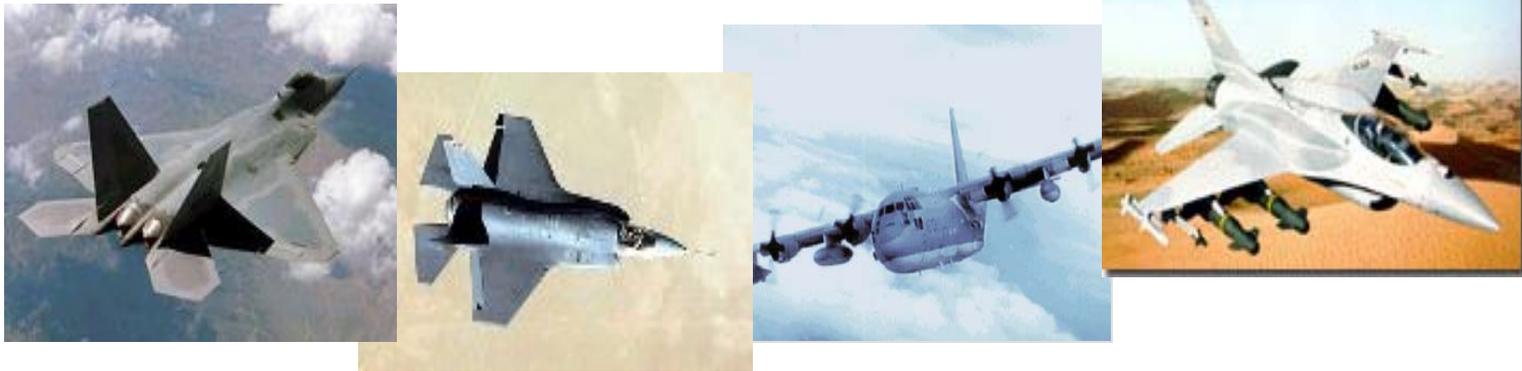# Using Technical Data
for
Program Assessment

Henson Graves

Lockheed Martin Aeronautics
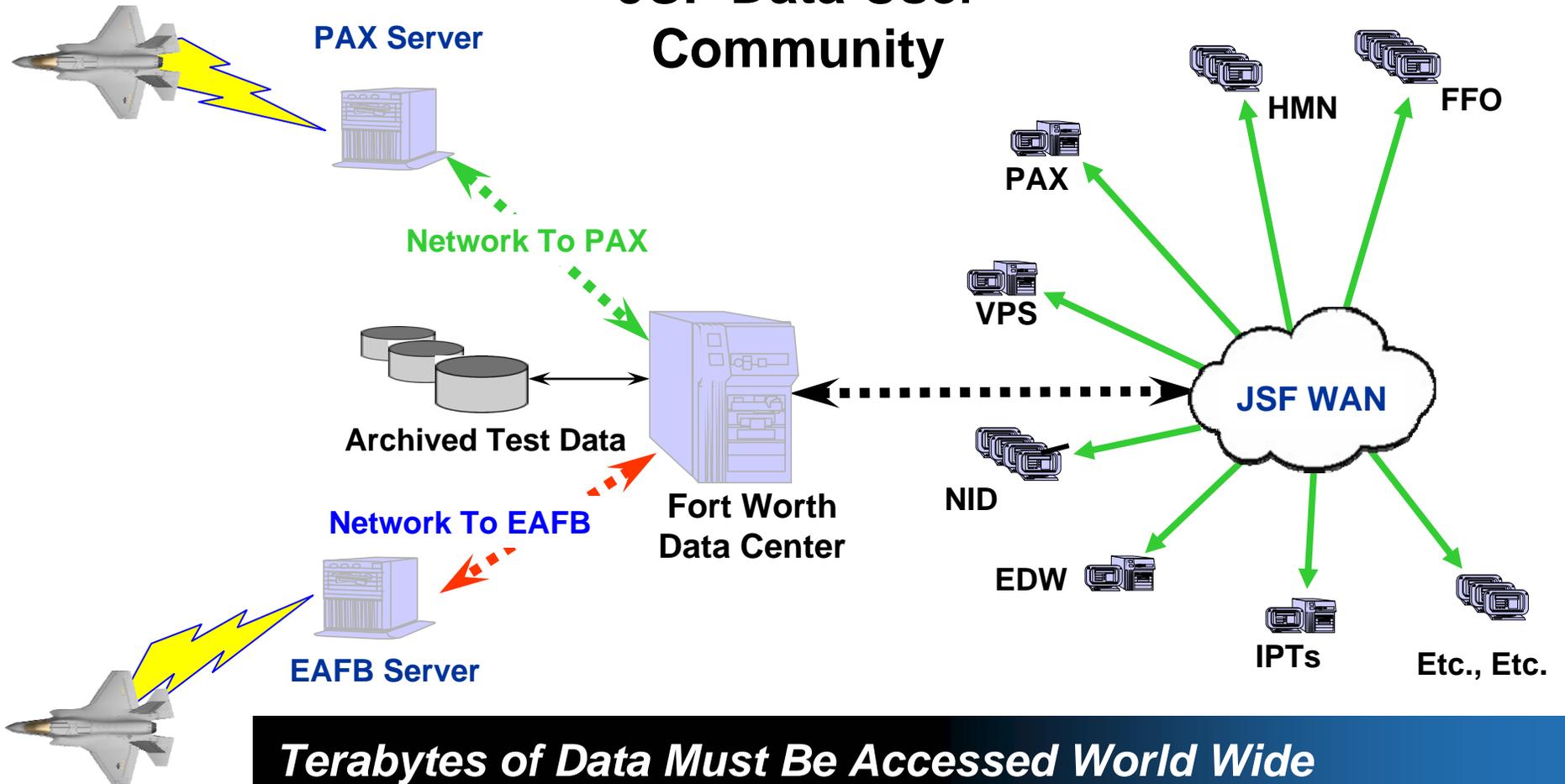**henson.graves@lmco.com**
817.935.5911

