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MINIMUM INFORMATION MODEL

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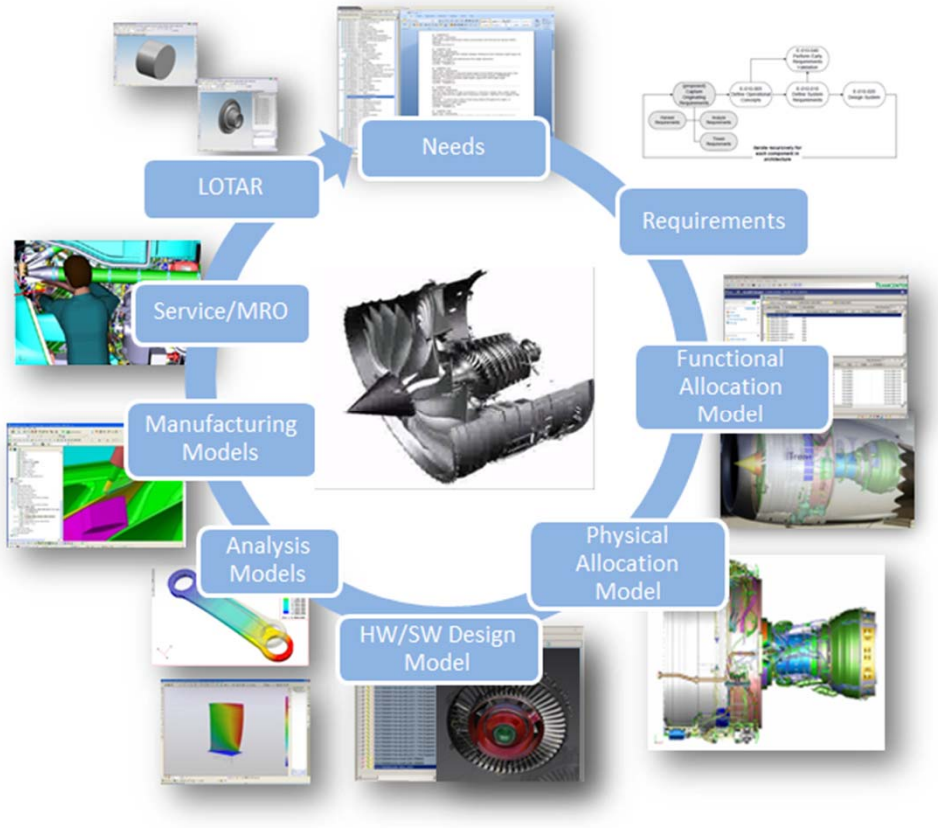
Introduction

- Conducted research which sought to identify the critical information needed in specific workflows across the product lifecycle.
- Operated with the premise that drawings are information-rich artifacts and that models often lack the same level of information.
- Two information models theorized and developed were the common information elements (CIE) and the minimum information model (MIM).
- Delphi study currently being conducted to further develop the information models.

Model-Based Enterprise

- An environment which leverages digital model-based representations to communicate
- Required models vary by author and consumer
- Includes model-based *activities* and model-based *things*
- Model-based definitions become carriers of information within the lifecycle



