Appendix D

Introduction to Simulation Data Management

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Abstract

This presentation will give an introduction to the topic of Simulation Data Management. This is currently a hot topic in industrial areas such as automotive or aeronautics, however, for the space thermal analysis community it is still quite new. The objective of the presentation is to give an overview of the field and to stimulate discussion about how space thermal analysis models could be managed and how the analysis tools could be developed to facilitate this.

An introduction to Simulation Data Management

Peter Bartholomew
(MDAO Technologies Ltd UK)

Background

- Consultancy relating to data management issues across the traditional mechanical engineering disciplines
  - (e.g. structures, thermal, mechanisms, propulsion)
  - and also the link between those disciplines and Systems Engineering
  - includes test results
- Organisational scope potentially includes
  - Specific departments within ESTEC
  - Technical support contractors
  - Deliverables from supply chain companies

Phase I – Discussion with ESTEC

- Capture of requirements
  - review existing methods used for identifying and accessing data – (hidden metadata†)
  - Priority
    - internal processes
    - Interaction with industry
- Existing initiatives to be accommodated
- Relationship with supply chain
  - What is delivered
  - Who owns data and IP
  - Access and Distribution rights

†Metadata = "data about data" *or*
"the things you know about your data"

Phase II – Supply chain companies

- Gain understanding of the data management processes being introduced within industry
  - Where you would see the master data residing
    - Location
    - Software
  - How to apply metadata to information held at remote sites

Phase III – Vendor companies

- Match vendor offerings against requirements

alternatively

- Identify contributing technologies and discuss options with relevant domain experts

Core Requirements

Simulation Data Management

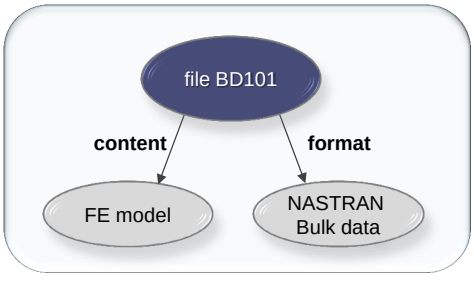
The need to define the SDM domain

- SDM is an emerging technology
- What constitutes SDM was thought to be understood
  - but we rapidly discovered that different people had different understandings of the definition
- High level definition:
  - **Simulation Data Management (SDM)** is a breakthrough technology which uses database solutions to enable users to manage simulation data and processes across the complete product lifecycle
- Capabilities defined under 3 headings
  - Data
  - Access
  - Security and Integrity

Classification of data items

For any data object / file we need to know

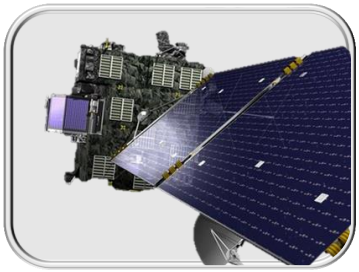
- What it represents – examples being:
  - Shape information of product
  - Pressure distribution over shape
- What format is used
  - STEP AP 203
  - Nastran bulk data
- Administrative: owner, creation date, ILM info.



- Classification is required to identify Data items

Links to product

For each data item links are needed to tie it back to the real world objects it represents:



- For some this will imply a link to PLM
- For others, simulation precedes CAD and the link may be to an SDM object or other business object

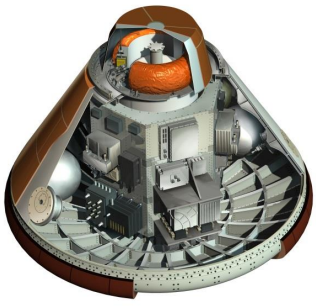
This includes loading environment with the relevant service/test cases recorded

