Universal Analytics, Inc.
Product Status

Presented to

NASA Goddard Space Flight Center

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Presentation Outline

- Overview of UAI/NASTRAN Version 20.0
- Overview of UAI/NASTRAN Version 20.1
- Plans for UAI/NASTRAN Version 20.2
- Plans for UAI/NASTRAN Future Versions

Overview of Version 20.0

- New Version Numbers
- NASTRAN Enhancements

New Version Numbers

- UAI's database technology, eBase, has become the core I/O system for several products:
  - UAI/NASTRAN
  - ASTROS
  - RenderMaster
  - eShell
- Synchronization of product ID numbers leads to Version 20

NASTRAN Enhancements

- Efficiency improvements
- Major new features
  - Nonlinear geometry
  - Flutter analysis
  - Engine head gasket analysis
  - Fluid/structure interaction with component mode synthesis
  - Design optimization with fluid pressures

NASTRAN Enhancements

- Efficiency improvements
  - New Boeing solver release with improved FBS
  - Reduced memory requirements
  - New “graphing” sequencing algorithm for 3x or more speedup of large, solid element models
  - Hardware based optimization speedup of 2x for the Boeing solver on HP PA8000
  - Hardware based optimization speedup of 2x for the Boeing solver on SGI R10000

NASTRAN Enhancements

- Nonlinear geometry
  - Full large deflection, large rotation features
  - Simultaneous support of nonlinear material behavior, including gap elements
  - Follower forces for pressure loading
  - Arc length solution technique implemented
  - 2nd order tetra element supported for all nonlinear solutions

Overview of Version 20.1

- Major new features
  - Modal Reduction in SOL MULTI
  - Multiple DMIG Input
  - Modal Participation Factors
  - Equivalent Beam Forces

Modal Reduction

- Purpose - automatically compute a reduced model - mass and stiffness matrices - stored in DMIG form, using boundary degrees of freedom and either
  - An automatically computed a-set of physical dofs, or
  - A generated set of generalized, modal dofs

Modal Reduction - Guyan Reduction

- Case 1 MODES - create a baseline set of modes
- Case 2 REDUCE
  - USING MODES = 1
  - AUTOREDUCE command
  - BOUNDARY command
  - SPC command
  - EXPORT REDUCED MODEL command
- Note, the previous AUTOREDUCE command is renamed NLREDUCE

Modal Reduction - MREDUCE

- Case 1 MREDUCE
  - METHOD command
  - BOUNDARY command
  - SPC command
  - EXPORT REDUCED MODEL command
- Note, the EXPORT command has options for controlling DOF ID re-numbering

Multiple DMIG Input

- Feature developed to allow multiple component modal models to be integrated into a new system model
  - Case Control
  - K2GG = (K1, K2, K3, … Kn)

Modal Participation Factors

- Help structural dynamics engineers understand
  - Which modes define the response of any selected grid point
  - What is the frequency content of response
  - What are the important modes in a structures' response

Modal Participation Factors

- The requirement - compute modal participation factors in modal frequency response analysis
  - For displacement, velocity and acceleration responses
  - At specific excitation frequencies
  - For a selected Subcase(s)

Modal Participation Factors

- Modal summation
  - The physical response of a DOF is expressed with the matrix equation:

$$u_i = \Sigma \Phi_{ij} * \zeta_j$$

  - Where u_i is the total response of the i^{th} DOF
  - Φ_{ij} are terms in the mode shape matrix
  - ζ_j is the modal displacement

Modal Participation Factors

- Modal summation
  - A contribution towards u_i, u_{ij}, may be computed for each mode j
  - Therefore, $u_i = \Sigma u_{ij}$

