Implementing a Model Based Approach to Design and Construction at Wisconsin DOT

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Topics

- WisDOT current AMG and model practices
- Changes to design to deliver 3D models
- WisDOT's model-centric approach to design
- Implementation status (lessons learned)
Model-Based Design Part of WisDOT Implementation of 3D Technologies

- Plan with Five Active Initiatives:
  - Statewide Real-Time Kinematic GPS Network
  - DTM Data Collection
  - 3D Design
  - Automated Machine Guidance
  - Field Technology and Inspection

WisDOT Model Concept Definitions

- 3D Surface Model
  - Produced for projects with Grading work
  - Includes surfaces for AMG operations of Grading, Base Course, and Paving
  - Initial model deliverable requirement will be 3D Surface Models

- Roadway Model
  - Evolution of model concept to include information for increased utility in design and construction processes, and ultimately expanded to downstream roadway lifecycle processes
3D Surface Model Content Concepts

- Surfaces
  - Exist, Top, Base Course, Subbases, Datum, Pavement
- Surface model data density will be design speed dependent
- Surface models must be synchronized with plan sheets
- Additional content
  - Longitudinal breaklines
  - Horizontal alignments
  - Vertical profiles
  - Superelevation transition information
- Fully staged model requirement will be decided on project-by-project basis
3D Surface Model Requirement

- WisDOT will implement a 3D surface model delivery requirement on projects starting after July 2014.
- Model content requirements and other details will be released later this year.

Design requirements based on construction needs

- Design workflow goal to develop construction ready surface models during the design process
- Must produce surface models with sufficient detail to support AMG operations
- 3D surface model output must be synchronized with plan sheets
What design requirements really mean

- 3D models need to be created in a 3D environment, not reverse-engineered from 2D
- 3D model will have much more detail than plan sheets
- Models will be data source for plan sheets
- Plan sheets need to have live connection to models
  - Reduce errors, maximize efficiencies, plan document is contractual

WisDOT’s approach to model-centric design (short version)

The standard method of designing highway projects with elevation data will be to develop 3D models.
WisDOT’s approach to model-centric design (long version)

- Transition from CAiCE and 2D workflows to AutoCAD Civil 3D and 3D model workflows
- Begin with 3D surface models for grading and base course as foundation
- Work towards expanding 3D surface models to paving, expanding roadway models, and advanced uses of models
- 3D surface and roadway models will be required design deliverable beginning 2014

WisDOT roadway design workflow

- The foundation of the roadway design workflow is corridor design

- 3D based tools are used to further define surfaces (gradings, feature lines, etc)
WisDOT roadway design workflow

◆ The roadway design workflow stresses 3D surface model development from the beginning, minimizing work needed to add required detail into design output.

WisDOT roadway design workflow

◆ Contains quality control mechanisms to help ensure 3D surface models match plan sheets
  ✓ Corridor surface - paste into refinement surface
  ✓ Add 3D definition to refinement surface the corridor doesn't model well
  ✓ Refinement surfaces used for:
    - AMG surfaces
    - cross sections
    - sheet data
How WisDOT is transitioning to models

- Provide transition timeframe (2 years)
- Provide training
  - Online, video-based training (80-100 hours for design)
  - Supplement with support and in-person sessions
- Workflow lifecycle
  - Get tools and training out to users, listen to feedback, roll improvements back into files and training, repeat

WisDOT Civil 3D training system

- Pdfs of written documentation organized by subject matter
- Contains both basic Civil 3D material and WisDOT workflows
- Training track PDFs organize material into job duties
- Most subjects have video material and exercise files
- Free and publicly open
WisDOT Civil 3D training system

- Face-to-face time
  - In-house staff – monthly office visits
  - Consultants – WisDOT-approved trainers
- End-user support
  - Email, phone, remote sessions

Implementation scope

- 300 in-house staff, approximately 800 consultants
- Windows XP to Windows 7 64-bit
- CAiCE/MicroStation to AutoCAD Civil 3D
  - Install customizations
  - Custom code (macros, subassemblies)
- 2D workflows to 3D workflows
  - Mostly impacts design with ramifications on plan production
**Implementation approach**

- Put together best practices internal to Methods Development with expert review
- Release standards and workflows statewide to early adopters
- Rely on early adopters for feedback
- Roll improvements to standards, workflows, and training back into the system
- Build up local expert base

So how’s that going for ya?

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**Software conversion issues**

- Lots of MicroStation experience going to AutoCAD
- Understanding AutoCAD/Map/Civil differences
- Moving from simple graphic elements to intelligent objects
- Learning all the possible live connections, what breaks them, refresh scenarios
**2D to 3D issues**

- Can be very difficult for staff that have lots of experience working in 2D
- 3D workflows have far more options, tools, and commands to learn
- 3D workflows work best when more detail is put in the process earlier than 2D workflows
- 3D surfaces aren’t just for AMG, they drive plan sheets
- The “Aha! moment”
  - Once I figure this out, it will make my job easier and my product better.

**General observations**

- Staff that don’t have lots of experience with a different system have an easier time learning.
- Transitions work best when staff:
  - Go immediately from training to production
  - Be just in one system
  - Have time and support to learn at their own pace
- Building up local expert base has been a challenge
Top lessons learned

- If you have elevation data, you’re designing a 3D product whether you can see it or not.
- The corridor model is not the output. Surfaces are.
- Since surfaces are the output, build them early and make sure they’re good.
- If you don’t have enough time to build fully-detailed models all at once, build good detail from inside to out.

Top lessons learned

- 3D models in design will impact design as much or more than construction.
  - 3D design review
  - Further model development (structures, lights, sign bridges, plantings, you name it)
  - Sharing models with others
Top lessons learned

- Designing in Civil 3D and producing sheets in MicroStation is not an optimal workflow.
- Most people aren’t excited about changes to their tools and work.
- If you’re going in the right direction and communicate to people, they’ll accept a lot of change in a little time.
- And the one thing that is true that people don’t believe:

Shocking, but true

- When workflows are focused on building 3D deliverables, adding them to existing deliverables does not noticeably increase total workload.