TRB Webinar:

Quality Management for 3D Model-Based Design and Delivery

November 25, 2025

12:00 – 1:30 PM (eastern)

PDH Certification Information

1.5 Professional Development Hour (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

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Purpose Statement

This webinar will share new practices developed through NCHRP Project 10-113 that help state departments of transportation (DOTs) modernize design quality management for the digital age. The session will outline a new guide for 3D model-based design and digital delivery, featuring process and product control approaches, open data standards, and a five-step review process to audit and certify digital designs.

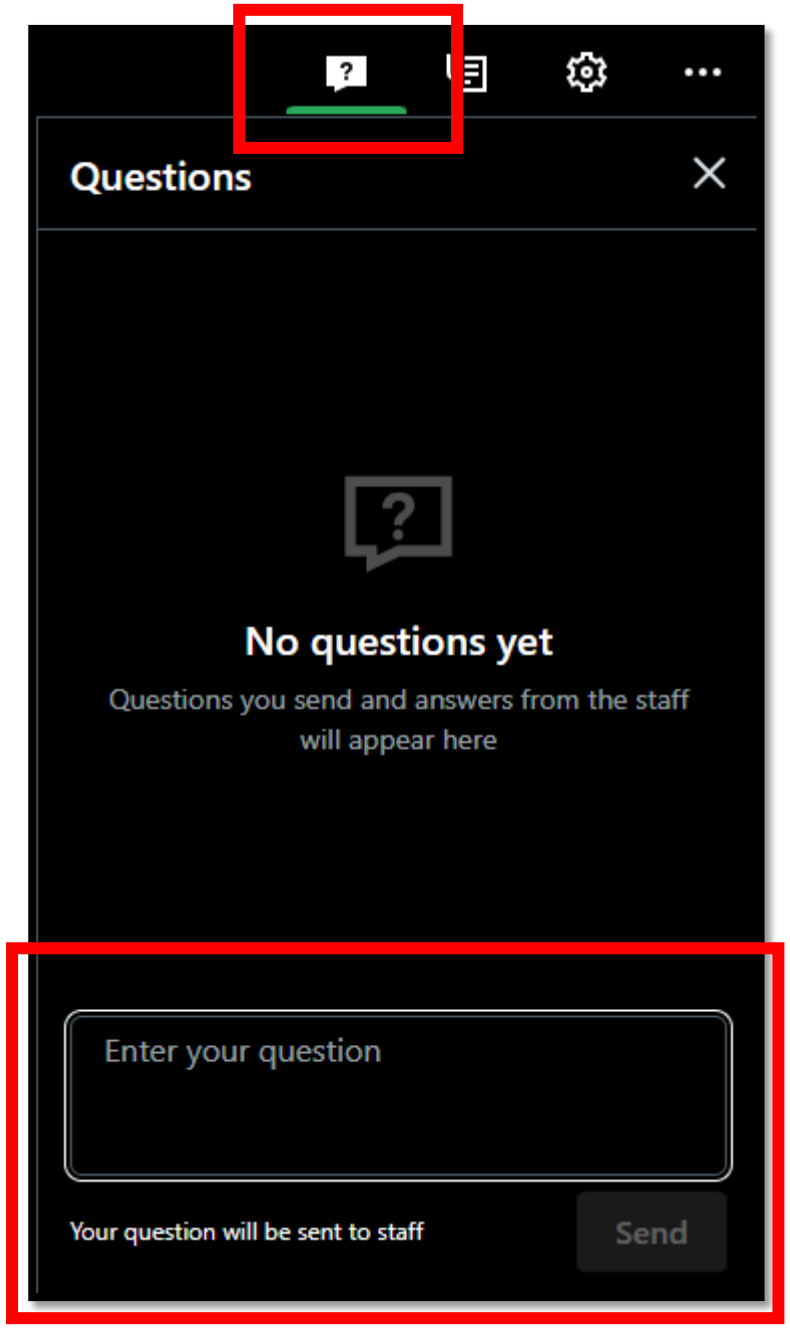
Learning Objectives

At the end of this webinar, participants will be able to:

- Describe the hallmarks of robust design quality management,
- Explain the role of software configurations and model development standards in design process control, and
- Identify tools and practices to update their organization's design quality management process for the digital age.

Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



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TRB Webinar: Quality Management for 3D Model-Based Design and Delivery

NCHRP Research Report 1153: Guidebook Overview

November 25, 2025

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Acknowledgements

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Project Objectives

The objective of this research is to provide a guidebook to assist State DOTs with developing quality management processes for 3D model-based approach for project development and delivery

Research Project Timeline

- **2020** Problem statement developed and submitted
- **2021** Funded, panel formed, issued RFP
- **2022** Awarded contract, research started September
- **2023** Interim Report 1, Agency testing, Interim Report 2 with guidebook outline
- **2024** Interim Report 3 with draft guidebook, workshops
- **2025** Final Report, guidebook, webinar, outreach materials, implementation plan

Agenda

1. Guidebook Overview
2. Quality Management Concepts
3. 3D Model Reviews
4. Setting up for Success
5. Implementation Considerations for Agencies
6. Moderated Question and Answer Session

Guidebook Overview

Objectives of the Guidebook

Provide guidance for implementing the quality process for:

- ✓ 3D model-based design review
- ✓ 3D model-based deliverable review
- ✓ data validation, and
- ✓ paperless documentation procedures

Managing Expectations

This Guidebook Is

- Guidance on how to update your quality program for digital delivery
- A holistic view of how the use of digital media (including 3D models) affects the quality process
- Pragmatic suggestions for current technology constraints and forward-looking
- Augmented by real-world examples in the appendix

This Guidebook Is NOT

- Materials that can be directly inserted into your quality program
- A checklist that addresses all concerns

Gaps

- Undefined skillsets
- Lack of capacity

- Out of date standards, job aids, and procedures

- No turnkey products
- Lack of features

Gaps: People

- Reviewers lack skills for navigating and manipulating 3D models
- Some modelers aren’t sure how to check their own work
- Unsure how to keep a digital record of checks, especially when there are no issues to document
- Undefined 3D modeling skillset required for model review tasks limits opportunity for training
- Lack of training resources (e.g., manuals, videos)