Jim Hollenbach

Simulation Strategies, Inc.
jimh@simstrat.com
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Agenda

- **Recap implications of complex product development**
  – Geographical distribution; explosive growth in technical data and management challenges

- **Analyze technical data management infrastructure requirements**
  – Program planning
  – Data production and use
  – Program performance assessment

- **Outline an approach to managing work products**
  – Based on using work product descriptions to specify templates with verification conditions
  – Which enables better evidence-based program performance assessment

- **Challenges**
  – Finding/developing usable technical standards
  – Integration across distributed legacy data repositories
  – Cultural change

- **Where we go from here**
  – Adopting/developing technical data standards

Complex Product Development Environments Are Globally Distributed

JSF Data User Community

PAX Server

Network To PAX

Archived Test Data

Network To EAFB

EAFB Server

Fort Worth Data Center

JSF WAN

PAX

VPS

HMN

FFO

NID

EDW
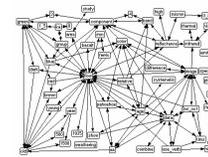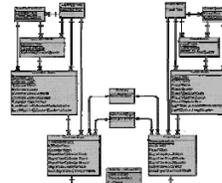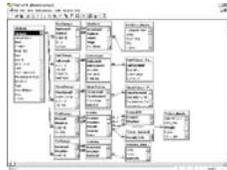
IPTs

Etc., Etc.

Terabytes of Data Must Be Accessed World Wide

Explosive Growth In Digital Data Volume
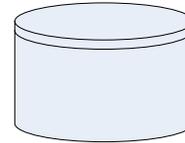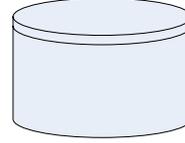
… overwhelms the ability of humans to know where data is, how data is organized, and what it means

Data models & schemas used to organize data
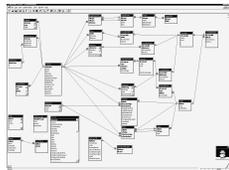
Gigabytes of metadata
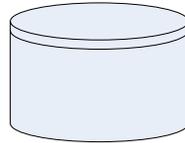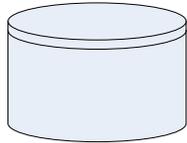
Terabytes of data

The volume of data on programs is now in the terabytes. Individuals are generally forced to rely on specifics of how each repository is organized, which varies enormously.