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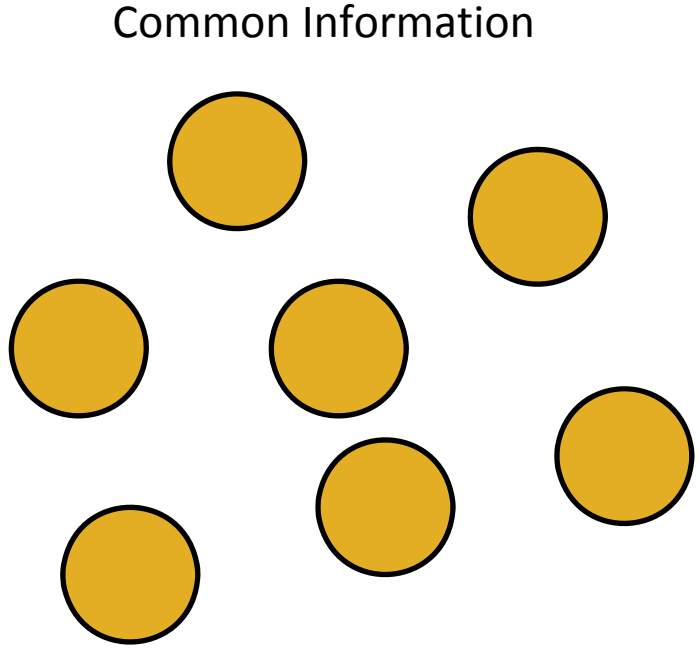
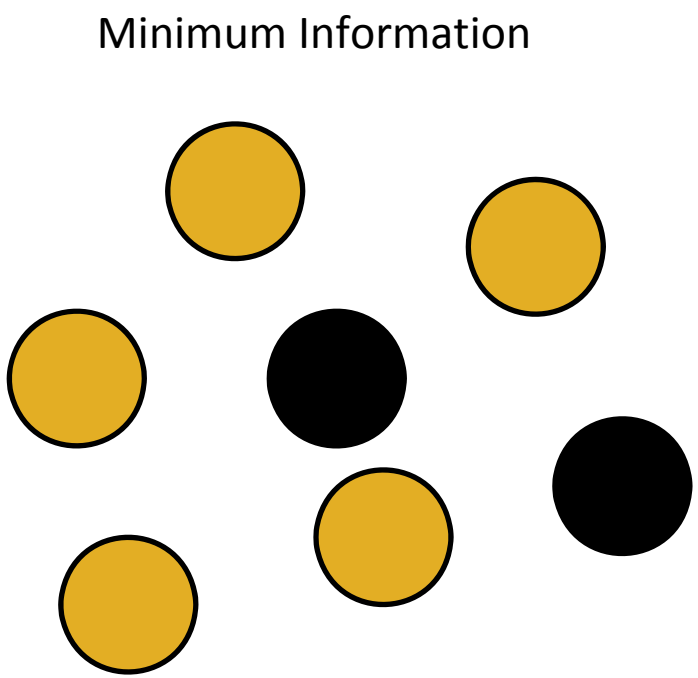
Common Information Elements

- Higher-level set of data, operates across the entire lifecycle of a product
- Can be common across industry sectors, companies, or divisions of companies
- The minimum information model is a subset of the common information elements



Minimum Information Model

- Low-level, operates at the specific workflow level or lifecycle phase
- Utilizes only necessary information
- Distinguishes differences between primary and auxiliary information
- Variance likely between workflow, enterprise, and industry
- Requires cyclical assessment



Research study overall parameters

- Study targeting industry professionals
  - Various sectors: aerospace, automotive, medical, consumer goods, etc.
  - Various job roles/functions: design, manufacturing, planning, management, sales, etc.
  - Various locations around the world
- Goal to identify items and elements in various workflows to establish the idea of a Common Information Model
  - Concept to prototype workflow
  - Prototype to detailed product definition workflow
  - Detailed product definition to manufacturing workflow
  - Manufacturing to inspection workflow
- Survey used to *identify*, follow up research to determine strength of relationships and value

Research Study Stage One

- Survey targeted industry professionals
  - Sectors: aerospace, automotive, medical, consumer goods, etc.
  - Position titles: engineer, management, sales, etc.
  - Global

- Objective: Identify items and elements in various workflows to help confirm the common information elements and minimum information model