Gaps: Process

- Formalized roles & responsibilities for reviewing digital files
- Lack of standards for modeling and file management leading to inconsistent model structure
- Lack of consistent and repeatable processes for checking digital files
- Lack of job aids (e.g., checklists)

Gaps: Technology

- Dynamic technology landscape with emerging products and features
- Lack of robust tools for reviewing models
- Lack of features to lock parametric models
- Lack of features to facilitate reviews, in particular, routines to automate some types of geometric reviews

Opportunities

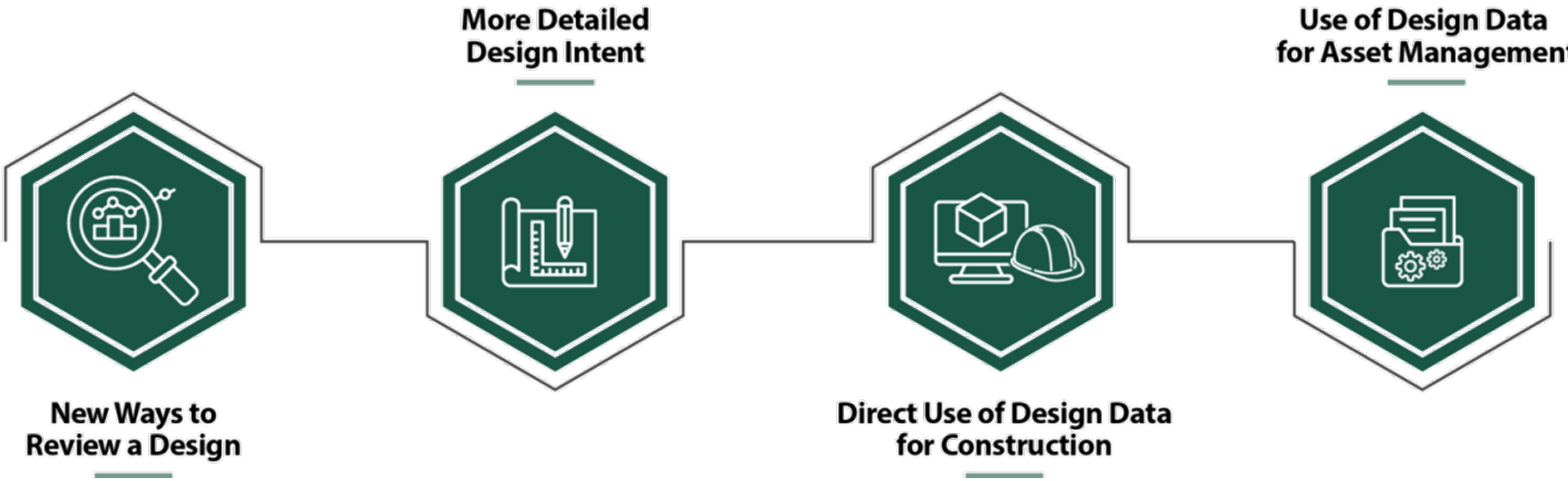

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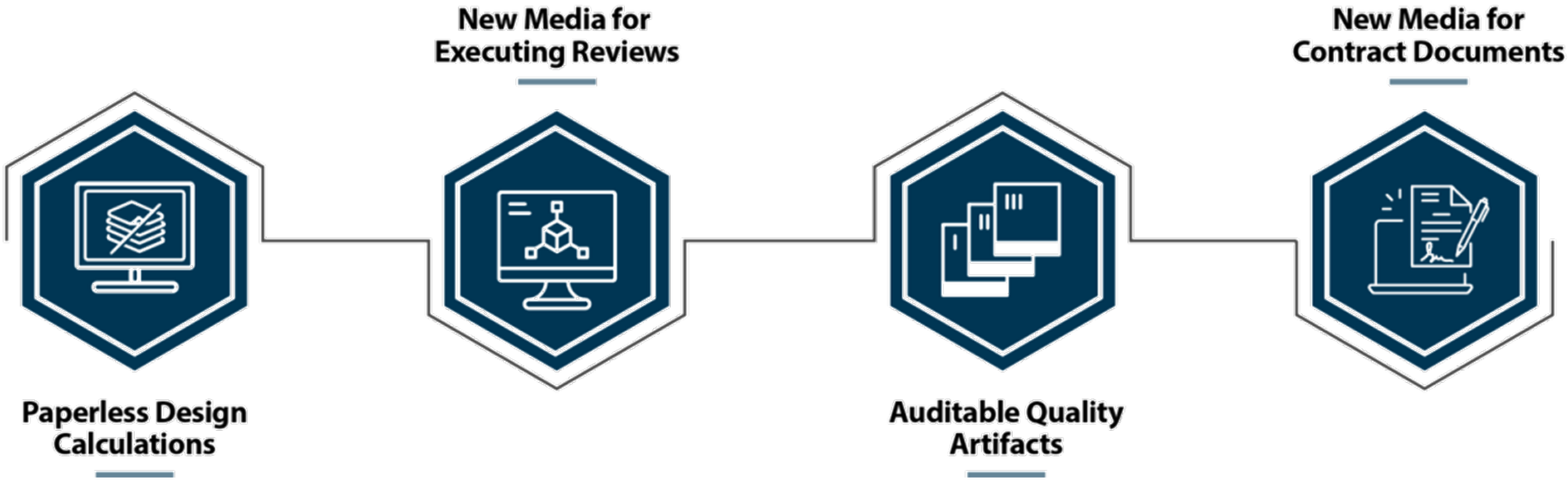
Figure 2 in Quality Management Guidebook

Challenges



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Guidebook Outline

Chapters

1. Introduction
2. Quality Management Concepts
3. Records Management
4. Model Reviews
5. Components of Review
6. Agency Considerations for Implementing this Guide