Work Products (Technical Data) Provide

…the evidence of program performance

Work Product Planning

- Descriptions of work products to be produced
- Tech Plans
- Templates
- Processes
- Schedules

Work Product Production & Release

Release looks at individual work products

- Work Products validated per plans and schedules

Program Performance Assessment

- Evaluation for completeness and for program maturity

Assessment looks at the collection of work products to determine data consistency, design maturity, …

Managing Technical Data Requires

- **Descriptions of work products for**
  - Identification and validation
  - Locating and understanding

- **Specification for each work product that**
  - Defines format and content
  - Facilitates quality and maturity assessment

- **Specifications that apply to collections of work products for assessment at decision events**
  - Completeness
  - Consistency
  - Program technical maturity
  - Impact of changes

A Work Product Is …

- **A document, report, analysis, test result, plan, etc. that is generated by the product development process**

- **Specified with a well-defined purpose in the development lifecycle with identified producers and consumers**

- **With unique identification, release and configuration control**

- **A work product may contain components including models and drawings**
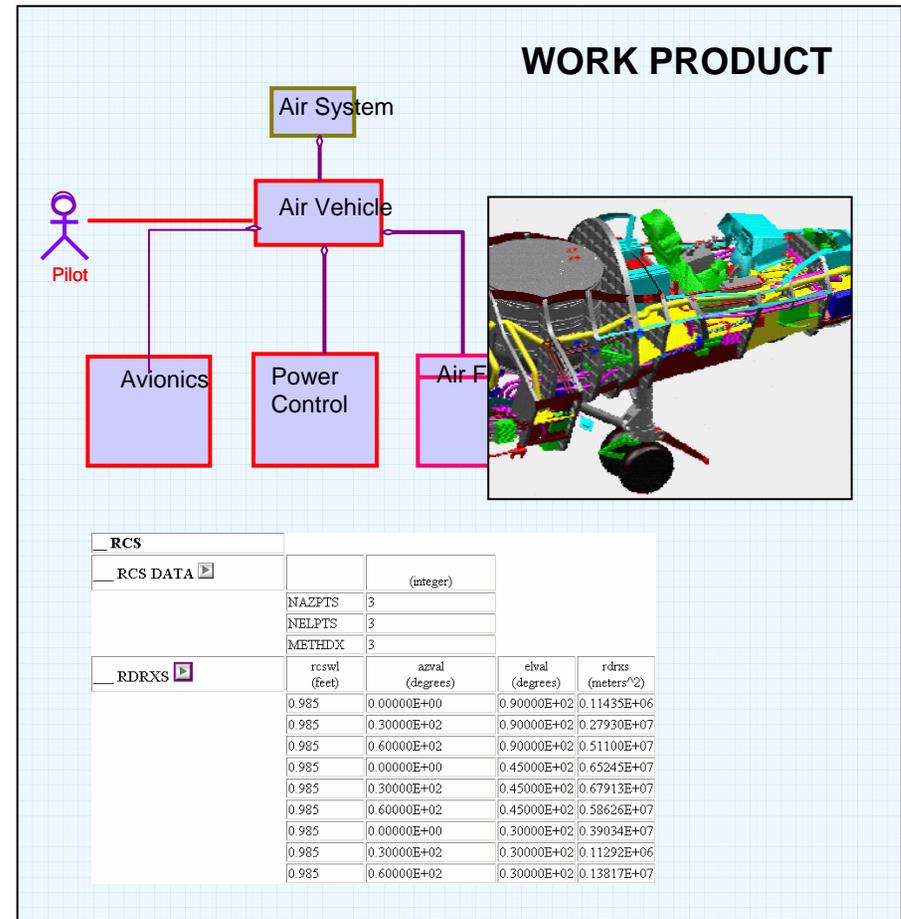
WORK PRODUCT