- **Links are required between the simulation and real world objects**

Capture of process

Confidence in an engineering simulation requires an understanding of the process

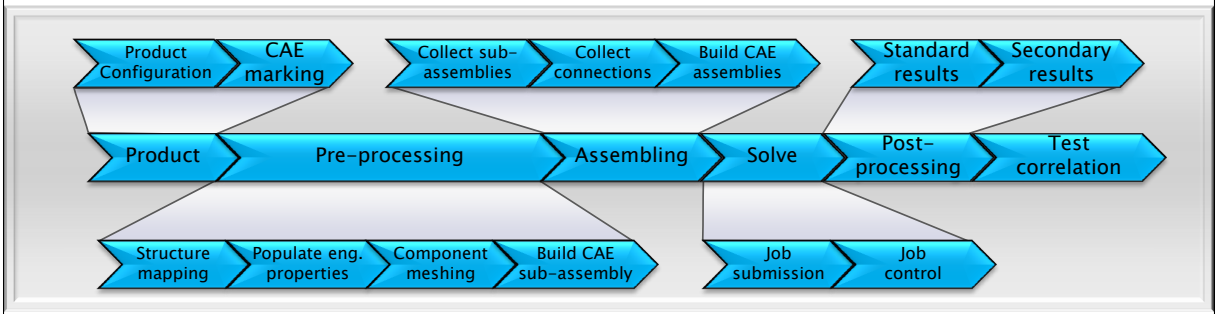
- What codes were used?
- What product (and product configuration) was analysed?
- What loading scenarios were modelled?



- Who performed the analysis?
- What past experience did they have?
- Is there service or test information available for similar products?
- What degree of correlation is achieved with analysis?

Simulation Process

The processes are often complex multi-step sequences



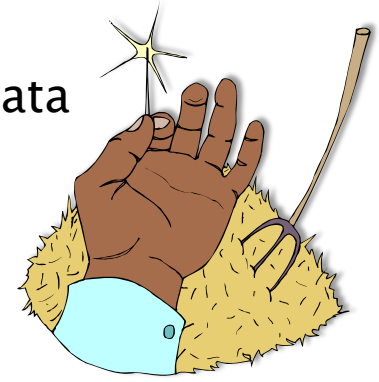
Complex CAE process – Ulrich Fox, Ford
NAFEMS SDM Conference, Frankfurt November 2010

- The process context needs to be recorded
  - to provide an audit trail for verification and
  - to support navigation as a means for search

User access and search

Even if you have annotated data and know what it is…

… can you find it?



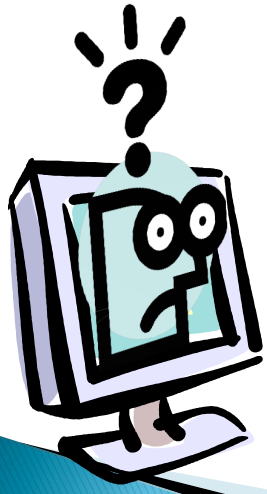
- Both keyword search (metadata & files) and navigation are needed to locate data items

- Both metadata and vaulted data files must be directly accessible to the user

Access – software application

The data management may be expected to underpin higher level functionality

- The metadata must be machine intelligible



Typically this is achieved through building a web of relationships between data objects, including:

- the classes they belong to
- project identifiers
- the processes that created them
- the team conducting the work and their clients

Integrity

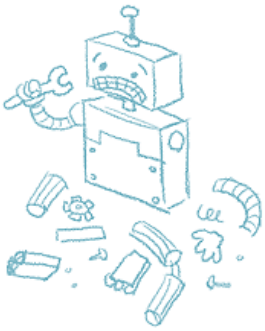
Integrity requirements are standard features of relational databases

Entity integrity

- requires there to be a unique identifier for every information object

Referential integrity

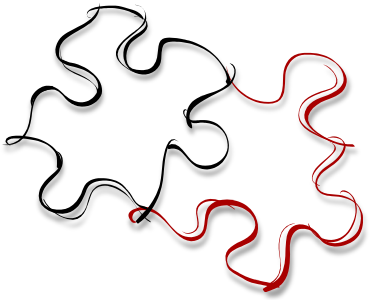
- requires that no references to missing data should exist
- *it is the lack of Referential integrity in the WWW that gives rise to Error 404 (and pain)*