Appendices

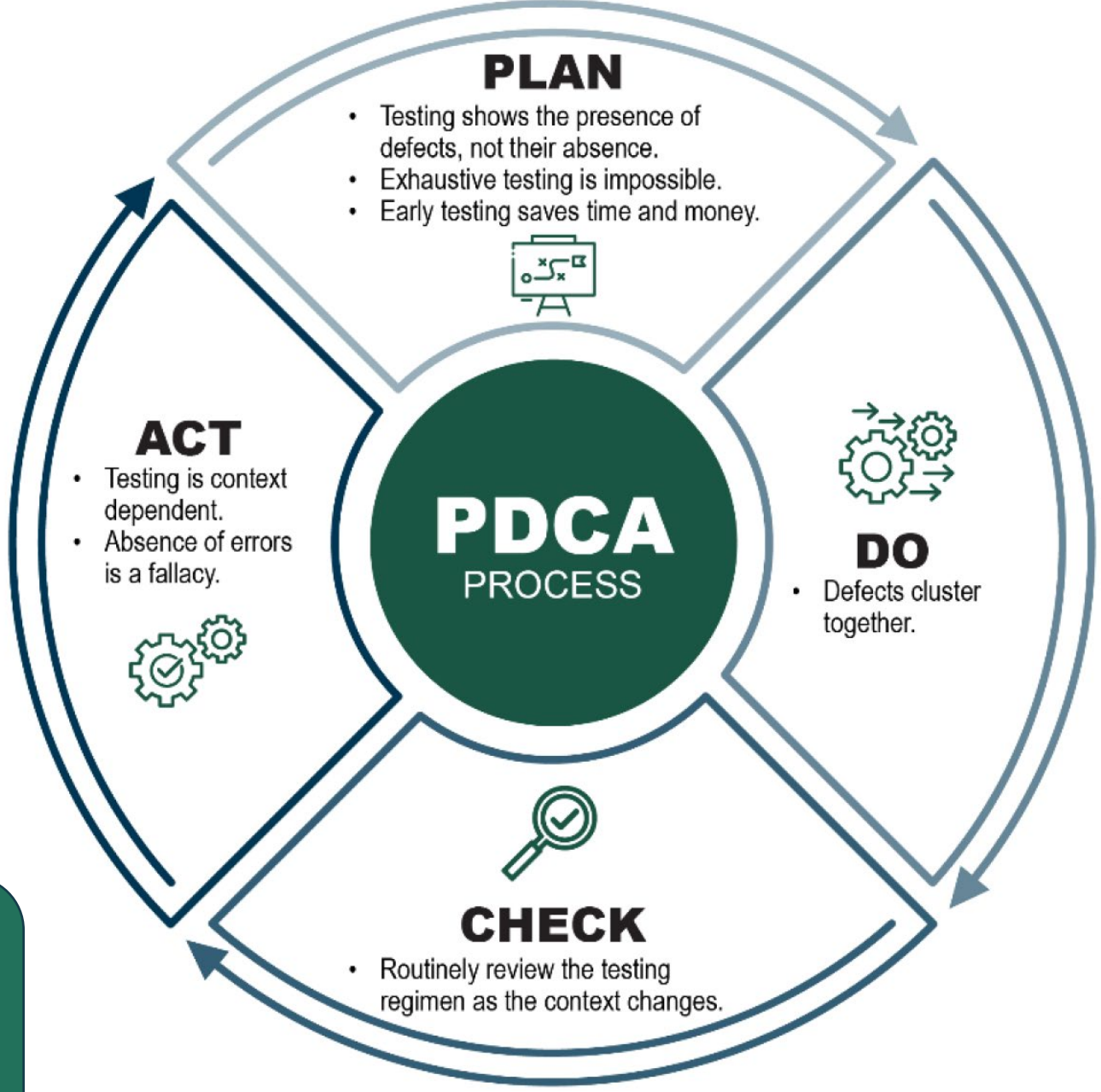
A. Glossary of Terms
B. Model Elements Taxonomy
C. Review Documentation Property Set
D. Competencies
E. Review Procedures
F. Sample Quality Artifacts

Quality Management Concepts

International Standards

- ISO 9000 series of standards for Quality Management Systems
- ISO 9000 establishes quality management system concepts including the “Plan-Do-Check-Act” process
- ISO 9001 establishes a certification framework for Quality Management Systems

A Quality Management System needs to be monitored for its effectiveness and routinely updated to reflect new practices or priorities.



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International Standards – ISO 19650

- ISO 19650 is an Information Management standard for Building Information Modeling
- Part 1 establishes concepts and principles
- Part 2 provides requirements for project delivery
- Part 4 provides requirements for information exchanges
- Part 5 provides requirements for security

ISO 19650 is compatible with an ISO 9001-compliant Quality Management System

Approaches to Controlling Quality

Process Control

- Controls how the product is produced to achieve repeatable and reliable outputs
- Requires monitoring the inputs
- Is applicable to design elements that follow a repeatable process that can be preconfigured
- Identified issues can be corrected before design is complete
- Monitoring can be automated

Product Control

- Compares the finish product to the specifications to check compliance
- Requires monitoring the outputs
- Is applicable to all design elements
- Identified issues lead to rework
- Monitoring is labor intensive