…work products are the primary evidence of program execution

A Work Product Template …

- **Describes the structure and content of a work product**

- **Specifies valid choices for work product attributes such as IPT names, product versions, etc.**

- **Specifies verifiable requirements for work products**

- **A template represents the starting point for author of a work product**

- **A template supplies pre-filled in content and relationships where possible**

- **A template can be used to generate an interactive form to construct the work product with choice lists for attribute values (automated validation)**
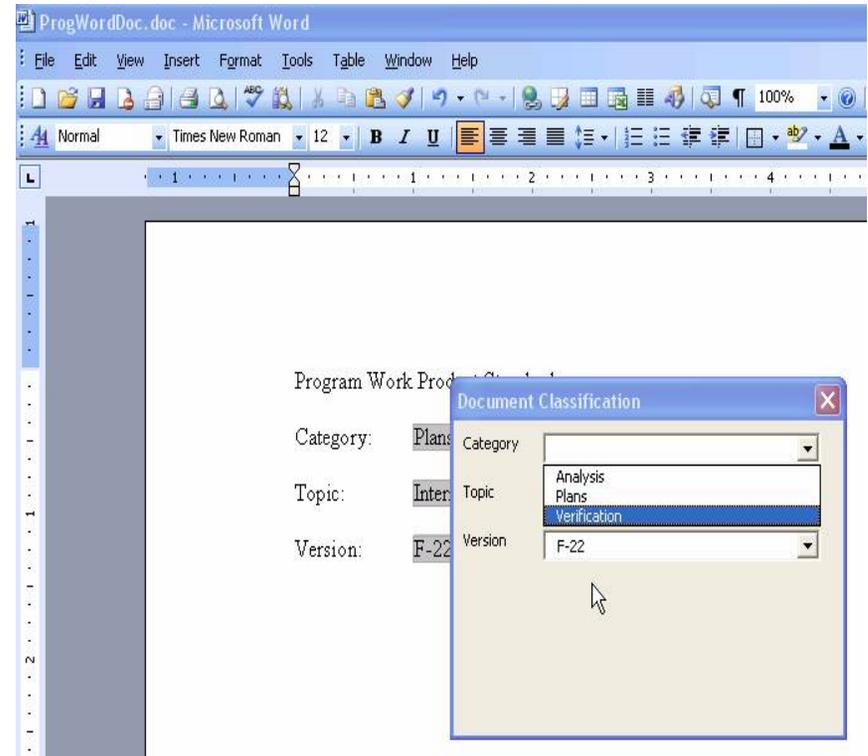
Problem: How To Construct Templates That

- **Cover all planned work products**

- **Provide maximum uniformity and commonality across all work products**

- **Provides a specification of identity up to versioning**
  - Any work products developed from the same template are versions of each other

- **Are machine-interpretable with rules for machine processing**
  - used to provide validation for structure and content requirements on work products

Work Products Have Structure

… that defines commonality and uniformity that need to be specified by templates

- **Specialization**
  - Level of detail, e.g., functional, system, physical specifications
  - Different tiers in the product structure, e.g., avionics, radar

- **Specific components and interrelationships**
  - E.g., a functional specification contains or references many specific component work products

