NASA DATA EXCHANGE STANDARDS FOR COMPUTATIONAL FLUID DYNAMICS

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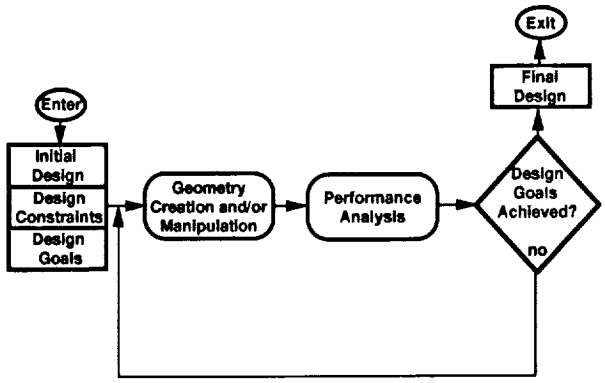
Overview

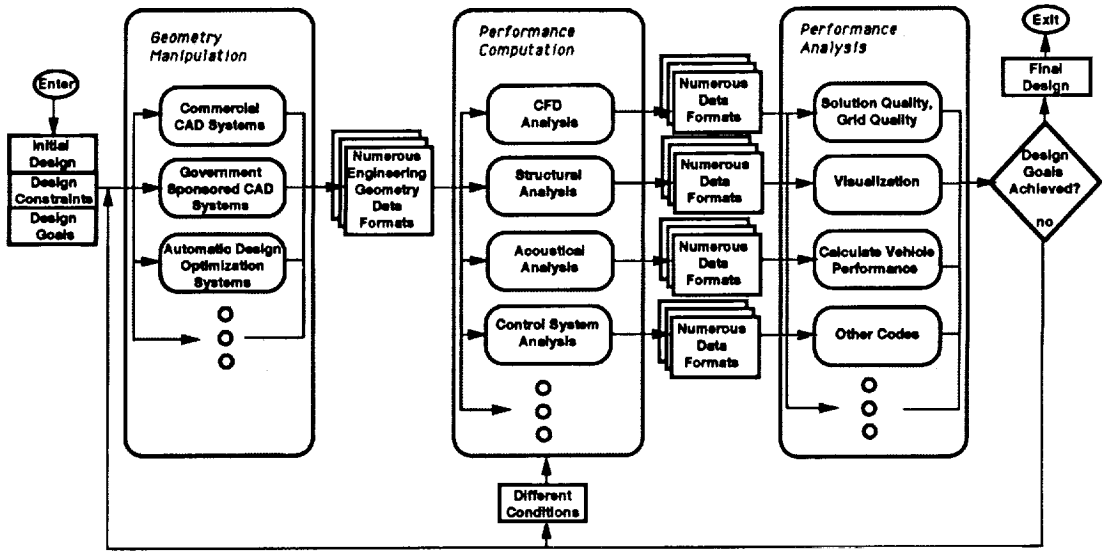
- Purpose of Data Exchange Standards
- Data Exchange in Engineering Analysis/CFD
- Geometry Data Exchange:
  - Existing Product Data Exchange Standards
  - NASA Data Exchange Committee
  - NASA-IGES
- CFD Grid and Solution Data Exchange
- Data Exchange for Multi-disciplinary Engineering