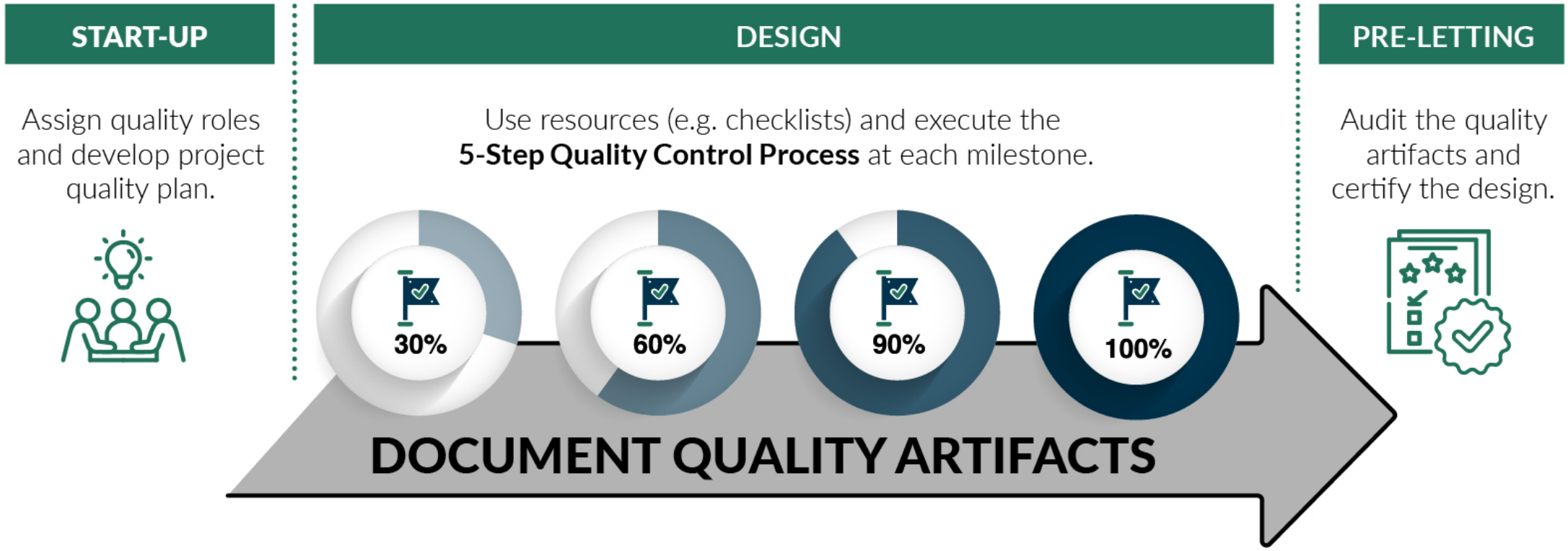
Process Control Examples

- Use a standard workspace configured for roadway design standards
  - Roadway elements can only be created in a way that meets standards
- Use a standard workspace configured for bridge design standards
  - Designers can only select from a catalog of girders that match the standards
- Use a MatLab model from a standard library that has been carefully tested

Quality Management System Notable Practices

- Clearly defined QC roles
- Standards for software, models & documentation
- Design manuals or documented criteria
- Checklists
- Project quality plans
- Quality audits
- Certification

Project Quality Management Process on a Project



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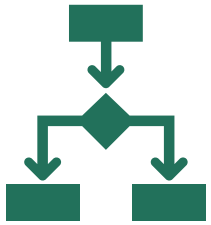
3D Model Reviews

Structured Review Definitions

In the Chapter



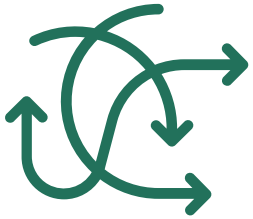
Purpose and Outcomes

Scope of review for different types of deliverables

Required documents to execute the review

In the Appendices

Competencies to execute the review



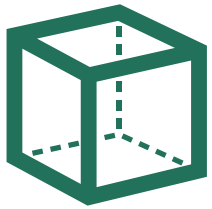
Detailed Procedures

Sample quality artifacts

Review Categories

Model Structure and Composition

3D Model Standards



3D Model Integrity

Design Compliance

Survey

Design Discipline (including Quantities)

Clash Detection and Spatial Coordination

Model Structure and Composition Reviews

- Addresses the use of modeling standards e.g., software configuration or workspace and naming conventions, model structure, templates or assemblies, element types, styles, and Level of Information Need (LOIN).
- Introduces the model structure and composition review types:
  - **Modeling standards:** compliance with the agency's CADD/BIM/Model Development standards
  - **Model integrity:** the modeling structure.

Design Compliance Reviews

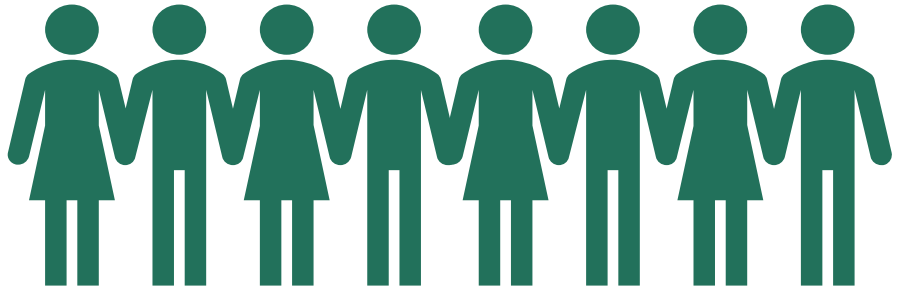
- Addresses the conformance of the model with the design *and* the conformance of the design with the applicable codes, standards, and technical criteria.
- Introduces the three design compliance review types:
  - **Survey:** compliance with agency geomatics or survey specifications for developing and delivering existing conditions models.
  - **Design Discipline:** overall functionality of the design and compliance with project requirements for design standards, design intent and project milestone deliverables, constructability, quantities, and cost estimates
  - **Clash Detection & Spatial Coordination:** analysis of each discipline model to evaluate the position of discipline specific model elements in relationship to each other as well as in relation to model elements from other disciplines.

Roles and Responsibilities

Responsibilities of **quality management roles** include originator, reviewer, back checker, verifier, certifier, and auditor.

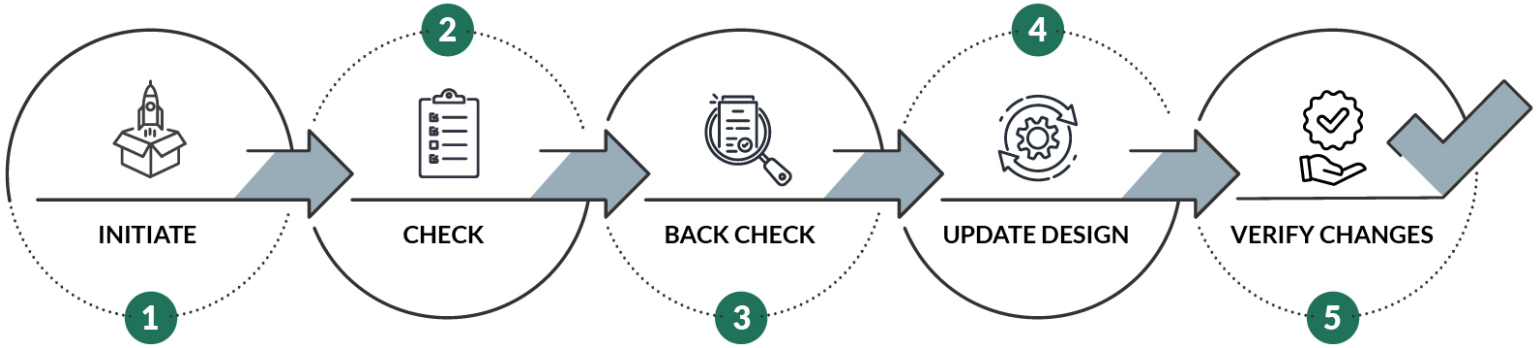
These responsibilities can be distributed across **project roles** depending on the project size and reviewer type such as:

