

NISTIR 5160

*Data Map Workshop for
Manufacturing Data*

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Data Map Workshop for Manufacturing Data

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Abstract

Due to the recent initiation of new work items by ISO TC184/SC4/WG8¹ (Manufacturing Management Data), attention in the PDES/STEP² community has returned to the scope of the modelling which is taking place within the projects under ISO TC184/SC4 (Industrial Data and Global Manufacturing Programming Languages). It is important that the scope of the modelling being performed under these projects be clearly defined.

As an initial step in promoting the clarification of the scope of each project, it seemed appropriate that a data map of the information required for manufacturing be defined. This data map would offer a high-level perspective on the information needs of the various projects, and would be useful in delineating the most relevant areas for each project.

The Data Map Workshop was held at NIST on March 19-20, 1992, to provide a forum for interested U.S. parties to come to a consensus regarding the contents of such a data map. The goal of the Data Map Workshop was to construct such a data map and formalize any conclusions reached during the construction of the data map. The results of this work will be distributed to the U.S. TAG to ISO TC184/SC4, TC184/SC4/WG3 (Product Modelling), TC184/SC4/WG5 (STEP Development Methods), TC184/SC4/WG8, and the IGES/PDES³ Organization.

Keywords

automated manufacturing, data maps, data models, manufacturing data, manufacturing management data, manufacturing standards

1. ISO is the abbreviation for the International Organization for Standardization. TC, SC and WG stand for Technical Committee, Subcommittee, and Working Group, respectively.

2. PDES is the acronym for Product Data Exchange using STEP. STEP is the acronym for the Standard for the Exchange of Product Model Data, a standard under development within the ISO.

3. IGES is the acronym for the Initial Graphics Exchange Specification.

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The Data Map Workshop

Due to the recent initiation of new work items by ISO TC184/SC4/WG8, attention in the PDES/STEP community has returned to the scope of modeling which is taking place within the projects under ISO TC184/SC4. It is important that the scope of the modeling being performed under these projects be clearly defined.

As an initial step in promoting the clarification of the scope of each project, U.S. participants in the WG8 effort resolved to define a data map of the information required for manufacturing. This data map was intended to offer a high-level perspective on the information needs of the various projects, and would be useful in delineating the most relevant areas for each project. The so-called Data Map Workshop focussed on the construction of the data map and the preliminary identification of areas of interest for each project within WG8.

The Workshop was organized by the editors of this publication, and was held at NIST in Gaithersburg on March 19-20, 1992. Attendance was solicited from several relevant groups: the conveners of each of the Working Groups under ISO TC184/SC4, the officers and technical committee chairs of the IGES/PDES Organization, and selected individuals from other organizations who had either been active or had expressed an interest in the progress of WG8. A total of 63 individuals were invited to attend.

The STEP effort includes working groups WG2, WG3, WG4, WG5, WG6, WG7 and JWG9 of ISO TC184/SC4. The STEP effort is focused upon the creation of standards for the exchange of data that describes a product¹. The definition taken of product here is broad: it refers to any end item resulting from manufacturing, including software.

ISO TC184/SC4/WG8, colloquially referred to as MANDATE (Manufacturing Management Data Exchange), addresses standards for the exchange of manufacturing management data. Manufacturing management data are data required for directing or regulating the movement of items through the entire production cycle from the ordering of the raw material to the delivery of the finished product.

While these scopes are distinct, it is clear that there will be areas where close coordination between these two WGs is required. As NIST has participants in both STEP and WG8, and is heavily involved in harmonizing other standardization efforts, NIST is participating in the coordination of these two efforts.

Workshop Goals

Two goals were agreed upon by the participants:

- To identify the information requirements of a manufacturing enterprise.
- To identify some of the boundaries of STEP and WG8 by neutral data mapping.