Specification

specialization

Functional Specification

Component of

Allocation

Block Diagram

Function description — Verification Condition

Design Constraints
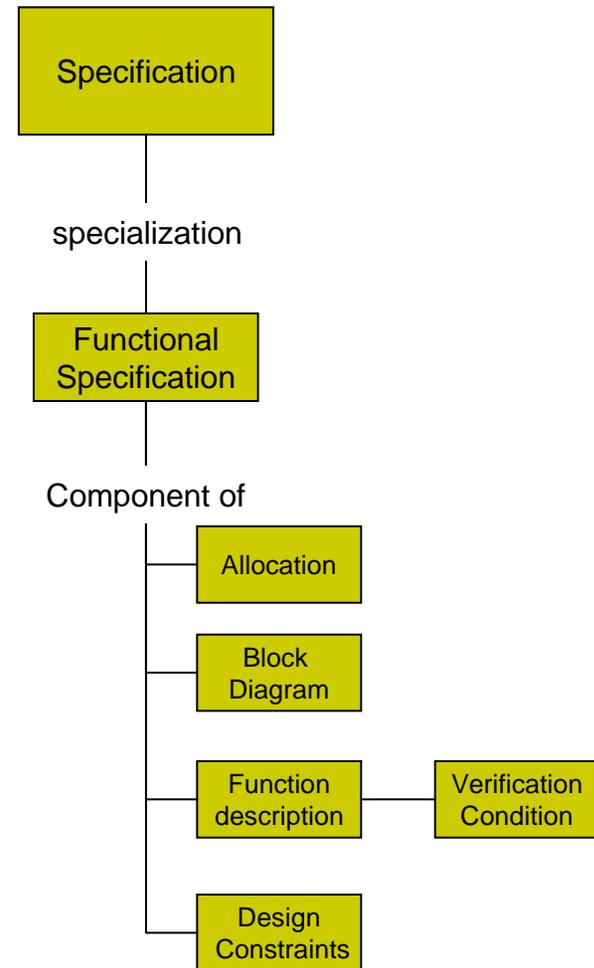
Work Products Participate In Relationships

… that are used for design traceability and product maturity assessment that need to be defined by templates
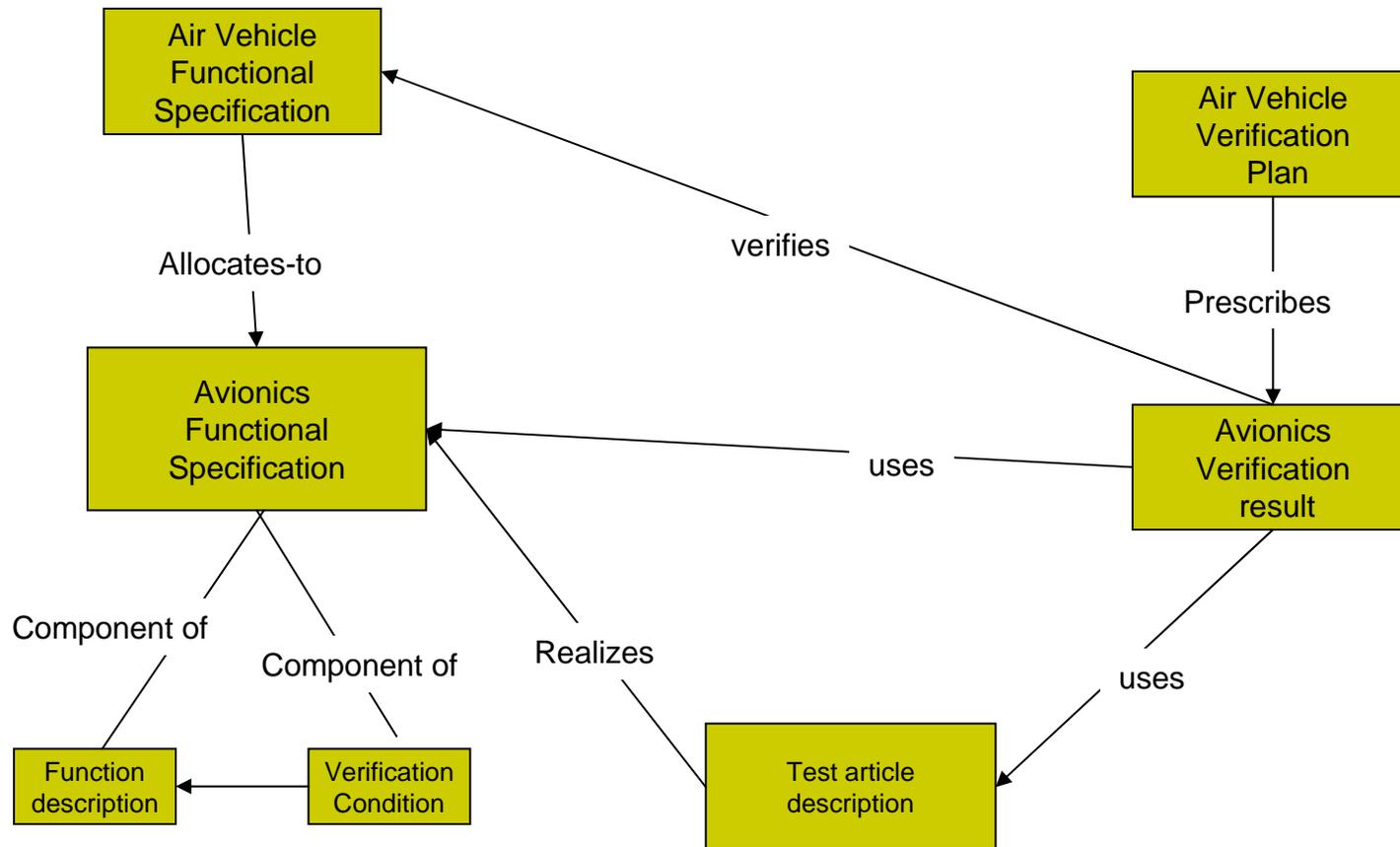
Our Approach Uses a Work Product Description