- Project Manager
- Design Manager
- Discipline Lead
- CADD/BIM Manager
- Discipline Model Manager
- Model Authors
- Quality Assurance Manager

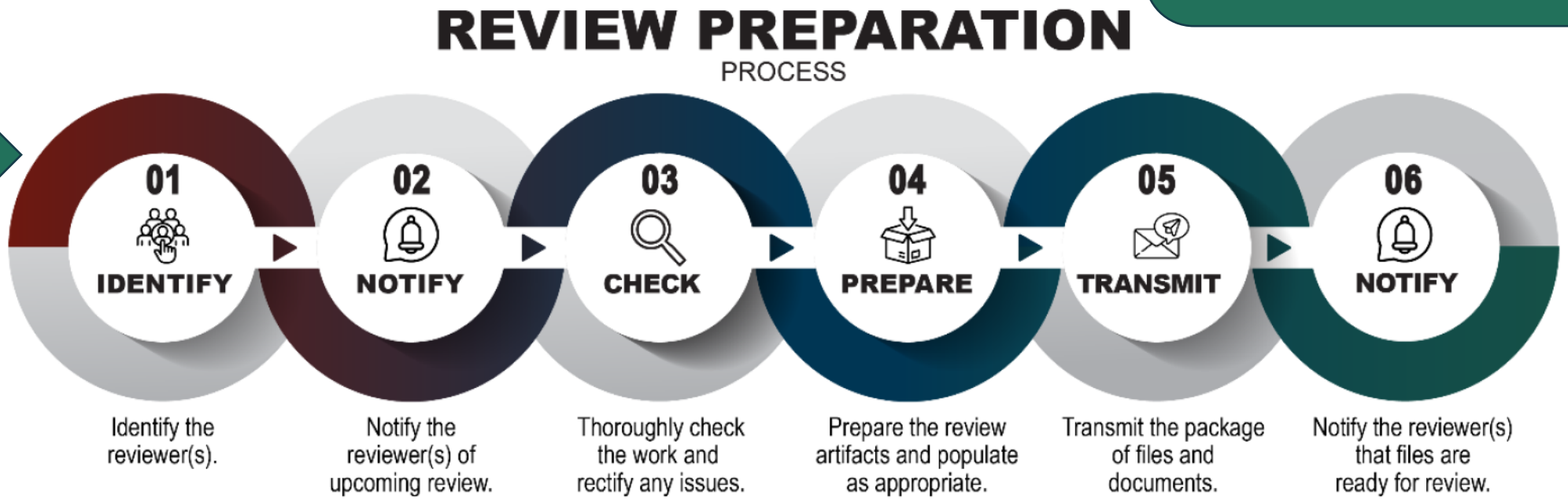


Agencies can use Appendix C to correlate **defined property sets** that can be attributed to model files based on review fields for these responsibilities.

Quality Management Process for a Deliverable



Review preparation emphasizes the need to check one's own work before submitting the work for review.



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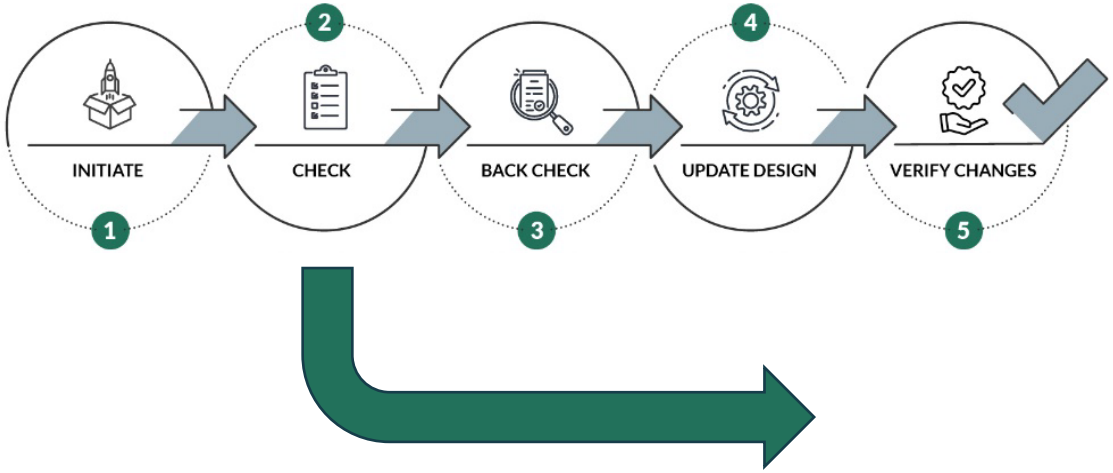
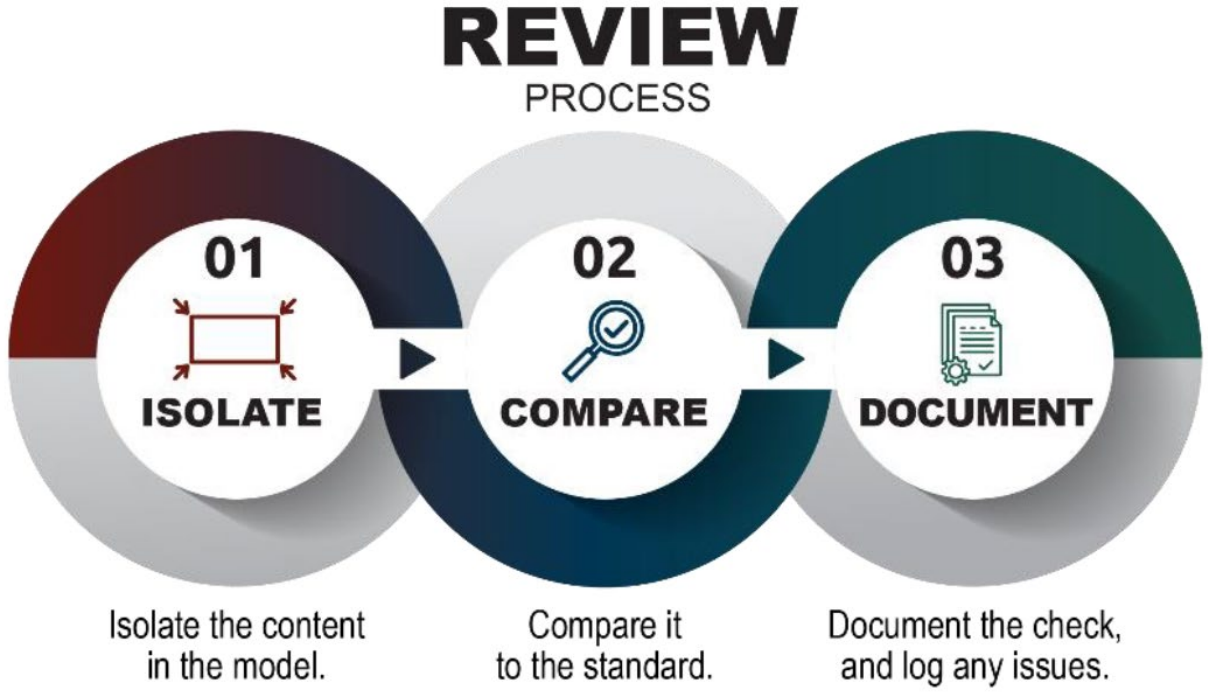
Quality Management Process for a Deliverable Continued