Purpose of Data Exchange Standards in Engineering

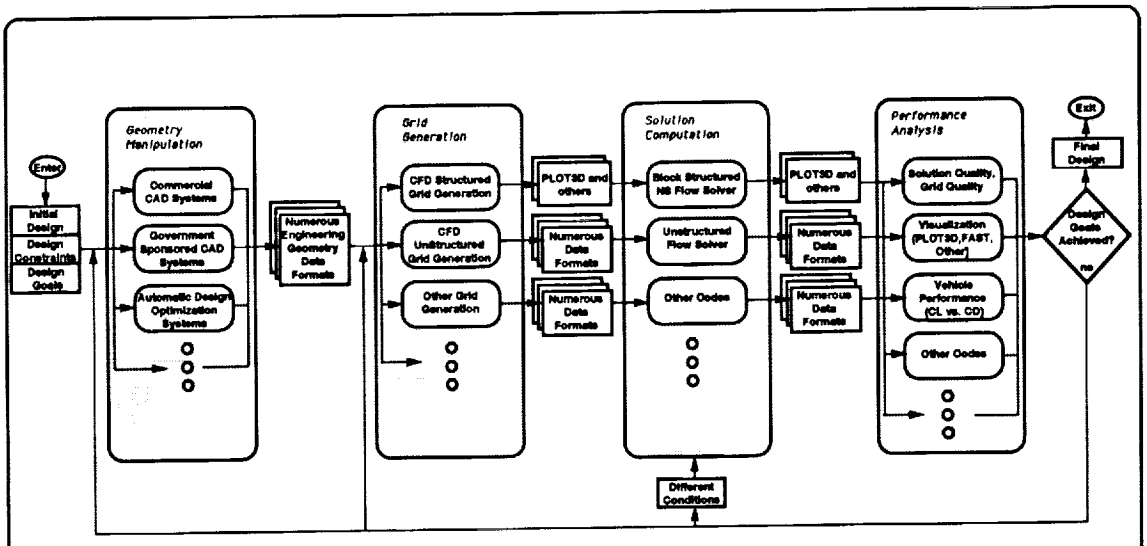
To provide a rapid and accurate method for exchanging data between different engineering processes



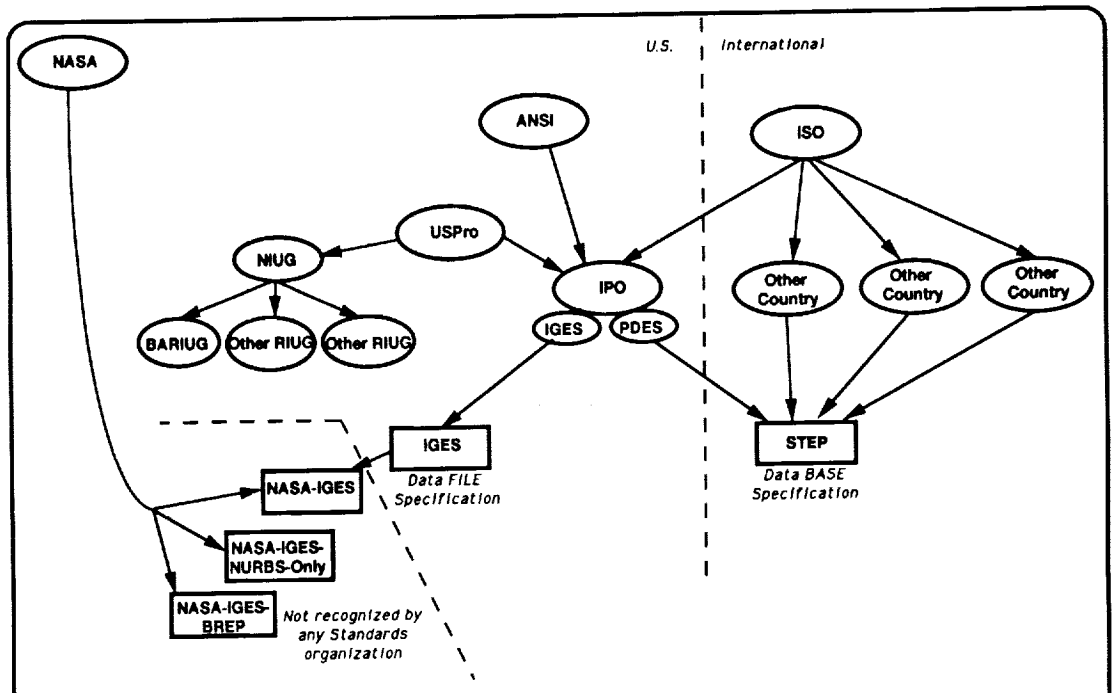
ENGINEERING ANALYSIS IN THE DESIGN CYCLE



