ISO 10303-209 Edition 2 – Multidisciplinary Design and Analysis

Background and Capabilities

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High Level Overview and Background

The second Edition of ISO 10303-209 (AP209 ed2 – now renamed Multidisciplinary analysis and design) has integrated a generic Engineering Analysis capability complimented by specific Computational Fluid Dynamics (CFD) and a generalized mesh based numerical analysis capabilities to the AP209 ed 1 classical Finite Element Analysis capabilities.

The AP209 ed2 CFD capability is based upon the NASA/AIAA Computational Grid Neutral System (CGNS) standard and the Volvo Aero Engineering Analysis Results (EAR)-model work. The generalized structured and unstructured analysis and mesh capabilities in AP209 ed2 are based upon work done in the Generic Engineering Analysis Model (GEM) project from the European Union. In addition there is a complete discrete/continuous mathematical field representation capability that has been added to AP209 ed2 based upon the David Talyor Labs/Boeing DT-NURBS package.

All these capabilities are in turn layered upon the ISO 10303-203 ed2 Configuration controlled 3D design of mechanical parts and assemblies, which provides capabilities for product identification and therefore Product Lifecycle Management (PLM), product shape representations from basic wireframe to full b-rep solids with Geometric Dimensioning and Tolerancing (GD&T), composite material structure and shape, and the presentation of both 2D drawings and 3D shapes.

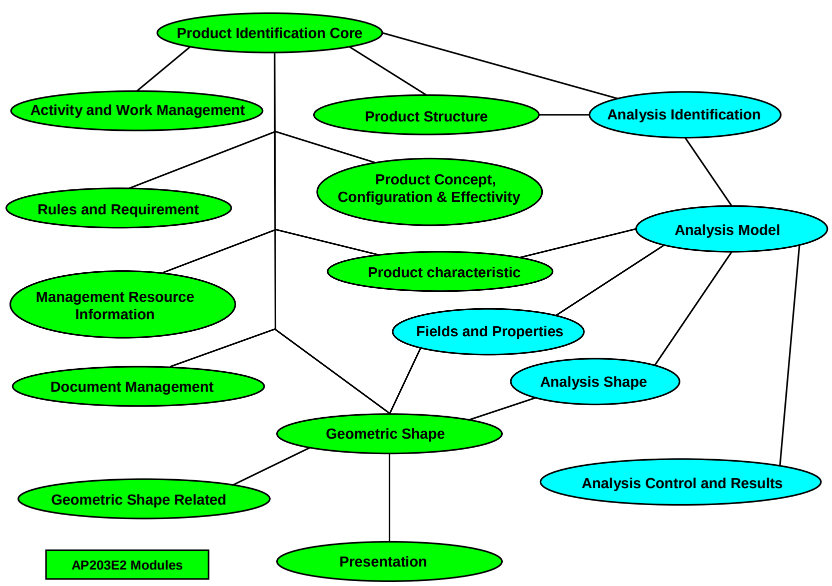

Figure 1. ISO 10303-209 ed2 High Level Overview

Detailed Capabilities and Rationale

Product Identification and PLM

The management of numerical analysis models and associated related analyses and shape information brings a new set of requirements to PLM of product data. Ap209 ed2 adds the capability to manage analysis product information with respect to the more usual design product information such as CAD and lightweight visualization models.

A critical aspect of this relationship that AP209 ed2 provides between Design and Analysis PLM is a capability that addresses the issue that the Analysis world typically iterates much faster than the design world. This is address by providing a relationship between Design and analysis versions of product data, rather than simply managing Analysis PLM data as just another set of files in the Design PLM product structure tree.

Classical Finite Element Analysis

To address the need to share Finite Element Analysis (FEA) information AP209 provides a capability to represent FEA model, boundary condition, and results information typical of that found in commercial tools. This includes first, second, and third order element types and associated properties, isotropic and anisotropic material properties that may be associated with composite structure laminate tables, and a very complete set of constraints and scalar/vector/tensor responses for nodes and elements.

All FEA model information may be related to geometric shape information. This may be done both at a high level (such as a based upon relationship) down to a low level where node locations are specified by world or parametric coordinate, and element aspects such as edges and faces shared with like types of geometry. Mesh properties may be applied to geometry independent of a mesh if required by a business process.

Computational Fluid Dynamics

The Computational Fluid Dynamics (CFD) capability for AP209 ed2 CFD provides both structured and unstructured meshes. Both types of meshes may be related to the classical FEA mesh representations by sharing field information between them. The relationships between meshes do not provide the mechanism for the interpolation of the field information, only the resulting fields for each mesh (more on this below in the section on the AP209 ed2 field capabilities).

Generic Structured and Unstructured Meshes and Numerical Analysis

The generalized structured and unstructured analysis and mesh capabilities in AP209 ed2 abstract the FEA and CFD problem into a physics neutral format. Associativities to geometry and field information are provided as a basis for the FEA and CFD capabilities. Similarly to the field representation, if there are relationships between 2D and 3D meshes, these are represented by the end states as it is impractical to enumerate all the classes of transformations and mappings between mesh representations.

These meshes are related by a very high level analysis framework that provides the capability to specify the numerical analysis problem. At the highest level this provides as structure to represent both mesh based and other numerical analyses such as lumped parameter/network analyses.

Discrete and Continuous Scalar/Vector/Tensor Fields for Property and Analytical Boundary Condition and Analysis Result Representation

The discrete/continuous mathematical field representation capability of AP209 ed2 provides a multi-dimensional discrete table and a NURBs based continuous multidimensional field representation capabilities. Throughout the development/adaptation of these capabilities there were many discussions which resulted in the decision that since the methods for interpolation vary widely between tools and even organization, resulting in the decision that it is impractical to standardize the mapping mathematics and processes. Instead the ability to represent the results of these mappings/interpolations is provided. This principle is found throughout the architecture of AP209 ed2.

The general field representation capability has been integrated with the mesh representations, and is used exclusively for representing field variables and analytical output. Though the classical FEA information is based upon traditional node and element properties, there is a capability to augment those with the general field capabilities.