1. ISO 10303, "Product Data Representation and Exchange, Part 1: Overview and Fundamental Principles," ISO TC184/SC4/Editing: Document N11 (Working Draft) (Available from the IGES/PDES/STEP Administration Office, National Institute of Standards and Technology, Building 220, Room A127, Gaithersburg, MD 20899.)

Workshop Methods

The group further agreed on the following approach for meeting the goals:

- Presentations of maps/models to base discussions upon
- A brainstorming session (the “inventory” approach of identifying data) to capture what information is needed to support manufacturing
- Classification of this information according to a top-down structure, possibly from multiple perspectives.

Presentations by Selected Attendees

What follows is a brief summary of what was presented by various individuals. These presentations were kept quite short to allow enough time for discussion. Supporting documents can be found in Appendix B.

Landon Miller (Vertical Systems, Inc.) - Dr. Miller asserted that WG8 intends to manage the meta-models of manufacturing data and standardized processes, because those are manufacturing management responsibilities.

Brian Seitz (IBM) - Mr. Seitz advocated three dimensions of categorization for data: levels of abstraction, type of existence, and type of discourse. Examples of ways to categorize types of discourse include substantive versus methodological, and data versus performance.

Mark Palmer (NIST) - Mr. Palmer described the objective and scope of the AP¹ Framework Project, and explained the AP Domain Taxonomy that he is developing for that project. He stated that the AP Framework addresses a portion of the domain of discourse described in the WG5 STEP Framework.

Frank Cusick (Digital Equipment Corp.) - Mr. Cusick presented DEC’s contribution to WG8 and a DOD product life cycle view for positioning manufacturing data, and showing his perception of the bounds of WG8.

Steve Ray (NIST) - Dr. Ray presented the bounds of manufacturing data modeled within the NIST Manufacturing Systems Integration Project.

Greg Paul (General Dynamics) - Mr. Paul presented the data models of the General Dynamics Consolidated Product Database (CPDB). The CPDB Program was an effort to model the processes and data requirements for the internal General Dynamics systems. It was presented as an example of the types of data and processes that would exemplify a manufacturing facility and it was used as a point of reference in the responsibilities/discussions relative to the types of data that were discussed later in the week.

John Harris (Westinghouse) - Mr. Harris pointed out the different needs of remanufacturing versus manufacturing. Many models remain unused after their creation. What is needed is a model which

1. Application Protocol – a layer of models under development within the STEP effort.

management can readily use to “manipulate” the factory.

Jimmy Wong (EDS) - Mr. Wong presented a generalization of information flow in a manufacturing environment. Several data categories were identified, such as: REQUIREMENT, SERVICE, RESOURCE, PRODUCT, PROCESS, PRODUCTION. A list of typical data in each category was also disclosed.

Jesse Crusey (NIST) - Mr. Crusey presented a high level data map from the NC Application Protocol being developed by PDES, Inc.

Discussion

Development of a high-level, abstract data map

Upon completion of the presentations, a discussion ensued about scope, level of abstraction, and purpose of this workshop. One conclusion reached by the group was that there are several perceptions of the scope of WG8 work. Some felt that WG8 was to be working on characterization of manufacturing data, while others felt it was to address manufacturing *management* data. The group ultimately agreed to the second interpretation. Under this interpretation, “manufacturing data” means the data needed to manufacture a product, and is within the scope of STEP. Manufacturing management data means the constraints, policies, and business practices which direct the manufacturing process – namely that information of interest to managers of manufacturing organizations, and possibly others. Other heuristics which helped in distinguishing the domains included characteristics such as: dynamic (WG8) versus static (WG3) data; meta-data versus data; policy versus mechanism.

The group agreed that the notion of “product” should be generalized to include treating a facility (for example) as a product as well as machines, and other resources.

Conversation then turned to a specific categorization of data, under this new interpretation of the distinction between WG8 and STEP data. The results are shown in Table 1. In this table, the column titled “other” refers to other standardization bodies.