ENGINEERING ANALYSIS IN THE DESIGN PROCESS



ENGINEERING DESIGN PROCESS COMPUTATIONAL FLUID DYNAMICS



U.S. and International Standards Organizations Related to Product Data

US & International Standards Organizations and Acronyms Related to Product Data

Organizations:

ISO	International Standards Organization
ANSI	American National Standards Institute
USPRO	U.S. Product Data Association
IPO	IGES / PDES Organization
PDES	Product Data Exchange Using STEP
NIUG	National IGES User Group
BARIUG	Bay Area Regional IGES User Group

Documents:

IGES	Initial Graphics Exchange Specification
STEP	Standard for the Exchange of Product Data
NASA-IGES	NASA subset of IGES
NASA-IGES-NURBS-Only:	NURBS only subset of NASA-IGES
NASA-IGES-BREP:	NURBS only geometry with B-Rrep topo. info
Superpatch	same as NASA-IGES-BREP

Other:

NURBS	Non Uniform Rational B-Splines
B-rep	Boundary Representation method for geometry topology

IGES Description

- Currently the most widely used method for product data exchange (including geometry)
- Large data file specification for all product information, superset of info, many ways to represent one item
- Version 4.0: Supported by all(?) CAD vendors
- Version 5.1: Current, supported by many vendors, includes NASA-IGES entities
- Version 5.2: Includes Open Shell (B-rep) in "grey pages", no vendor support yet, due out middle 1993
- Version 6.0: Final version, due in 1994

NASA Geometry Data Exchange Subcommittee Activities

- Formed May, 1991, by NASA Steering Committee, includes personnel from Ames, Langley, & Lewis
- Surveyed CFD geometry requirements and existing geometry data exchange standards
- Selected a subset of IGES for CFD users
  - Focus is on NURBS based geometry
  - Added Geometry Topology Info to help automate grid generation
- Released draft NASA-IGES Specification on 9/30/91, final draft in October 92, NASA Reference Publication due out in 1993

NASA Geometry Data Exchange Subcommittee Activites (cont)

- All three Centers committed to utilizing NASA-IGES, some current activities include:
  - Lewis personnel developing Test Plan, test data, and code to generate NURBS from point data
  - Langley personnel developing and testing IGES test data
  - Ames personnel developing test cases and code to translate general IGES files to NASA-IGES files
  - All three Centers coordinate activities on a regular basis

NASA Geometry Data Exchange Specification for CFD (NASA-IGES)

- Written for use by CFD scientists and engineers as well as CAD vendors
- Includes mathematical formulation of each type of geometric representation
- Includes an abstract representation of the database requirements for each entity
- Appendix contains the IGES protocol for NASA-IGES and NASA-IGES-NURBS-ONLY

Geometry Topology: NASA-IGES-BREP / Superpatch

- Provides connectivity/topology information for the curve and surface geometry entities
- Allows grid generation software to traverse the geometry so the grid can be constructed independent of surface layout choices made by the original designer
- Supplies important information for development of automated grid generation software
- Similar to Boundary Representation (B-rep) solid modeling technique

NASA-IGES ENTITIES

- NASA-IGES-NURBS-ONLY Geometry Entities:
  - Entity 126: Rational B-Spline Curve
  - Entity 128: Rational B-Spline Surface
  - Entity 141: Boundary
  - Entity 142: Curve on a Parametric Surface
  - Entity 143: Bounded Surface
  - Entity 102: Composite Curve
  - Entity 124: Transformation Matrix
- Other Geometry Entities Allowed in NASA-IGES:
  - Entity 100: Circular Arc
  - Entity 104: Conic Arc
  - Entity 106: Copious Data
  - Entity 110: Line
  - Entity 116: Point
- Non-Geometry Entities:
  - Entity 0: Null Entity
  - Entity 212: General Note
  - Entity 308: Subfigure Definition
  - Entity 314: Color Definition
  - Entity 402: Associativity Instance
  - Entity 406, Form 15: Name
  - Entity 408: Singular Subfigure Instance