Research Study Stage One

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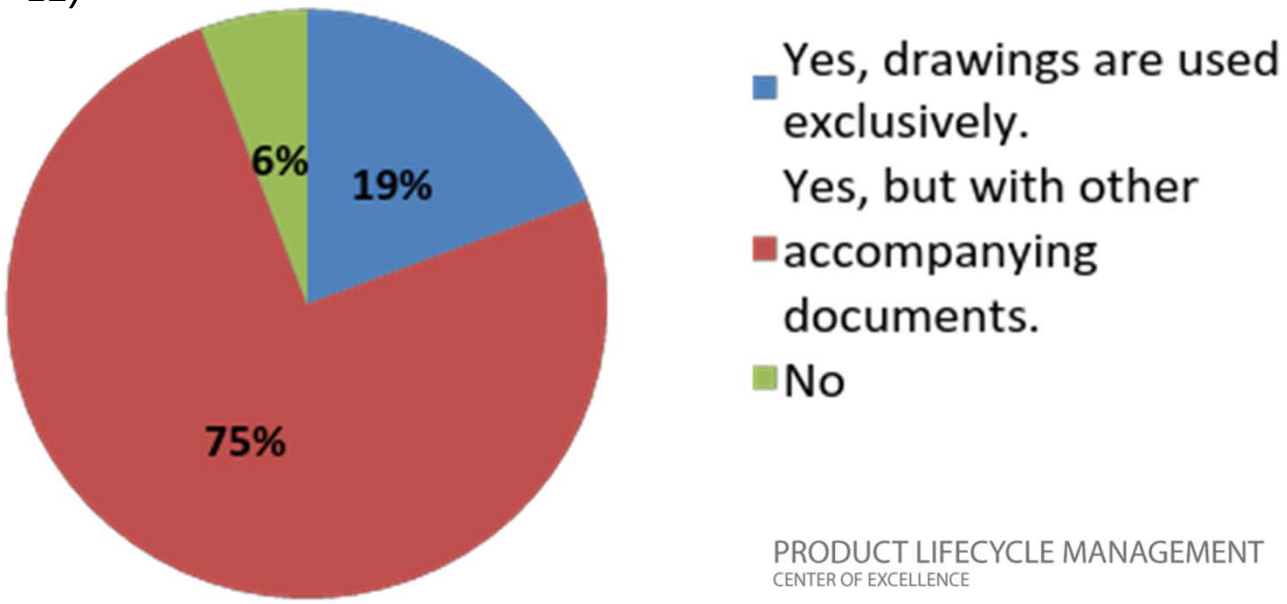
- Concept to prototype workflow
- Prototype to detailed product definition workflow
- Detailed product definition to manufacturing workflow
- Manufacturing to inspection workflow

Stage One Conclusions

- 2D drawings were the most common method for consumption
- Inhibitors to MBD adoption:
  - Information doesn't take form that is useful in a model at given stage of lifecycle
  - Work done on manufacturing floor
  - No method for 3D model manipulation

Are drawings used to communicate information in the workflow (n = 12)



Stage One Outcomes

These items are common across the phases of the lifecycles

These items are specific to a given workflow and its actors

The resulting model is what is necessary to replace a drawing in a given workflow

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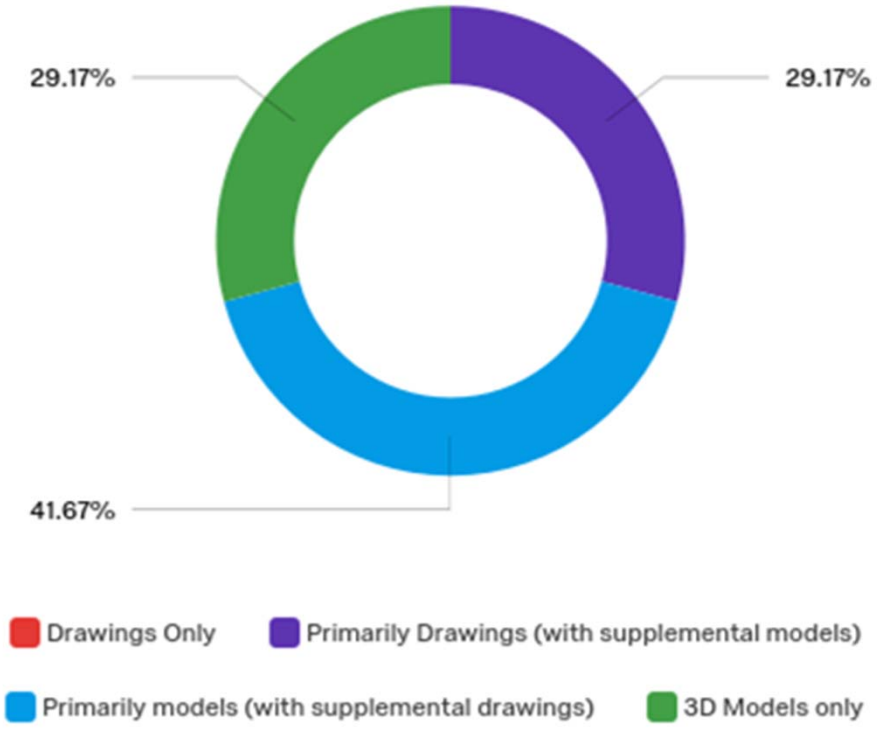
Stage Two: The Delphi Study