…to specialize a generic template to produce a template for a work product with a given description

User Authoring Scenario
1. User presented with a valid list of versions
2. Choice of version used to determine possible components/subsystems
3. Choice of version, product component determines admissible work product categories
4. User determines category from filtered list of categories, which determines valid topics
5. User choice then builds content and organization for template

Description

Product Version: F-35 Carrier Version
Product Structure: Avionics
Work product category: Specification
Topic: Functional

Template

| TITLE: CV Avionics Functional Specification |
| Allocation of Air Vehicle |
| Functional Block Diagram |
| Functions with performance conditions and verification conditions |
| External Interfaces |

… the work product category with its topic specialization, as well as the product version and product structure component all contribute to defining a specific template

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Template Specialization Depends on Work Product Descriptive Attributes

… the attributes below determine work product templates

- **Product Version**
  - The specific configuration description of the product, e.g., Carrier Version

- **Product Component**
  - The specific subsystem or configuration item of the product version

- **Work Product Category**
  - Specifies structural components of a template, e.g., plans, specifications

- **Topic**
  - Specializes the category for a specific subject matter domain, e.g., external loads

… the work product category with its topic specialization, as well as the product version and product structure component all contribute to defining a specific template
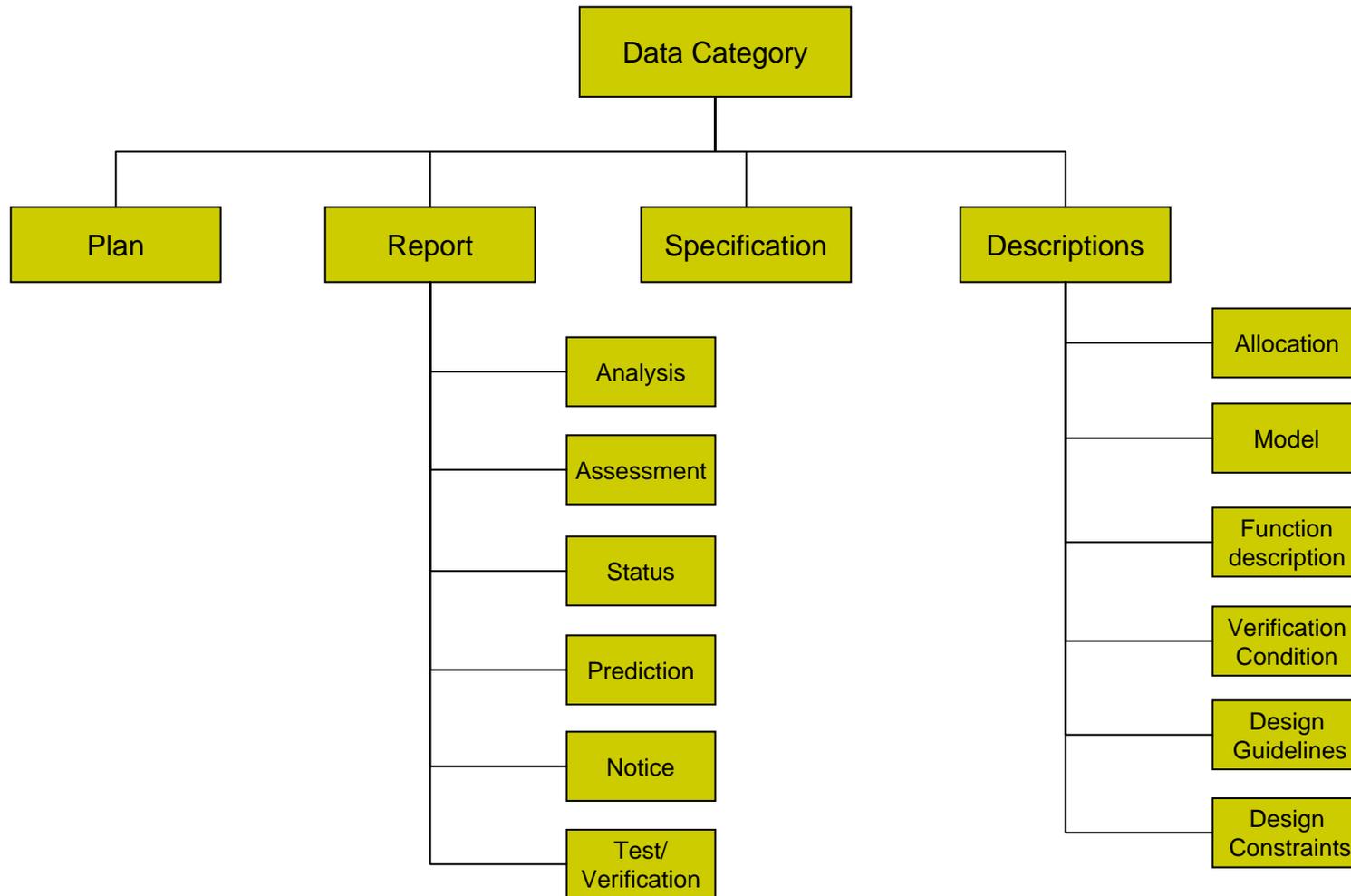
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Work Product Categories Can Be Defined From Bottom Up or Top Down

