MACHINE CONTROL CONSTRUCTION AND 3D DESIGN

**IOWA DOT’S EXPERIENCE**

West Virginia DOT Designers Conference

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Iowa Department of Transportation
PRESENTATION OVERVIEW

• How We Started with AMG
• Where We Are Today with AMG
• Overview of Our 3D Design Effort
• Next Steps
• Benefits of 3D Design
• Future Direction
HOW WE STARTED:

• In March of 2003 we laid out several long range goals for the Office of Design. Two of which were:
  • Move from our traditional 2D design environment to designing in a 3D environment.
  • In addition we wanted to be able to provide the contractor with the necessary files to perform machine control grading.
HOW WE STARTED:

• We worked with the Center for Transportation Research and Education (CTRE) at Iowa State University on literature search of the state of the practice.

• We met with:
  • Contractors (McAninch)
  • Equipment manufacturers (Catepillar)
  • Makers of the GPS equipment (Topcon, Leica, Trimble)
HOW WE STARTED: OUR INITIAL AMG PROJECT

- At that time we pulled 2D cross sections into a 3D model.
- We provided files in ASCII, Land XML, & Trimble Terramodel.
- We reduced our cross section spacing from 25ft. to 10 ft.
- We were not able to model the entire project and identified those locations in the plans.
HOW WE STARTED: OUR INITIAL AMG PROJECT

• Our first pilot project was let in January 2006
  • A 9 mile grading project let in 4 section and awarded to 3 contractors
  • The use of AMG was mandatory
  • Two contractors used Trimble equipment and one used Topcon.
The shaded areas on the map highlighted by the arrows designate the areas where machine control grading information was not available.
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SOME KEY TAKEAWAYS:

• Don’t Reinvent the Wheel. Imitation is the sincerest form of flattery and sometimes the best way to make progress.

• Work Closely with you AGC

• Work Closely with your Contract Administration Staff

• Work Closely with your Survey Professionals
WHERE ARE WE TODAY WITH AMG?

• According to the Office of Contracts, since 2006
  • Let approximately 75 machine control grading projects,
  • 25 machine guided paving projects,
  • Two stringless paving contracts involving PCC Overlays.
  • Involving over 30 contractor

• All files are provided pre-letting as part of the bidding package.
WHERE ARE WE TODAY WITH AMG?

• We provide files in a generic format that can be converted to something more specific.
  • Alignments in LandXML
  • Surfaces in LandXML
  • 3D Line Strings in DXF

• The paper plans are still the controlling document and the electronic files are provided as information only. However; we let one project in January where the electronic files for AMG have precedence over the plans.
WHERE ARE WE TODAY WITH AMG?
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LESSONS LEARNED FROM OUR AMG EXPERIENCE

• If possible make your first pilot project mandatory AMG.
• Meet regularly during the project with the contractors and your Contract Administration staff.
• Start small. It’s easier to build buy-in if you can demonstrate some early success stories.
• We have found that both paving and grading contractors prefer using 3D line strings because they are more accurate.
• Develop guidance on plan review or validation of the electronic files.
LESSONS LEARNED FROM OUR AMG EXPERIENCE

• Design your models at the correct interval.
  • After speaking with the industry we chose 5 foot minimum. We have heard that some modelers are going down to 2.5 or less to insure a smooth surface.

• Return on Investment: The answer isn’t easily quantifiable, but our experience has shown that it has been well worth the investment.
3D DESIGN EXPERIENCE

- In Iowa, the design effort is primarily centralized to the main office, with rehabilitation projects designed by the Districts.

- Our workload is 70% in-house design and 30% by consultant. That is in terms of both number of projects and the dollar amount.

- We moved to a 3D Environment in 2009 when we migrated to Bentley’s Corridor Modeler software.

- We are in the process of migrating to Bentley’s MicroStation V8i Select Series 4 (SS4). January 2016 all new projects will be in SS4.