NASA-IGES-BREP ENTITIES

- Topology Entities:
  - Entity 186: Manifold Solid B-Rep Object
  - Entity 514: Shell, Closed and Open
  - Entity 510: Face
  - Entity 508: Loop
  - Entity 504: Edge List
  - Entity 502: Vertex List
- Geometry Entities:
  - Entity 126: Rational B-Spline Curve
  - Entity 128: Rational B-Spline Surface
  - Entity 102: Composite Curve
  - Entity 124: Transformation Matrix
- Non-Geometry Entities:
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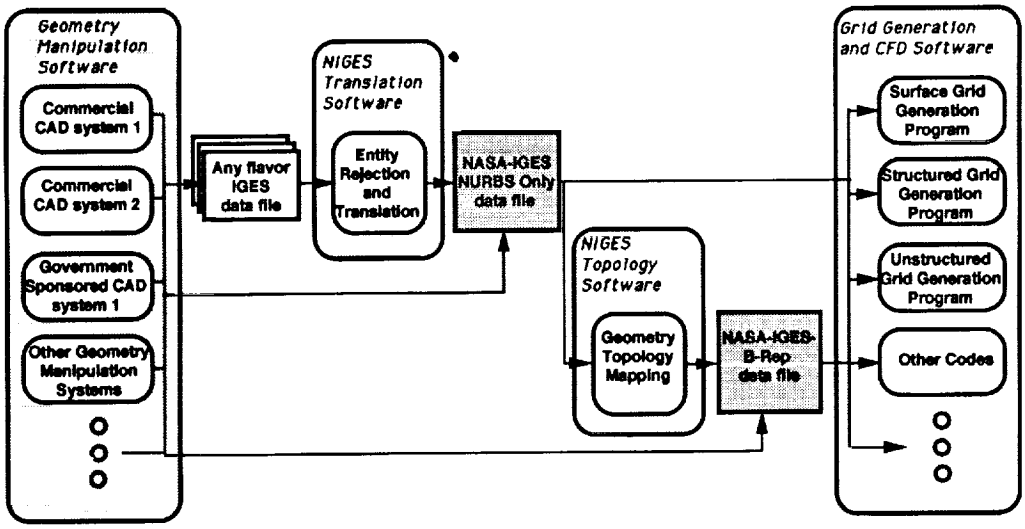
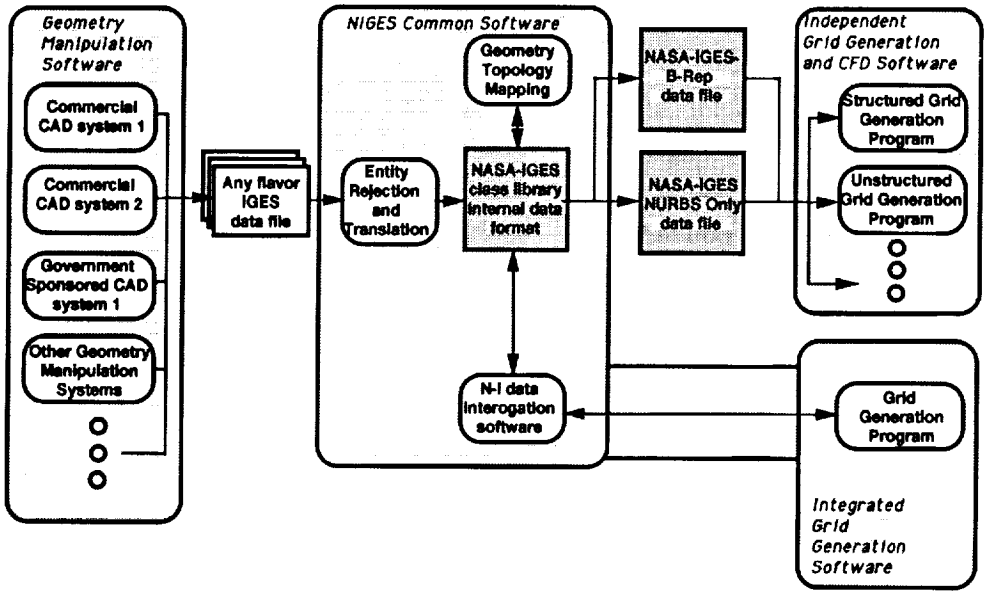
  - Entity 406, Form 15: Name