- A survey used to understand what elements are necessary in MBDs to survive throughout the lifecycle
- Consists of multiple rounds of questions
- Rounds one and two concluded, round three is currently active
- Interviews done to contextualize the results from Rounds 1 and 2

Delphi Study Round One

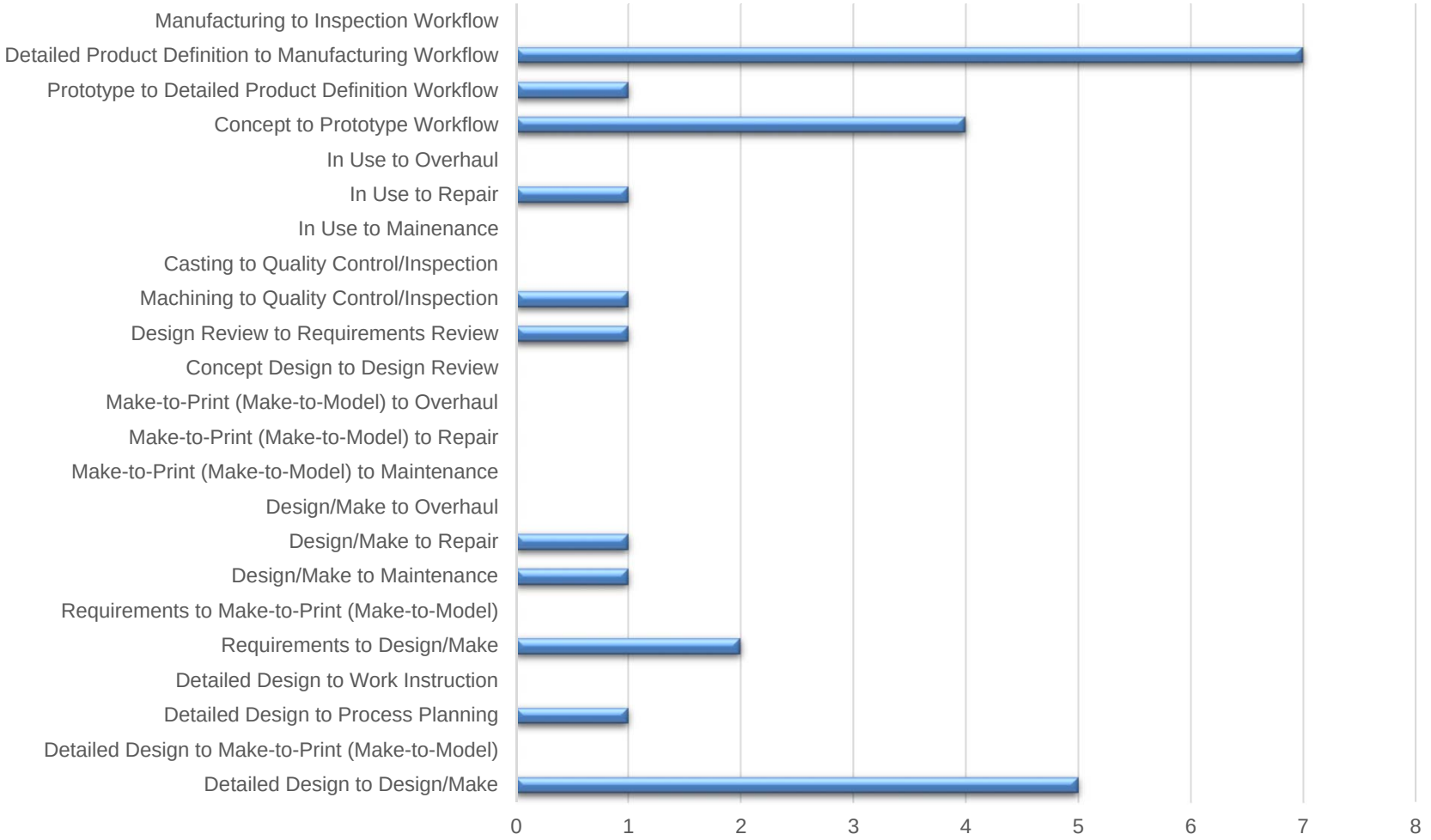
- Used to understand where MBD is at currently within industry
- There is a large interest in understanding MBE/MBD
- 3D models are extremely important for task completion
- Drawings, while still used, are not the sole point of information for most