- All of our projects are now designed in 3D, with the exception of 3R and maintenance projects.
KEY TAKEAWAYS FROM OUR TRANSITION TO 3D DESIGN

• **Just in time training.** This is essential to gaining early success, and sustaining it through implementation. Make sure as designers are trained they can immediately apply what they have learned to a real project. Studies show that retention is down to 25% after 5 weeks if they are not able to apply what they have learned.

• **Designer Resources:** Documentation and videos outlining how to perform certain tasks is also valuable. We have developed a video library to supplement our training effort. We also have documentation on the level of detail required at the major milestones in our development process.
DESIGN GUIDANCE: 30 PERCENT DESIGN
DESIGN GUIDANCE: 60 PERCENT DESIGN
DESIGN GUIDANCE: 90 PERCENT DESIGN
DESIGN GUIDANCE:
WHAT NOT TO MODEL FOR AMG
DESIGN GUIDANCE:
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KEY TAKEAWAYS FROM OUR TRANSITION TO 3D DESIGN

• **IT support is crucial to success.** That support can either be internal IT staff and through your software provider if that is available but it is a fundamental block to your success.

• **Designing in 3D will take more time.** We estimate 5-10 percent more depending on the complexity of the projects, and the experience of the designer. This is not necessarily because designing in 3D is more difficult as much as it is elements that may have been left to a detail sheet or standard drawing are now worked out in the model.
KEY TAKEAWAYS FROM OUR TRANSITION TO 3D DESIGN

• **Change will take time, and it will not be easy.** This is a new environment that for some will be exciting and for others it will be scary. 3D Design requires designers to think differently and you have to allow for that transition. The key is you are bound to encounter resistance, and that’s OK.

• **Not plug and play.** Take the time to review your development process and examine how moving to a 3D environment may affect your workflow. Some of the changes may be subtle, and some may result in significant changes to how work is accomplished. The key is its an opportunity to improve the process.
KEY TAKEAWAYS FROM OUR TRANSITION TO 3D DESIGN

• **Communicating Design Intent:** At the end of the day a plan is nothing more than a communication tool and what it communicates is design intent. Moving to a 3D environment provides the opportunity to communicate more effectively with designers, contractors, stakeholders and the public.
NEXT STEP: THE ELECTRONIC FILE AS CONTROLLING DOCUMENT

In case of a discrepancy between contents of the contract documents, the following items listed by descending order shall prevail:

1. Addendum
2. Proposal Form
3. Special Provision


5. Plans
7. Developmental Specifications
8. Supplemental Specifications
9. General Supplemental Specifications
10. Standard Specifications
11. Materials I.M.

Except From SP-120279
SPECIAL PROVISIONS FOR CONFORMITY WITH AND COORDINATION OF THE CONTRACT DOCUMENTS
NEXT STEP: THE ELECTRONIC FILE AS CONTROLLING DOCUMENT

1105.04, D.

Replace the Article:

The Contractor shall not take advantage of any apparent error, omission, or discrepancy in the contract documents. The Engineer will be permitted to make such correction in interpretation as may be deemed necessary for the fulfillment of the intent of the contract documents subject to compensation as provided in Articles 1109.03, 1109.04 and 1109.16. Written notice of changes in the contract documents will be given to the Contractor by the Engineer. Field adjustment of digital contract files, if necessary, will be completed by the Engineer.

Except From SP- 120279  SPECIAL PROVISIONS FOR CONFORMITY WITH AND COORDINATION OF THE CONTRACT DOCUMENTS
OTHER BENEFITS: 3D RENDERINGS
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OTHER BENEFITS: ANIMATIONS
PREPARED FOR A PUBLIC HEARING TO SHOW THE OPERATION OF A J-TURN INTERSECTION
OTHER BENEFITS: INCORPORATING LIDAR

TopoDOT by Certainty 3D and Leica CloudWorx
OTHER BENEFITS: INCORPORATING LIDAR
OTHER BENEFITS: INCORPORATING LIDAR
OTHER BENEFITS: INCORPORATING LIDAR
THE FUTURE OF PLANS

QUESTIONS?
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