Integrity

To achieve this both data and metadata must only be accessible through the SPDM system

- the user cannot be expected to create unique identifiers
- metadata needs to be protected from uncontrolled deletion to avoid a breakdown of referential integrity



(It will be necessary to delete data objects but essential metadata should be maintained and the policy/authority for their deletion should be recorded)

- The system must ensure its own integrity, in particular entity and referential integrity

Security

Companies will have procedures in place to control the release of their data by denying unauthorised access to data objects

- It is required that an SDM system work within the constraints of corporate security and business rules

(It may be possible to supply an alternative system to many clients provided it offers an equivalent level of security)

Core requirements – summary

Data Items: Metadata

1. SDM needs to manage and classify data items in all CAE formats
2. Data Items need to be linked back to real world objects
3. Process context needs to be recorded

Data Access: Function

4. It should be accessible to human beings *Search*
5. It should be available to software applications *Database*

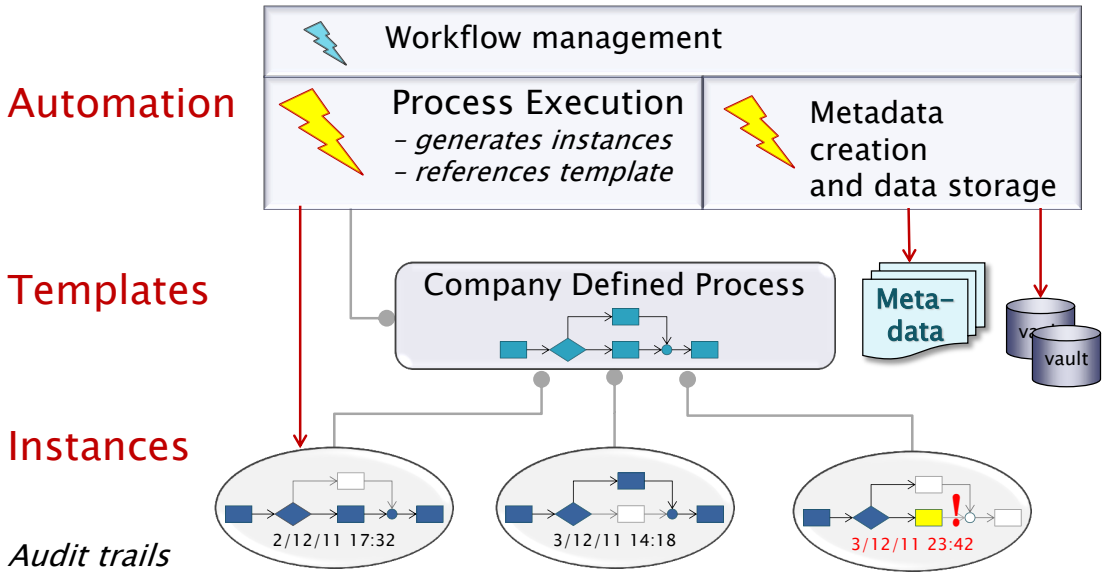
Security & integrity:

6. The system should maintain the consistency of data sets
7. The system must comply with business and security rules

PROCESS

Simulation Data Management

Interpretations of 'process'