Which of the following best represents the form of product definition data you utilize to perform your job?



Delphi Study Round One

What workflow do you most commonly participate in?



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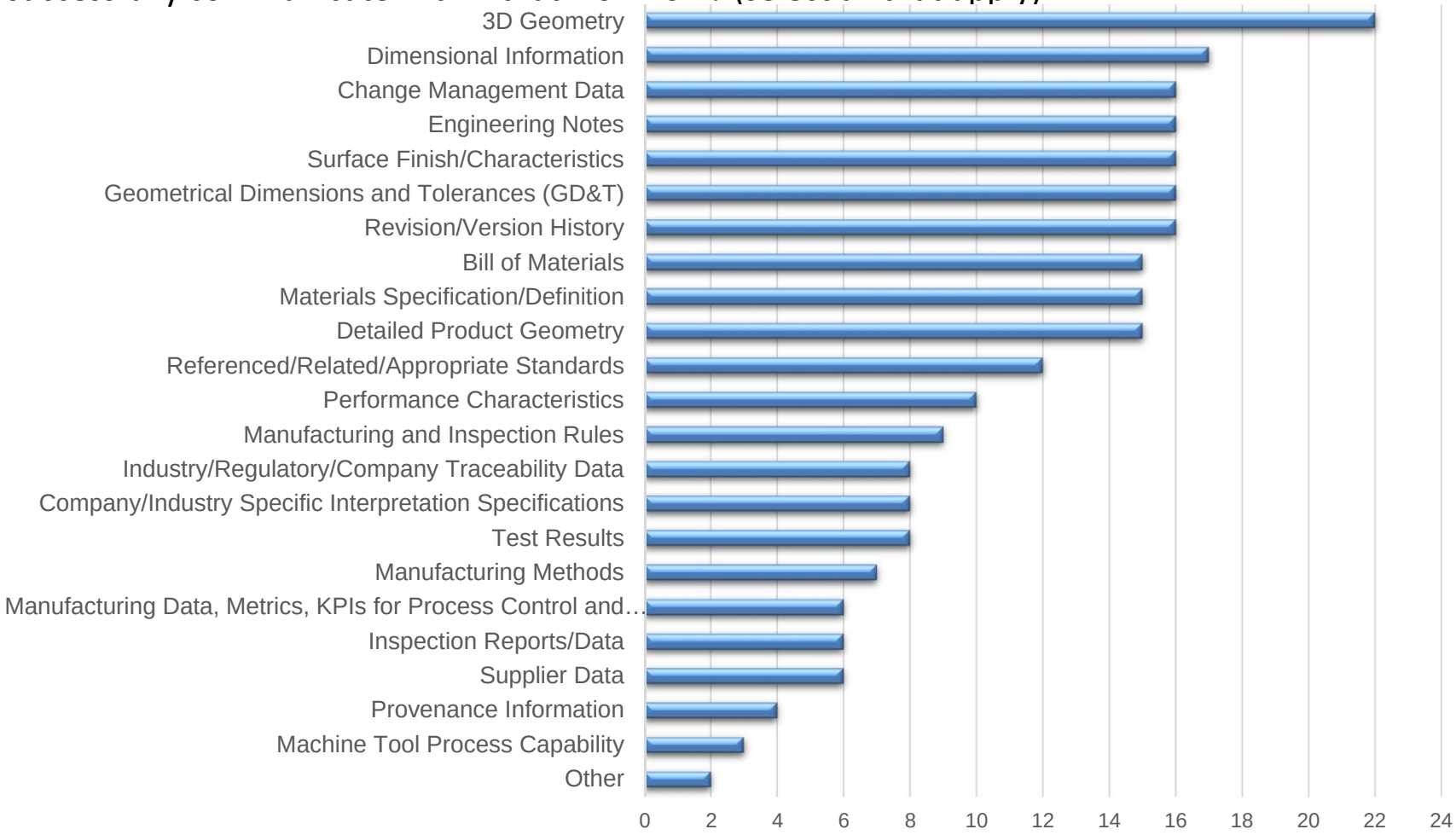
Delphi Study Round One