...there are lots of gray areas here and choices to be made concerning whether the categories are descriptive or prescriptive

The Benefits of the Description & Template Approach

- **Planners**
  - Provides sufficiently detailed descriptions of planned work products that can be for machine validation

- **Producers**
  - User friendly way to author work products with pre-filled in content and machine checked work product validation

- **Users**
  - Enables location, access, understanding through descriptions

- **Examiners**
  - Enables completeness checking for events
  - Identification of supersession

The description and template approach can be used for program assessment even when approach is not fully automated

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Determining Descriptive Classifications & Relationships

… is an example of "ontology engineering" in the domain of technical data management

Ontology Engineering: Defining terms and relations among the terms for a domain

– Defining concepts in the domain (classes)

– Arranging the concepts in a hierarchy (subclass-superclass hierarchy)

– Defining which attributes and properties (slots) classes can have and constraints on their values

– Defining relationships between classes

– Defining individuals and filling in slot values

The class model represents the general domain knowledge, the instance information represents specific program knowledge

Challenges

- **Standardizing the concepts**
  - Defining classes & relationships
  - Populating classes with instances of program specific information

- **Implementing templates to capture and validate data**
  - Capture metadata separately
  - Use templates for interactive form validation

- **Providing a portal with application logic to manage data**
  - With services to integrate distributed data repositories

Users

TDM Portal
- use metadata to drive portal
- location & browsing
- data access
- Audit reporting