A discussion followed addressing the different levels of abstraction of data. It was felt that WG8 information is generally at a higher level of abstraction. For example, manufacturing policies guide how manufacturing activities are performed, and would be within WG8 scope. These policies would be represented by major process definitions. Very detailed process definitions are probably out of WG8 scope.

Considerable discussion focussed on how processes, process plans, and resources were to be handled and defined.

Processes:

One participant suggested the following view of plans:

The Process Plan Model - This is a model defining the structure in which to house a plan.

The Process Plan - This is a particular description of how to make a part.

Routing Plan - In discrete manufacturing, this refers to the sequencing, material handling, determination of standard times and costs, and possibly the identification of specific manufacturing resources.

Production plan - This includes the time assignments and all specific resource identifications.

Under the above breakdown, there was consensus that the Process Plan Model (currently within WG3) should remain in WG3; Routing plans and Production plans are within the scope of WG8, and responsibility for standard process plans is yet to be determined.

Resources:

Discussion then moved to the use of resources. It was agreed that establishing the rules of behavior of resources in support of the execution of processes is still a major area which is not being addressed. It was unclear whose responsibility that should be – this may be an extension of MMS (Manufacturing Messaging Specification - ISO TC184/SC5/WG2). The group agreed that this is not within the scope of either STEP or WG8.

Classes of resources include at least:

- People / organizations
- Machines
- Processes
- Facilities
- Materials
- Time
- Information
- Money

Minimum requirements (and responsibilities) for characterizing resources include:

<u>Property</u>	<u>Responsible party</u>
• Identity	STEP & others
• Location	STEP
• Time	Other
• Capabilities	STEP
• State	possible MMS extension
• Rules of behavior	possible MMS extension

The modeling of generic resources is within the scope of STEP. The taxonomy of resources is within the scope of WG8 in coordination with WG5. WG8 and WG5 will address the higher levels of abstraction. Those responsible for MMS, and others should handle the most detailed levels of abstractions.

Workshop Results

The key results of the workshop are summarized below.

- The characteristics which distinguish manufacturing management versus product-related data were established; these characteristics include scope, abstraction level, content, data volatility.
- A consensus was reached on the scope and responsibilities of WG3 and WG8 for all items discussed.
- A data list (see Table 1), was produced which helps to identify where respective organizations have responsibility.
- The data list identifies areas which require continuing coordination.

Workshop Recommendations

It was resolved by the participants that:

- The results of this workshop be presented to and incorporated in the plans of ISO TC184/ SC4 PMAG, SPAG, WG5, WG3, WG8, U.S. TAG to SC4, SC5/WG1, and the IGES/PDES Organization.
- The data list be enhanced and maintained in order to manage the relationships between the various groups.
- The dependencies and relationships among the data in our data list need to be further refined – for example, relationships among processes, routings and operations, work orders, and other job launch mechanisms.
- A framework for classifying and differentiating manufacturing data would be useful for the purposes of enhancing the standards developed within TC184.

Table 1: Data Categorization

Design	STEP	WG8	Other
Analysis data (FEA, FEM, FDM)	•		
BOMs	•		
Capacity plans		•	
Configuration - shop floor (status)		•	
Conformance test data (e.g. inspection data)	•		
Cost estimation (process)		•	
Design intent	•		
Design records	•		
Engineering specifications	•		
Environmental information - product related	•		
Environmental information - process related		•	
Facility / location definitions	•		
Inventory control		•	
Lot information (control)		•	
Machines	•		
Product Maintenance	•		
Maintenance management		•	•
Material data, properties	•		
Material handling		•	
Material regulations, standards	•		•

Table 1: Data Categorization (contd.)

Design	STEP	WG8	Other
Measures: physical, time, calendars (units)	•		•
NC and control data	•		•
Organization	•		•
Operation plan	•		•
Operational data (PC, QC, time, etc.)		•	
Orders - external (purchase orders, external procurement, sales orders)		•	•
Orders - internal		•	
Person	•		•
Policies (manufacturing, safety, engineering....)		•	
Process ¹	•	•	
Procurement		•	•
Product	•		
Production control		•	
Production forecasts		•	
Project control (PERT, CPM, etc.)		•	
Receiving data		•	•
Resource definitions	•		
Resource capabilities	•		

1. There are three aspects to Process: the structure for representing a process (WG3); the populated version of this (WG8); a set of standardized processes (WG8).