Audit trails are tracked at instance level

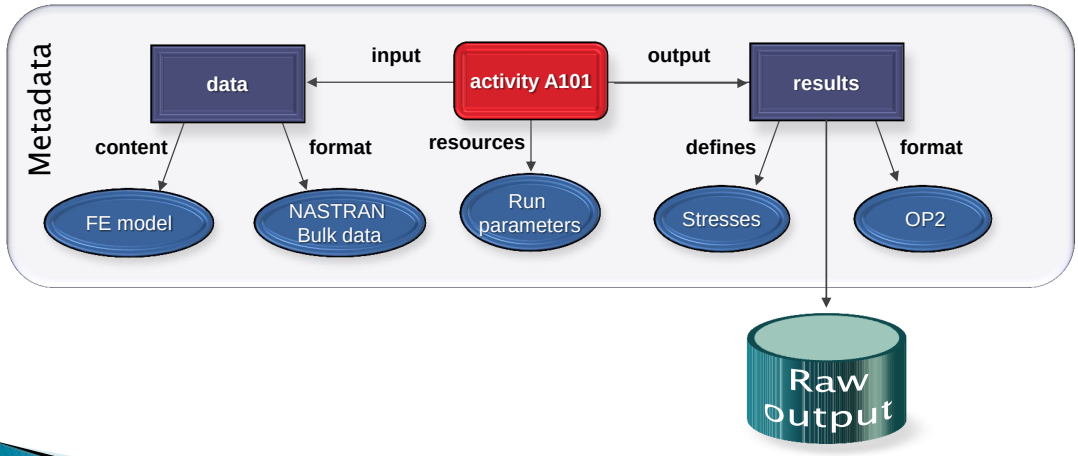
There are many of these
They can exist independent of any template

Even when they are nominally an instance of the process, there may be deviations

Data object and process views

Data Modelling of processes

- 'activities' needs to be represented by full data objects and relationships with their own attributes



Solution Approaches

Simulation Data Management

Solution Strategies

Software packages – compatibility with industry?

1. PLM systems
   - CAD focus with enhancements
2. Simulation Process Data Management systems
   - engineering analysis focus, data and process

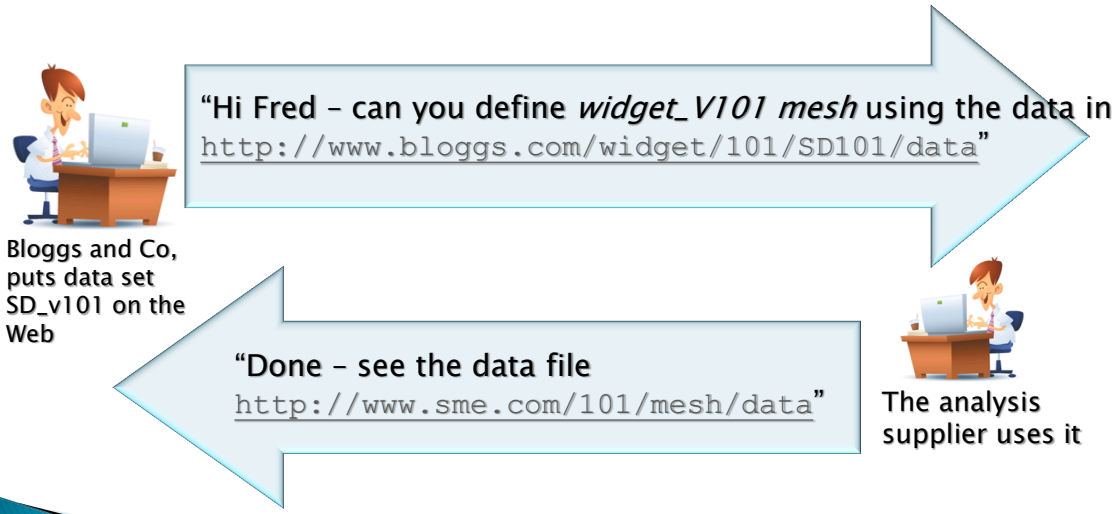
Emerging technology

3. Links between objects defined using Semantic Web technologies
   (the W3C standard for the semantic web uses RDF triples)
   - supports semantic search
   - computer interpretable

Questions?

Web of simulation information

Through a sequence of simple business transactions…



Web of simulation information

… a web of data objects and relationships is built