Information Model

Technical Data

Technical Data

Technical Data

Technical Data

Personnel & Organizations

Plans & Schedules
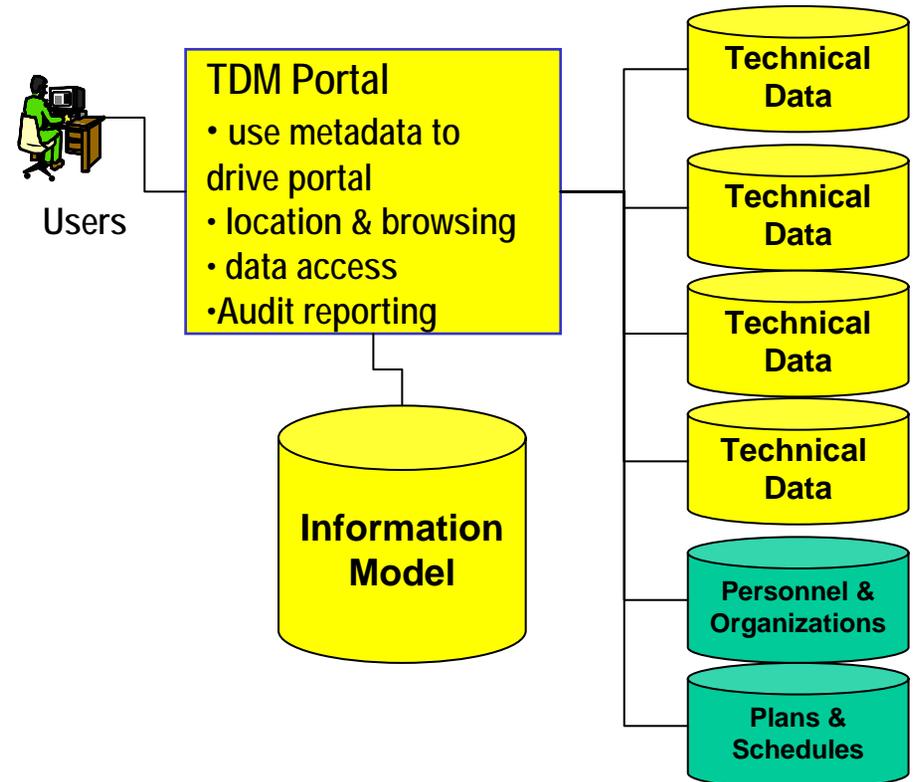
…is the approach practical? The answer is yes

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Where To Go From Here

- **Develop a full Technical Data Management (TDM) ontology**
  - Expand the scope from data required for design and development to data required for operation and sustainment

- **Use Semantic Web framework including the ontology languages OWL**
  - TDM and Information Portal are 2 of 5 use cases listed for requirements development of the ontology language, OWL

- **Integrate TDM ontology with PLM standards (e.g., GEIA-927, AP233, AP239)**

- **Leverage this assessment capability to improve earned value management**

Questions/Comments

What Is An Ontology (Natalya Noy)

- An ontology is an explicit description of a domain:
    - concepts
    - properties and attributes of concepts
    - constraints on properties and attributes
    - Individuals *(often, but not always)*
- An ontology provides a shared understanding
    - the common vocabulary and rules of use

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This Diagram Illustrates the Scope of the STEP AP239

Association relationship

Allocation relationship

Interfaces

System View

Perform Trade Study

Perform Manufacture

System

Requirement View

System_version

Trade Study View

Design View

Realization View

Requirement

System_view_definition

N alternative_Parts

Part

Real_component

Requirement_version

N alternative_Part_versions

Part_version

Real_component_version

Requirement_view_definition

N alternative Part_view_definitions

Part_view_definition

Real_component_view_definitions

subclass

Measures_of_effectiveness

Analysis

Mapping to Modules

Weights

Regularization_function

- Requirements - Text Requirement Module, Property Based Requirement Module
- System - Product
- Part (design only) - Part Modules
- Real_component - Product_as_Individual Module, Product_as_realized entity
- Analysis - Realized with several AP210 modules in the Structure Module Set
- Interfaces - Interface Module or Product Interface Module, choice under review 21