Table 1: Data Categorization (contd.)

Design	STEP	WG8	Other
Routing plan		•	
Safety instructions	•	•	
Safety statistics		•	
Schedules - materials, production, maintenance. Algorithms		•	
Serialization control	•	•	
Shape data	•		
Shipping data	•		
Specifications & standards - material, process	•		
Statistical process control data		•	
Status		•	
Surface information	•		
Test inspection	•		
Testing data	•		
Time estimation (process)		•	
Tools (cutters, fixtures, die/molds)	•		
Traceability via lots, serialization	•		
Traceability via effectivity	•		
Usage of product, specific, intended	•		
Utilities (specification), such as electrics, etc.	•		
WIP - intermediate product description	•		
WIP - tracking data	•	•	

Appendix A – List of Participants

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1. Attended second day only
2. Attended first day only

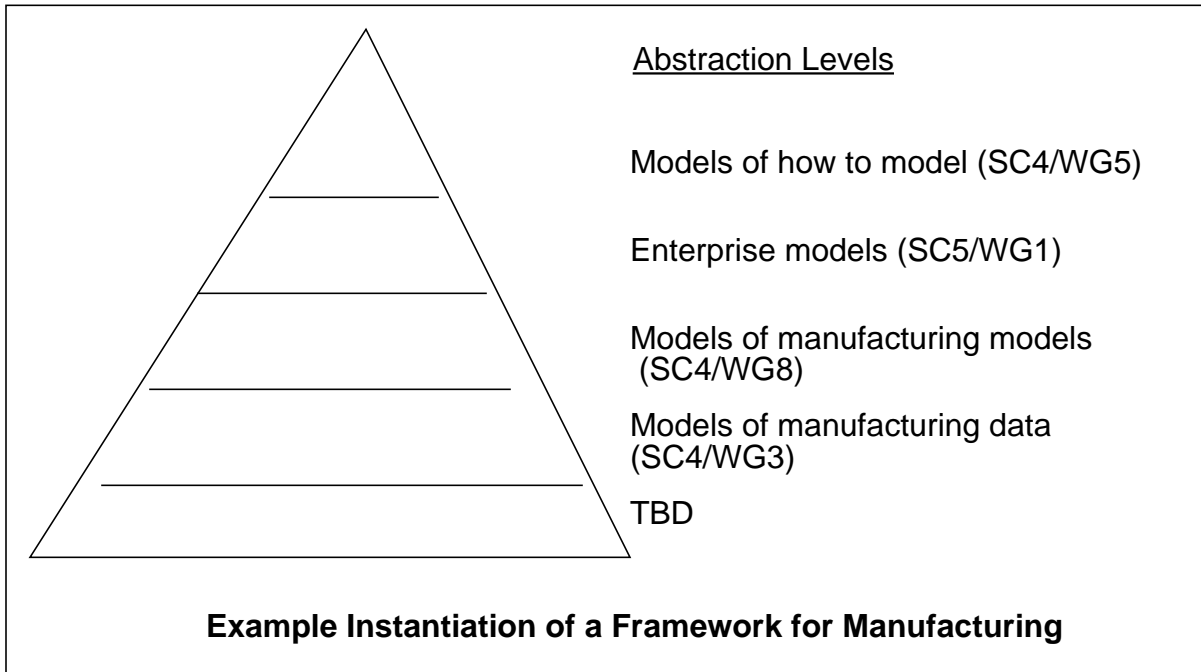
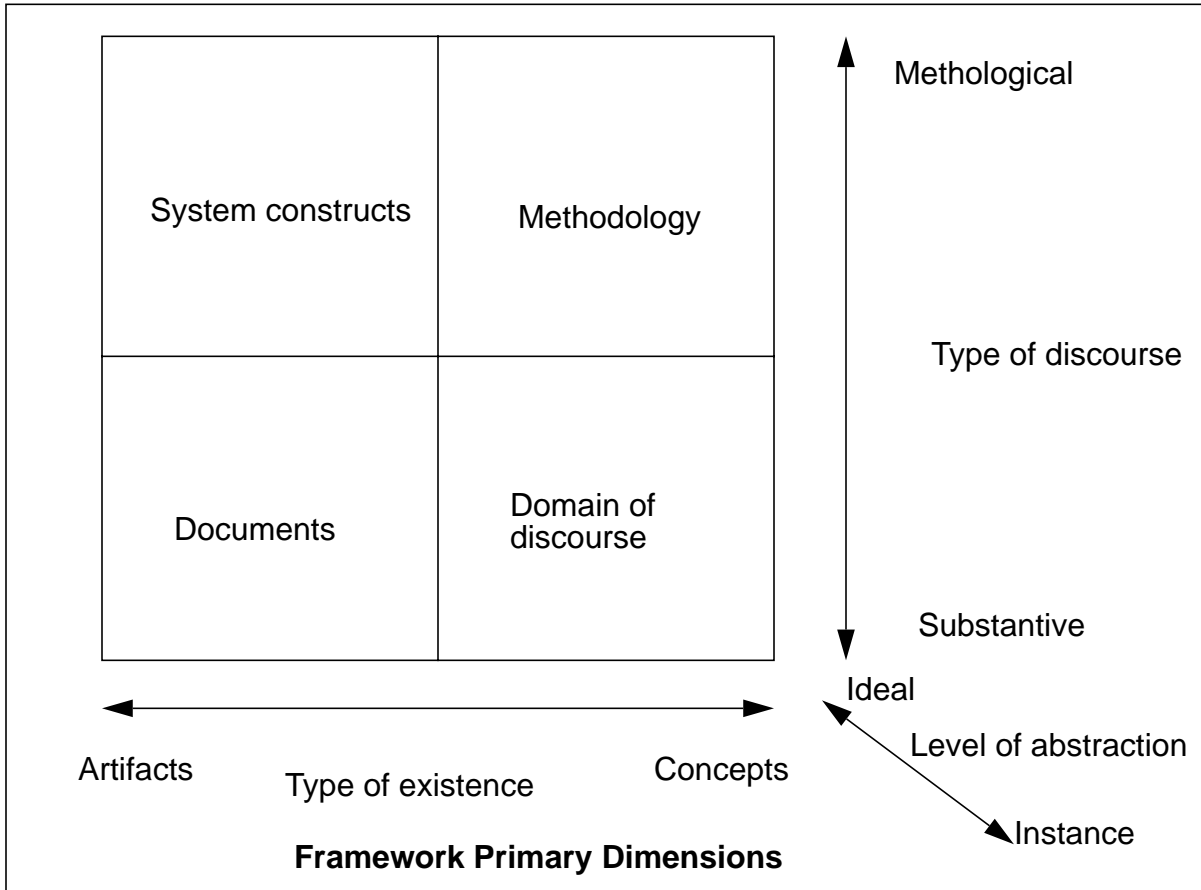
Appendix B – Presenter’s Supporting Slides and Documents

Presentation of Landon Miller:

He suggested viewing manufacturing information as follows:

<u>Concepts</u>	<u>Processes</u>	<u>Products</u>
Models (behavioral, simulation, etc.)	Activities Resources	Attributes

