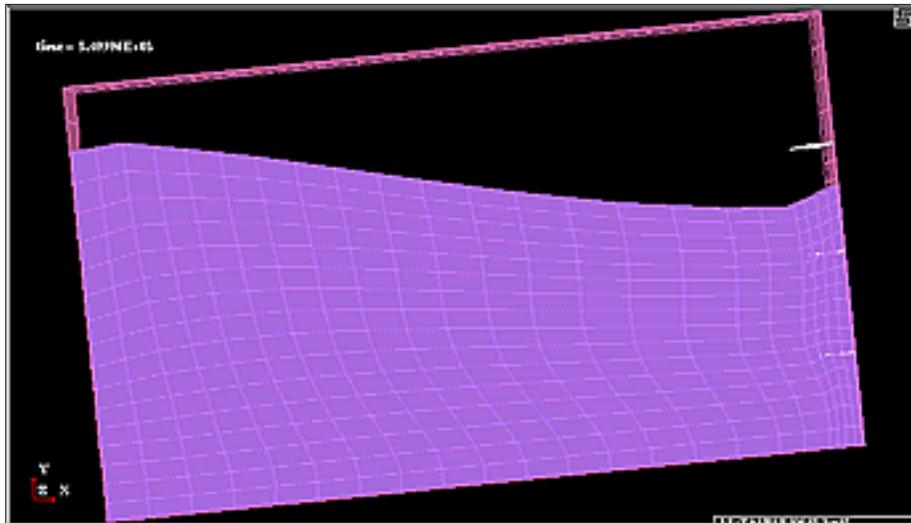   2. Structure deflection affects fluid flow
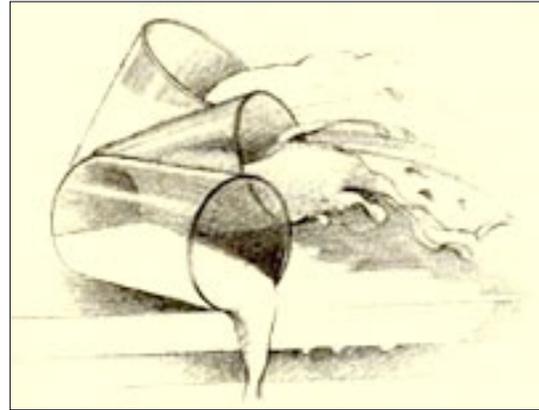
Fluid Solid Interaction in ANSYS

- Called Load Vector-Coupling in ANSYS
- Involves use of FLOTRAN to solve fluid portion
- Now a time dependent analysis
  - Iterate on each time step before advancing
- Big Change in 6.1: fluid and solid meshes need not match!

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Things to Think About First

- Disk Space
  - ❍ You need to store a lot more data
    - ■ More DOF s
    - ■ Larger Model
- Model Size & Run Time
  - ❍ Sequential or iterative, run time can kill you
- Convergence
  - ❍ Difficulty in converging within a physics will cause problems converging between physics
- UNITS!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
  - ❍ Most common mistake is mismatch of units
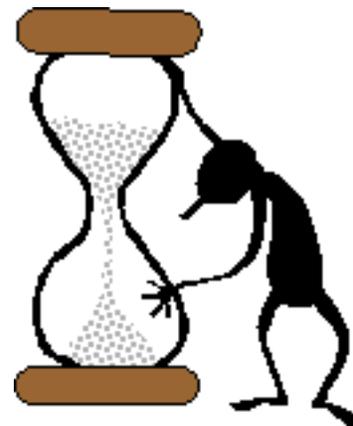
The Fluid/Solid Mesh Interface

- Meshes usually don t match up
  - ❍ Fluid and solid mesh requirements are very different
  - ❍ This forces interpolation across boundary

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- Two interpolation methods:

Interpolation Method	Fluid to Solid Load Transfer	Solid to Fluid Transfer
Conservative	Force in the 3 coordinate directions	Displacements
		Mesh velocities
	Heat rate	Temperatures
Non-conservative	Force density in the 3 coordinate directions	Displacements
		Mesh velocities
	Heat flux	Temperatures

- You need two sets of geometric entities and two sets of nodes at boundaries
  - **Do not merge geometry or nodes at interface!**

Process for FSI Analysis

1. Setup the fluid and solid analyses
   - Do this as if they were separate solutions minus loads at interface
2. Flag fluid-solid interfaces
   - Assign FS numbers using SFx family of commands in each model
3. Specify the fluid-solid interaction solution options
4. Obtain the solution
   - Simply use solve, ANSYS handles the rest