CFD Geometry Data Exchange Utilizing NASA-IGES and NASA-IGES-BREP Data Files



CFD Geometry Data Exchange Utilizing NASA-IGES and NASA-IGES-BREP Data Files and Class Library

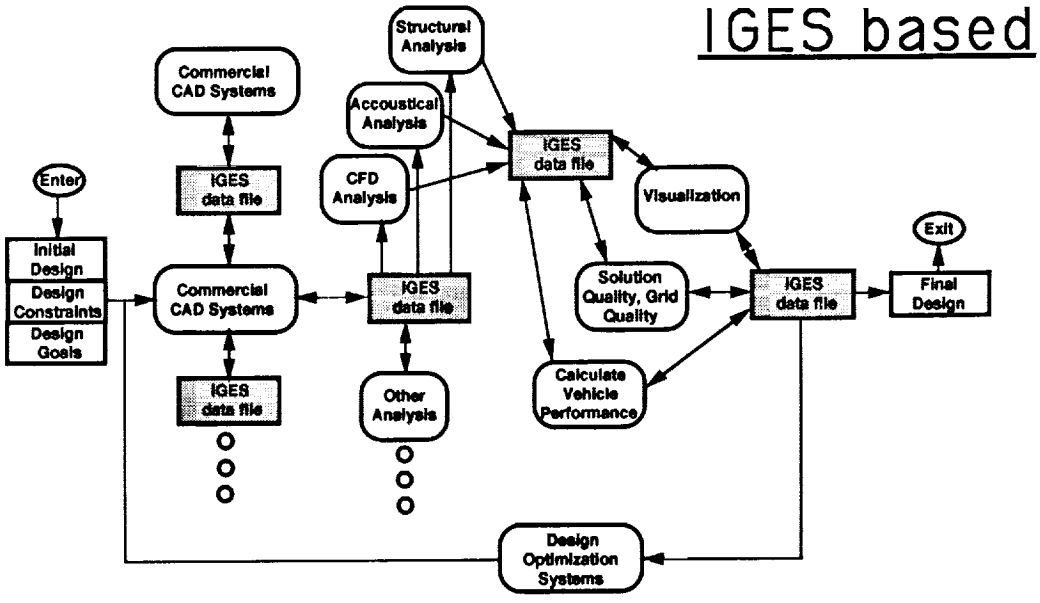


CFD Grid & Solution Data Standards: Design Goals

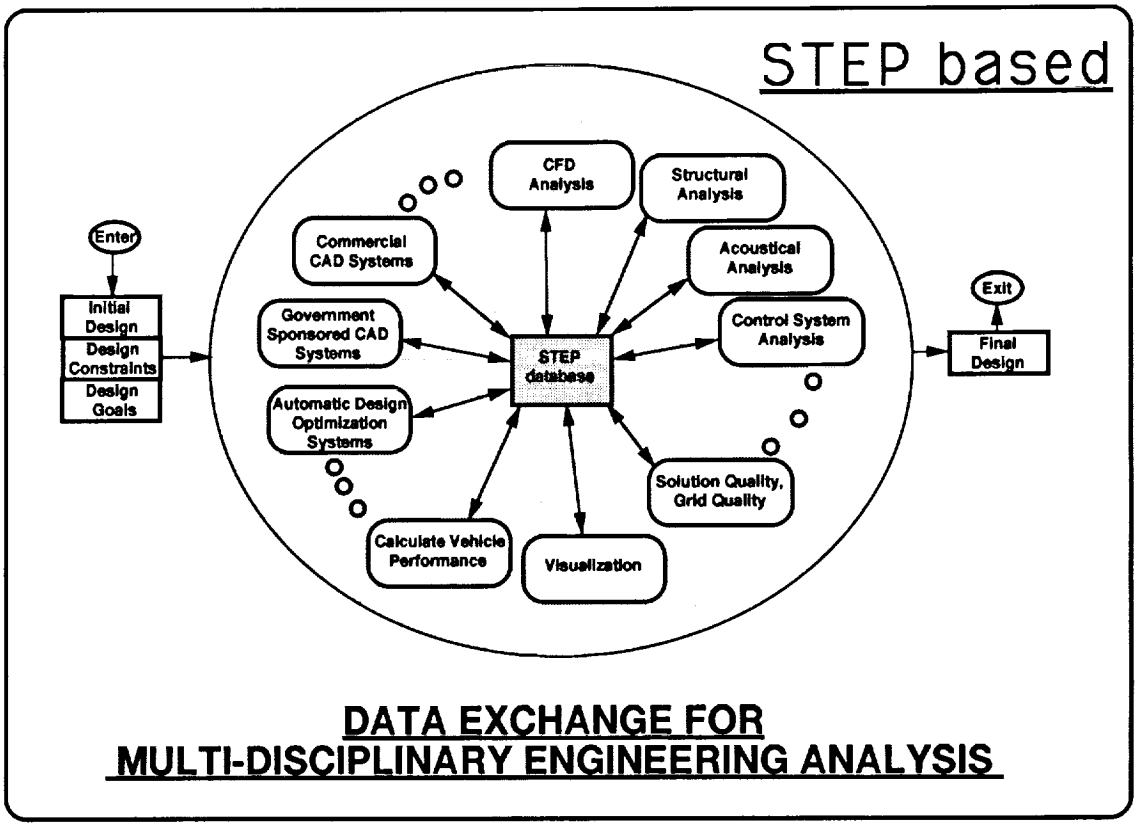
- **Include enough information to reconstruct connectivity information used by any specific application**
  HELP>>> Fill in the supplied table or provide documentation of your grid & solution data requirements
- **Insure reasonable space efficiency:**
  - **Disk space vs. ease of use**
    HELP>>> My calculations show Unstructured Grid Formats require 10 - 20 times the storage space of structured. If you disagree, describe your assumptions and calculations
  - **ASCII vs. binary**
    HELP>>> Why stick with ASCII? IEEE binary?

CFD Grid & Solution Data Standards: Design Goals (cont.)

- **Select a format that is compatible or expandable for multi-disciplinary analysis:**
  - **Surface data only?**
    HELP>>> This is what CFD would exchange with a structural analysis package, why ship more?
  - **Linked to the geometry?**
    HELP>>> Required for accurate surface grid adaption
  - **Which other disciplines?**
    HELP>>> Structures, Controls, Thermal, ????



DATA EXCHANGE FOR MULTI-DISCIPLINARY ENGINEERING ANALYSIS



How To Help (or Get Help) on NASA Data Exchange Standards

- To get on the email foum for Grid Generation contact: siggrid-request@nas.nasa.gov (or my email below)
- To get a draft copy of the "NASA Geometry Data Exchange Specification for CFD" (NASA-IGES) contact me
- To assist with Grid & Solution Data Exchange Standards, fill out a data requirements sheet for your software (available at the back of the room) or provide documentation of your requirements, send to me
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