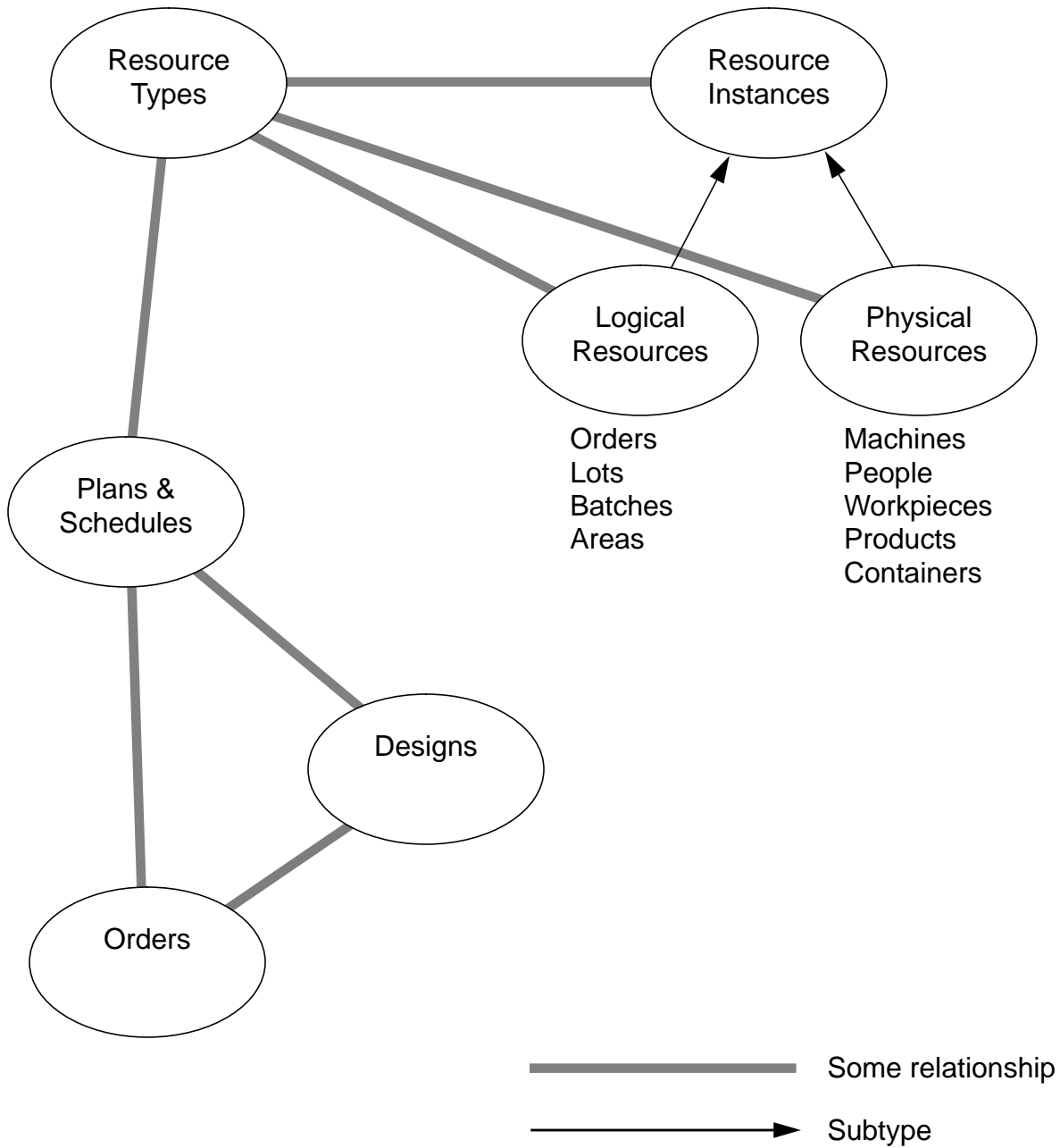
Presentation of Brian Seitz -



Presentation of Mark Palmer-

Presentation of Frank Cusick-

Presentation of Steve Ray-



High-level view of manufacturing data

Presentation of Greg Paul-

Presentation of Jimmy Wong-

Presentation of Jesse Crusey-

Material Received in Advance-