The high-level procedure for Design Intent reviews is relatively simple, but in practice it requires two distinct skillsets:

1. Domain expertise to navigate the design standards, and
2. Modeling skills to open the file, isolate content, and view the properties.

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Review Process and Preparation

4 key areas that need to be updated

- Review Timeline with new review types
- Preparing a Model for Review
- Review Protocols
- Standardizing Clash Routines

Section 4.5.3 provides guidance to agencies to establish their own review protocols. Appendix E provides an example set of review protocols.

	Survey	Discipline Design	Spatial Coordination	Model Standards	Model Integrity
Pre-Design	✓	N/A	N/A	✓	N/A
30% Design	TBD	✓	✓	✓	✓
60% Design	TBD	✓	✓	✓	✓
90% Design	TBD	✓	✓	✓	✓
Final Design	✓	✓	✓	✓	✓

Competencies

Competencies included in the Appendix

- CADD
- Common Data Environment
- Design

Appendix D contains a library of competencies organized in categories and sub-categories

Foundational

ID	Competency	Prerequisite(s)
CAD1	Apply file naming conventions that identify the model type	N/A
CAD2	Identify the correct software to open a file	CAD1
CAD3	Access a software feature that displays a list of objects in a model	N/A
CAD4	Interpret 2D and 3D model elements and relate to design features	N/A
CAD5	Make a copy of an object	N/A

Competencies can be used to develop and expand review types and develop customized training content for specific roles

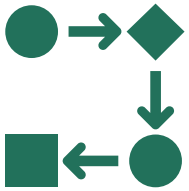
Review Procedures

- Review Initiation
- Modeling Standards Review
- Model Integrity Review
- Survey – Geodetic
- Survey – Topographic Features and 3D Surfaces
- Survey – Land Boundaries & ROW
- Discipline Design Review
- Clash Detection and Spatial Coordination

Chapter 4 defined the scope of the review & review information needed for the review procedures

Appendix E combines competencies and step by step review procedures

Core competencies for executing review



Review Procedure

Setting Up for Success

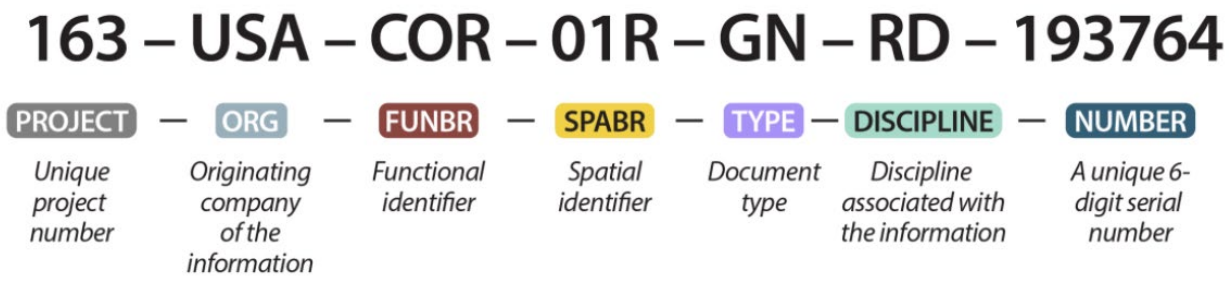
Components of Successful Review Processes

A standard approach to model development provides the design team and reviewers with a structured framework for planning, creating, and verifying model-based deliverables. Chapter 5 covers:

- Information Modeling Standards
- Common Data Environment
- Naming Conventions
- Software Configuration Development and Management
- Model Management Tools

Describes the role of Level of Development (LOD) / Level of Information Need (LOIN)

A sample naming convention based on ISO 19650-2 can be used to develop an agency's standard



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Information Modeling Standards

Information Modeling Standards specify the level of detail and information for a specific purpose.