Based on the workflow you selected, which of the following elements are necessary to successfully communicate within that workflow? (select all that apply)



Other: Avionics & Flight Software Design, There is a lot not covered here mainly everything in the SE and SW domain

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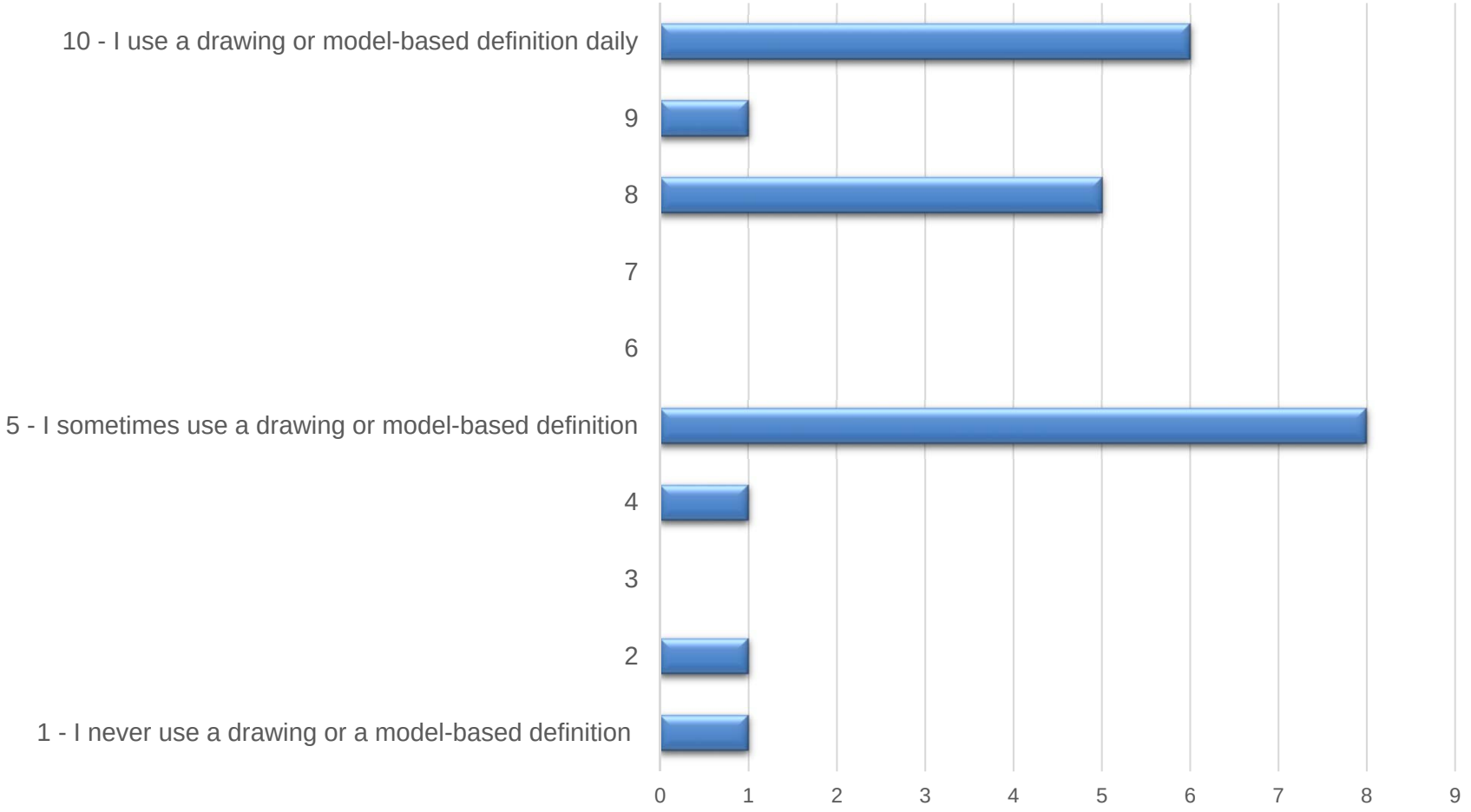
Delphi Study Round One