Setting Up the FSI Solution

1. Specify basic information
   - `FSAN` to turn on FSI
   - Set solution order with `FSOR`
     - `FLUID,SOLID` or `SOLID,FLUID`
     - Order should be determined by driving physics
   - Establish static or transient with `FSTR`
   - Use `FSIN` to establish interpolation methods
2. Specify time controls
   - `FSTI` specifies end time

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- ■ Should be multiple of time steps
  - ❍ `FSDT` specifies FSI time steps
    - ■ Must also specify FLUID and SOLID times with `DELTIM` and `FLDATA4,TIME,STEP`
    - ■ These steps must be smaller than the FSI step
3. Specify iterations
   - ❍ Use `FSIT` to specify maximum number of stager iterations
   - ❍ Will iterate on FSI solution until number of iterations is met or load values converge
4. Specify convergence
   - ❍ Use `FSCO` to specify convergence norm for quantities transferred across fluid-solid interface
   - ❍ Convergence is normalized:
     - ■ Conv = log (μx/μmin)/(log μmax/μmin)
     - ■ You specify μmax
5. Set output frequency
   - ❍ `FSOU` specifies every step or every Nth step
6. Specify relaxation
   - ❍ `FSRE` of 1 does not allow any relaxation
   - ❍ Need to play with this for your problem to get a feel for it

Notes on FSI

- ● Are you sure you need FSI?
  - ❍ Is coupling one-way or not important?
  - ❍ Oftentimes you can run a CFD analysis first, then put the loads on your static structural
- ● Crawl...walk...run
  - ❍ Analyses can get very long, so try to set up simple test cases to get the process down
  - ❍ Get static and fluid parts running by themselves first
- ● Convergence of static and fluid solutions are critical

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- ❍ FSI part won t solve if static or fluid are unstable
- Try to avoid remeshing of fluid area
  - ❍ Can slow down things a lot because new mesh needs to converge
- Try to simplify in 2D
- Learn more about Multi-Physics analysis!
  - ❍ PADT [training classes](#) make things easier
    - ■ [Flotran I](#) (including basic FSI): April 14-16
    - ■ [Flotran II](#) (more FSI): May 19-20

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The New *Solutions* E-Zine

by Rod Scholl

ANSYS Inc. has moved their periodical on-line. The *Solutions* magazine is now an E-Zine. This will be nice for many users, since the hardcopy versions were somewhat difficult to come by. Now one only needs a subscription via email. To subscribe to this quarterly publication, simply go to the login page, click the new member link, and fill in the registration form.

The look and feel is very slick. The content seems to be similar to previous issues. Typically, it highlights some of the new ANSYS products, demonstrates use of ANSYS in industry, and usually includes a technical article about using ANSYS.

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Fuel Your Expertise at Lunch Seminars

by Rod Scholl

At PADT s free monthly seminars you will see FEA users from the entire region   as well as many PADT employees   keeping up with the latest ANSYS enhancements. These lunch seminars are a fast way to learn volumes about using ANSYS. The topics are usually presented by Eric Miller, and vary from demonstrating new ANSYS features/products to in-depth technical coverage of analysis techniques, both old and new. In short, this is where many users pick up all that knowledge that helps them feel ahead of the game.

The tentative schedule for the remainder of 2003 is shown in the table below. Please see the Seminar Series page for the most current details on schedule, directions, and contact information.
To attend any of our seminars, simply send an RSVP to Samantha, or call her at (480) 813-4884.

Seminar Schedule

Mar 19, 2003 ANSYS Environment & ANSYS NASTRAN	Sep 24, 2003 Probabilistics and DFSS with ANSYS
Apr 16, 2003 Workbench	Oct 22, 2003 ANSYS Post Processing
May 22, 2003 ANSYS Material Nonlinearities	Nov 12, 2003 ANSYS 8.0 Overview
Jun 18, 2003 Fatigue and Reliability	
Jul 23, 2003 Tables, Equations, Mapping, and Interpolating	
Aug 20, 2003 Simulation for Electronics	

More to come...

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About *The Focus*

The Focus is a periodic electronic publication published by PADT, aimed at the general ANSYS user. The goal of the feature articles is to inform users of the capabilities ANSYS offers and to provide useful tips and hints on using these products more effectively. *The Focus* may be freely redistributed in its entirety. For administrative questions, please contact Rod Scholl at PADT.

The Focus Library

All past issues of *The Focus* are maintained in an online library, which can be searched in a variety of different ways.

Contributor Information

Please don t hesitate to send in a contribution! Articles and information helpful to ANSYS users are very much welcomed and appreciated. We encourage you to send your contributions via e-mail to Rod Scholl.

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