- Geospatial positional accuracy and point density requirements for base survey mapping

Appendix E for Survey Review Procedures

- Object-based design elements organized following a specific Model Element Table

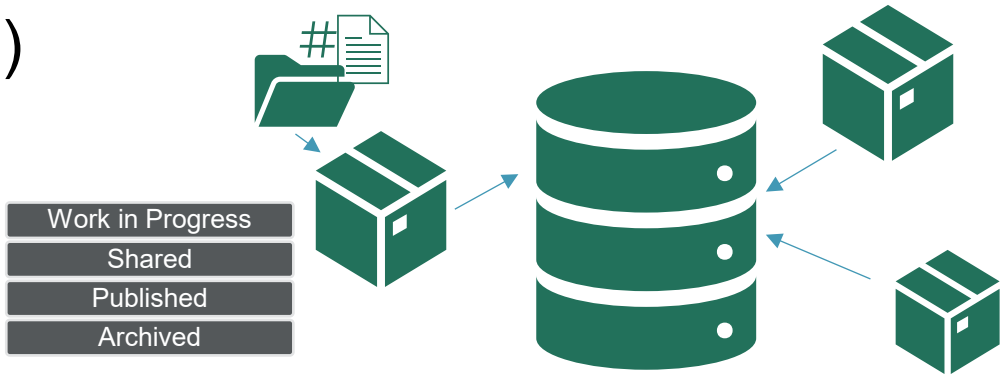
See Appendix B for the Model Elements Taxonomy

- Level of detail and information specified by milestone deliverable
- CAD standards for software configuration

Common Data Environment

CDE - a **collaborative space** for production of federated models that bring together information containers from multiple sources and parties

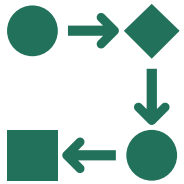
- Processes for approval and records management
  - Notifications and alerts plus **audit trail**.
  - Workflow engines to **automate** review and approval processes.
  - **Configure workflows** to project methods and procedures.
- Protects the security and quality of information throughout production, review, and delivery.
  - Permissions controls (gated CDE workflows)
- Information Containers



Software Configurations

- Specifications for software configuration
- Requirements for software packages and versions for the development of models (if applicable)

Sections 5.2.3 & 5.2.4 provide guidance to agencies on naming conventions, drawing symbology (e.g., points, lines, annotation), 2D and 3D object libraries, etc.



Customized ***repeatable*** processes and workflows using modeling standards.

Consistency with design and modeling standards between users

Ability to implement **process control** and checks against the configuration.

Model Management Tools

Model Content Documentation tells reviewers what is in the model, saving time and providing a resource to compare with agency standards.

- BIM Execution Plan (BEP)
  - **File** List and Types
  - Model Uses
  - Review tracking

Provided to reviewers for their reference to understand the project needs and implementation process for model generation.

- Model Element Table (MET)
  - Standardize for consistency
  - **Object** information
    - What's Included
    - LOD/LOIN

Agencies can incorporate a MET into a formal review process by maintaining a scalable template for different project types.

Review Tools and Job Aids

Review tools and job aids that form the primary tool for executing reviews, i.e., include:

- Checklists
- Generating Reports
- Automated Tools
- Software Applications for 3D Model Reviews

Section 5.3.1 provides guidance to agencies to establish their own. Appendix F provides example checklists.

Each section provides details on the types or categories of tool and job aid and provides guidance to agencies on implementing these core elements of how the 3D model reviews are executed as part of an agency's standards and policies.

Agency Considerations

For Implementing This Guide

Recommendations

Change Management and Workforce Development

- Establishing roles and responsibilities
- Defining competencies for model-based design reviews
- Setting up committees, working groups, and collaborations with peer agencies

Planning Changes to the Quality Process

- Reviewing and updating current quality management policies and procedures
- Implementing agency-specific standards, job aids, and quality artifacts

Technology: Current Functionality and Future Developments

- Evaluating technology relevant to the quality management of 3D models
- Partnering with software vendors to develop short and long-term strategies for successful implementation

People: Change Management & Workforce Development

While the roles and responsibilities of design team members are not dramatically changing, the competencies required, and methods used to perform and document reviews are different for a model-based environment.

This section describes recommendations for short and long-term activities related to upskilling the current workforce, including:

- Agency Recommendations
- Coordination, Collaboration and Partnerships
- Training Content and Delivery

Appendix D provides 3D modeling competencies. Appendix E lists the competencies required for each of the five review types.

Process: Planning Changes to the Quality Process

This section provides recommendations for agencies updating the quality management process. Three key areas are identified that may need to be evaluated and updated.

- QA documentation requirements
- QC standards and procedures
- Review tools and job aids

Chapter 3 provides recommendations for management of digital records. Appendix C offers a collection of review documentation property sets.

Items to consider during evaluation include updating or establishing roles and responsibilities, introduce new documentation, update standards and criteria for review processes, and create or update modeling standards.

Review Tools and Job Aids

This section describes items to consider while evaluating software and updating job aids.

- Assess current CDE
- Acquire model based review tools
- Working with vendors on configurations
- Updating checklists or other job aids

Chapter 5 has general recommendations. ISO 19650-1 defines functional requirements for procurement of a CDE.

Sample checklists are provided in Appendix F for reference.

Process: Implementing Standards and Process Control

Section 6.3.2 and 6.3.3 provide guidance on defining and implementing processes for:

- Establishing Information Modeling Standards
- Leveraging modeling software configuration to create a consistent and repeatable model-based design processes
- Creating on boarding training procedures

Don’t forget!

Product Control vs Process Control

Technology: Current Functionality and Ongoing Developments

This section provides a summary of current software functionality and gaps, existing automation tools and the role of open data standards

Existing automation tools can be broken into three types

- CADD Standards Compliance Checks
- Design Code Compliance Checks
- 3D Design Review and Clash Detection Checks

Human reviewers are essential for checking nuances of design, but software can provide automated checks of design standards and changes between milestone reviews. It is important for agencies define their standards and functional requirements based on performance outcomes rather than prescriptive methods.

The Role of Open Data Standards

Current development for the deployment and adoption of open data standards is being developed through two AASHTO Pooled Funds:

- TPF-5(372) – Building Information Modeling (BIM) for Bridges and Structures
- TPF-5(523) - Building Information Modeling (BIM) for Bridges and Structures – Phase II

Open data standards rely on the IFC schema that is used to reference model elements within a design to the IFC data structure.