Assuming you use a MBD across the lifecycle of your products, which elements are common from one life cycle stage to the next? (Select all that apply)

Other: Trade and IP Designations and Classification, Model context and requirements

Delphi Study Round One

To what extent does your job role involve the use of a drawing or model to complete your job effectively?



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Delphi Study Round One

Full list of elements utilized:

- 3D Geometry
- Dimensional Information
- Detailed Product Geometry
- Revision/Version History
- Geometric Dimensions and Tolerances
- Materials Specifications/Definitions
- Surface Finish/Characteristics
- Manufacturing Methods
- Machine Tool Process Capability
- Performance Characteristics
- Test Results
- Supplier Data
- Company/Industry Specific Interpretation Specifications
- Manufacturing and Inspection Rules
- Engineering Notes
- Bill of Materials
- Provenance Information
- Industry/Regulatory/Company Traceability Data
- Referenced/Related Appropriate Standards
- Inspection Reports/Data
- Manufacturing Data/Metrics/KPIs for Process Control and Improvement
- Change Management Data
- Product Specifications

Delphi Study Round Two

- Used to evaluate the importance of each element inside and outside the workflows that the participant selected
- Asked to rate elements on a scale of 1-Not Important to 7-Very Important
- Elements of a MBD mean different things to different users
- Only specific elements are necessary, many elements can fit into a few
- Narrowed down the results to twelve key terms for use in round three

Example Results from Delphi Study Round Two

Q4 - 3D Geometry

Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	3.00	7.00	6.65	0.82	0.68	40

Q5 - Dimensional Information

Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	1.00	7.00	5.85	1.56	2.44	39

Q6 - Detailed Product Geometry

Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	2.00	7.00	6.21	1.24	1.55	39

Q7 - Revision/Version History

Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	2.00	7.00	5.58	1.44	2.09	38

Q8 - Geometric Dimensions and Tolerances (GD&T)

Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	1.00	7.00	6.03	1.37	1.87	39

Q19 - Bill of Materials

Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	1.00	7.00	5.27	1.75	3.06	37

Delphi Study Round 2 elements

Twelve elements utilized:

- 3D Geometry
- Dimensional Information
- Detailed Product Geometry
- Revision/Version History
- Geometric Dimensions and Tolerances
- Materials Specifications/Definitions
- Surface Finish/Characteristics
- Engineering Notes
- Bill of Materials
- Referenced/Related Appropriate Standards
- Change Management Data
- Product Specifications

Delphi Study Interviews

- The use of a MBD has a steep learning curve
- Training is an important factor for MBD
- Culture of the company can slow down or increase adoption rate and success
- Technology has existed for years but the infrastructure can be expensive
- Anyone familiar with large amounts of technology should be able to adapt faster

Delphi Study Round Three

- Establish connection and importance between workflow and information element
- Obtain a view of how culture could factor into the ability of a company to adopt MBE/MBD
- Understand if education (or lack thereof) could factor into the ability to adopt MBE/MBD
- Confirm/expose the role of infrastructure in the MBD/MIM process

Conclusions (so far…)

- Common information elements provide an information base from which to develop an MBD
- Minimum information models are viewpoints of a model-based definition
- The relationship between CIE and MIM will vary between workflows
- Developing a model-based environment is a challenge
  - Lack of infrastructure
  - Lack of experience
  - Lack of willingness to change
- Understanding the information needs involved can help alleviate the stress of adoption
- Drawing contained implicit information, whereas MBD creation often requires explicit input

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