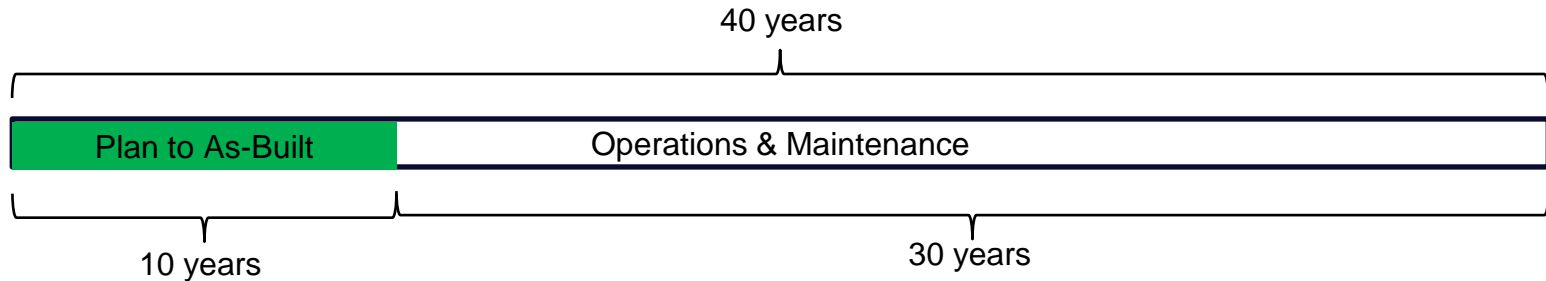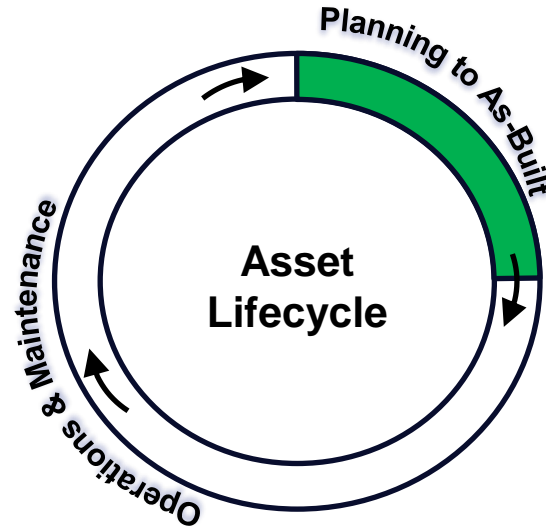# Digital Project Delivery

Digital Delivery Geometric Consistency Concerns

TRB Geospatial and Geodetic Aspects of
Building Informational Modeling Subcommittee, AKD70(2)

Joe Bima

Digital Project Delivery − Asset Centric Paradigm

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The Problem - A Reality Gap

Status

Engineering Design, Construction, and Asset Management Based on

2D + 1D

2D + 2D

(Hz & Vert Survey and Plan & Profile Sheets)

Desire

Digital Delivery and Model as the Deliverable Based on

3D

(3D Coordinate Systems)

Problem

The Underlying Reality is That:

2D + 1D ≠ 3D
2D + 2D ≠ 3D

Disconnect Produces

- Project Errors
- Schedule Delays
- Increasing Costs

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2D + 2D
2D + 1D

Plan & Profile Sheets
Hz & Vert Survey

- Has worked for 1000's years

- **IN**compatible with 3D Software
- **IN**compatible with GNSS
- **IN**compatible with Robotics

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3D

Computer Model Frameworks

- Natural System for Software
- 100% Compatible with GNSS

- Does **Not** Fit 2D+1D Paradigm!
- INcompatible with Survey
- INcompatible with Water Flow

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3D+g

Computer Model Frameworks

3D Spatial Plus Gravity

- Natural System for Software
- 100% Compatible with GNSS

- Does Fit 2D+1D Paradigm!
- Is compatible with Survey
- Is compatible with Water Flow

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2D + 2D ≠ 3D

2D + 1D ≠ 3D

The Digital Reality Gap

- Ignoring this is Huge Problem
- Wishful Thinking **Won't** Work

- Reality-Aware Engineering Will Solve This

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Digital Reality Gap

Owner Expectations

100% digital twin ecosystem for
civil infrastructure assets

Physical Asset ◀◀◀ ▶▶▶ Digital Twin

Graphic from UDOT

Physical Reality

Physical Asset — Digital Reality Gap — Digital Twin

Modified from UDOT
Graphic

Objective: HOW to close the Digital Reality Gap

Drivers:
- Asset Lifecycle
- DPD/MALD, DAB, O&M
- NGS modernization
- Convergence of workflows
- Innovation
- Safety