In relation to quality management:

- buildingSMART IFC File Validation Service
- Information Delivery Specification (IDS)

Summary

NCHRP 10-113: Quality Management for 3D Model Based Project Development & Delivery

Deliverables include:

- Guidebook
- Final Report
- Implementation Plan
- Outreach Materials: Webinar
- Data Dictionary for Quality Management Metadata

Research objective was to develop a guidebook that can serve as a national industry reference for quality assurance with 3D model-based project delivery

The guidebook provides a **consistent**, **repeatable**, **reproducible**, and **traceable** quality management process that is equal to or better than existing paper-based processes.

Questions

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Upcoming events for you

January 11-15, 2026

2026 TRB Annual Meeting

Washington, DC

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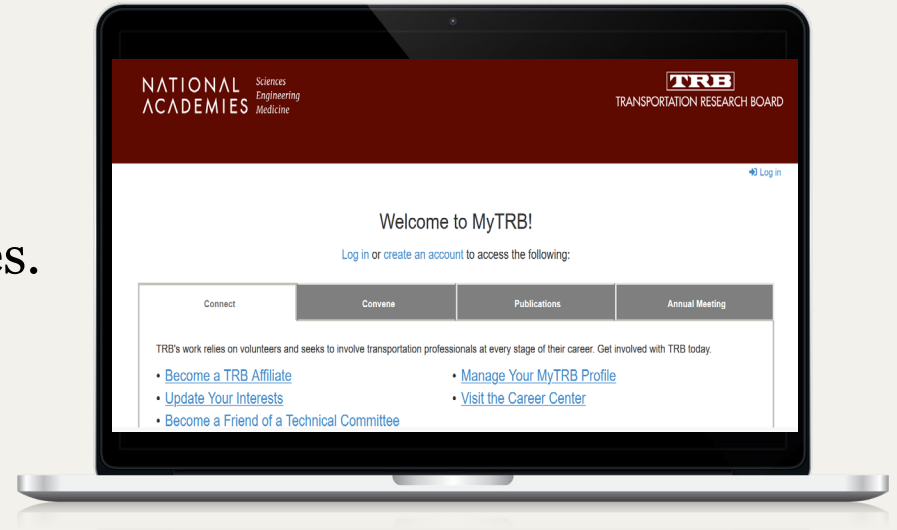

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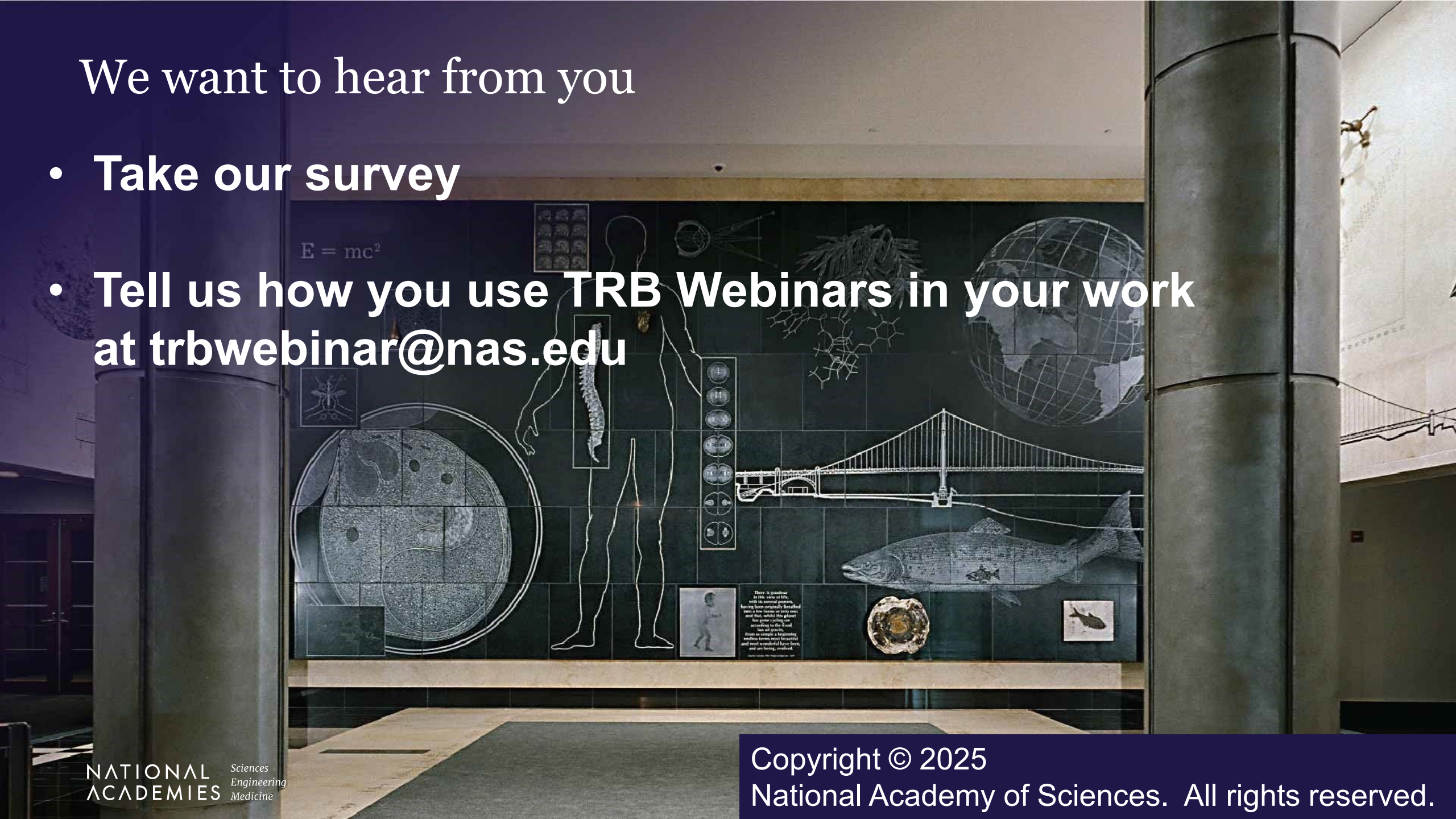

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