Modal Participation Factors

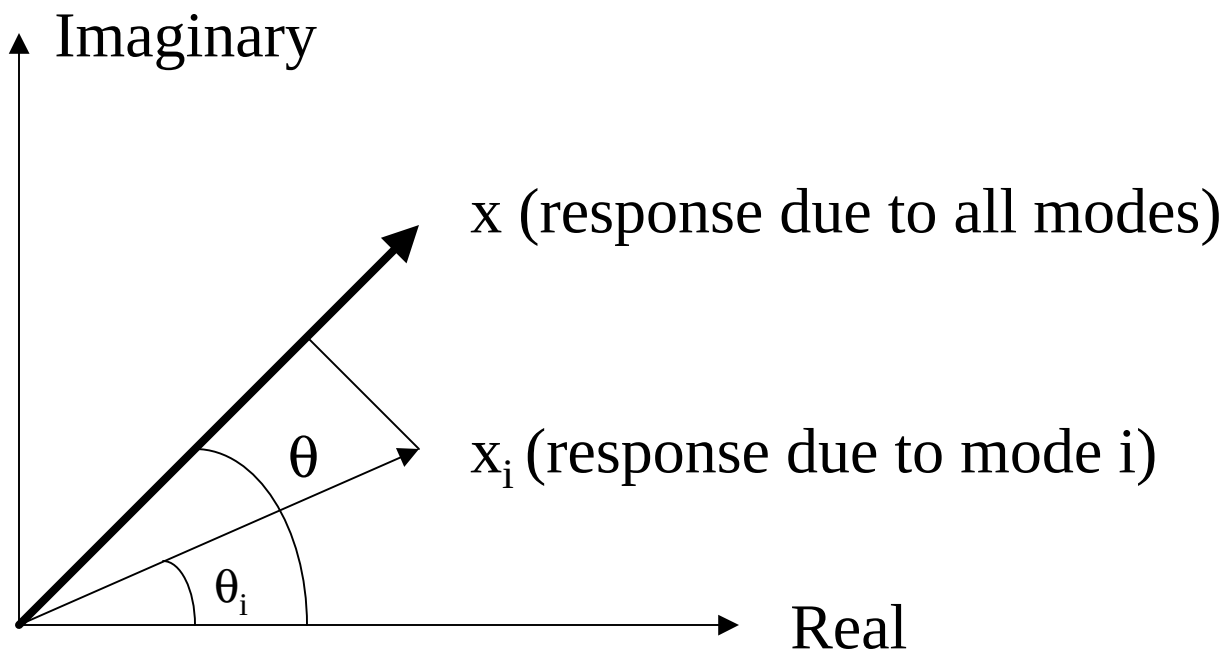
- The definition of Modal Participation Factor (MPF) is
  - For each u_i (at either a given frequency of excitation or time step, depending on the type of analysis), and for each mode j, the MPF is the quantity u_{ij}

Modal Participation Factors

- For transient response, u_i and u_{ij} are real numbers and the MPF calculation is straightforward
- For frequency response, u_i and u_{ij} are complex numbers and the MPF calculation is defined in a special way...

Modal Participation Factors

- For complex (frequency) responses



Modal Participation Factors

- For frequency response, the MPF is computed as the projection of response in any given mode on the total vector response

Modal Participation Factors

- Operational procedures
  - Perform a modal frequency response analysis using UAI/NASTRAN
    - » Utilize required Case Control commands
  - Execute program ‘MPF’
    - » Interactively select data for MPF calculations

Modal Participation Factors

- Execute UAI/NASTRAN with:
  - Executive Control
    - » Sol 11 (Modal Frequency Response Analysis)
  - Case Control
    - » The following commands must always be included:
      - ARCHIVE $ Request creation of an archive database
      - DISPLACEMENT = ALL or sid
      - SDISPLACEMENT = ALL
  - Bulk Data
    - » Normal input, no special MPF input data

Modal Participation Factors

- Execute program MPF consisting of a c-shell script named ***MPF*** and an executable program named ***modal_ufact***

Modal Participation Factors

- The following data are required to execute
  - Database name (*filename*) created in a SOL 11 run
  - Number of enforced motion DOF
    (0 if no enforced motions)
  - CASE ID (subcase number from Case Control)
  - GRID ID
  - COMPONENT ID (1-6)
  - Response type factor (1=Disp, 2=Velo, 3=Acce)
  - Excitation frequency value

Modal Participation Factors

- Sample output from program MPF

Displacement Participation Factors

****** TOTALX, TOTALY, TOTALN ******
0.1516E+04 -0.1590E+03 0.1524E+04

****** MODE,**	**COMPONENT ******
1	**1.4506E+03**
2	**1.0079E+02**
3	**-1.9844E-13**
4	**-2.6895E+01**
5	**3.4756E-14**

Modal Participation Factors

- Modal participation factors are computed for modal frequency response analysis
- Modal participation factors quantify the participation of each mode in the structural response
- The procedure is efficient and easy to use
  - Only one UAI/NASTRAN run required
  - Interactive access to MPF calculations

Plans for Version 20.2

- Analysis/Test reconciliation solution
- Parallel operation using substructuring
- Substructuring enhancements including LTMs and residuals
- Nonlinear enhancements, including contact surface modeling
- Design sensitivity and optimization user interface enhancements

UAI/NASTRAN Future Versions

- User access to APEX
- HEXAR, PENTAR, TETRAR elements
- Interface element
- Other features based on customer issues and requirements