- Interoperability
- AI
- $s
- re-thinking traditional engineering methods

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Convergence = Digital Twin

Technology and Objectives

Digital Twin

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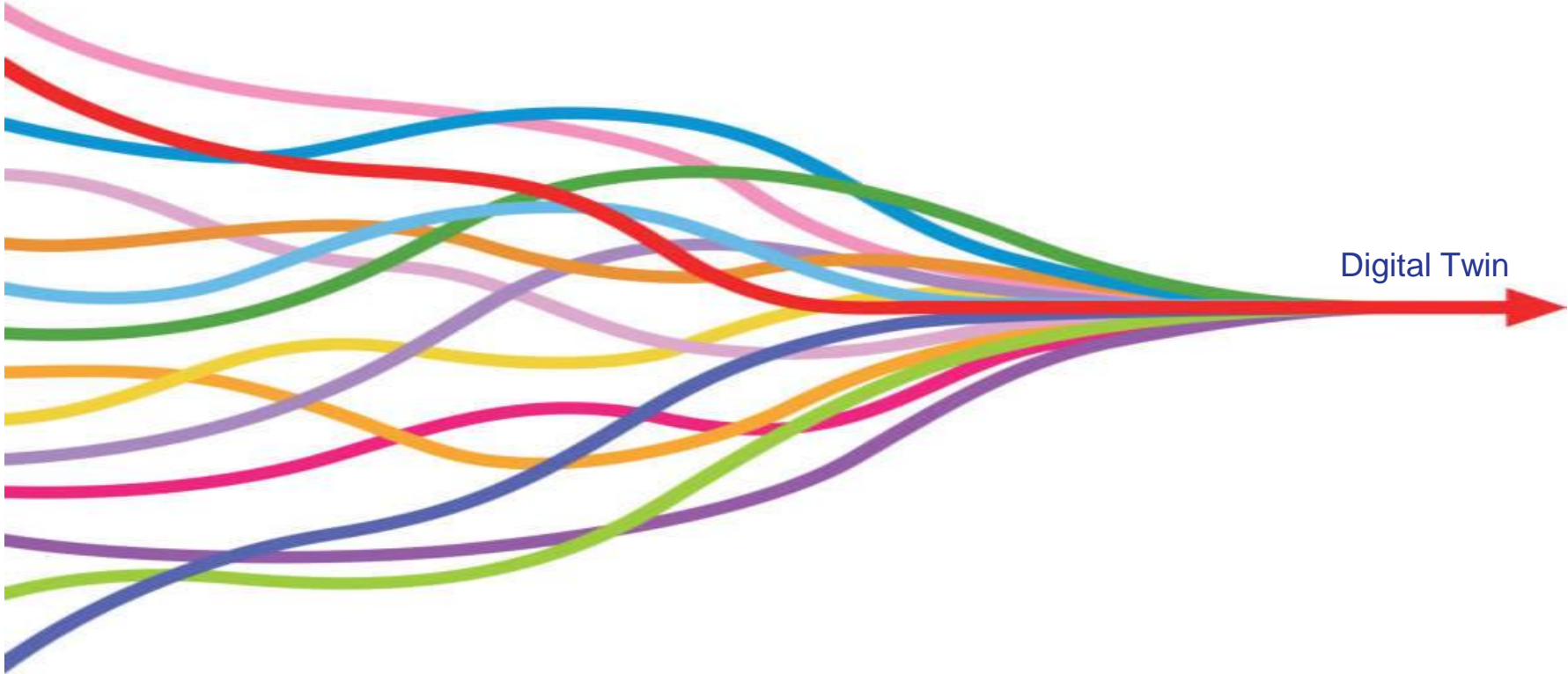
Challenges deep-dive

Challenge 1	Challenge 2	Challenge 3

Awareness

Many individuals and organizations do not realize the significance

Education

Understanding what the problem is, where it occurs.

Solution

Foster incumbents and new entrants to create products / resources that bridge the reality GAP, but first, they must know what to solve for.
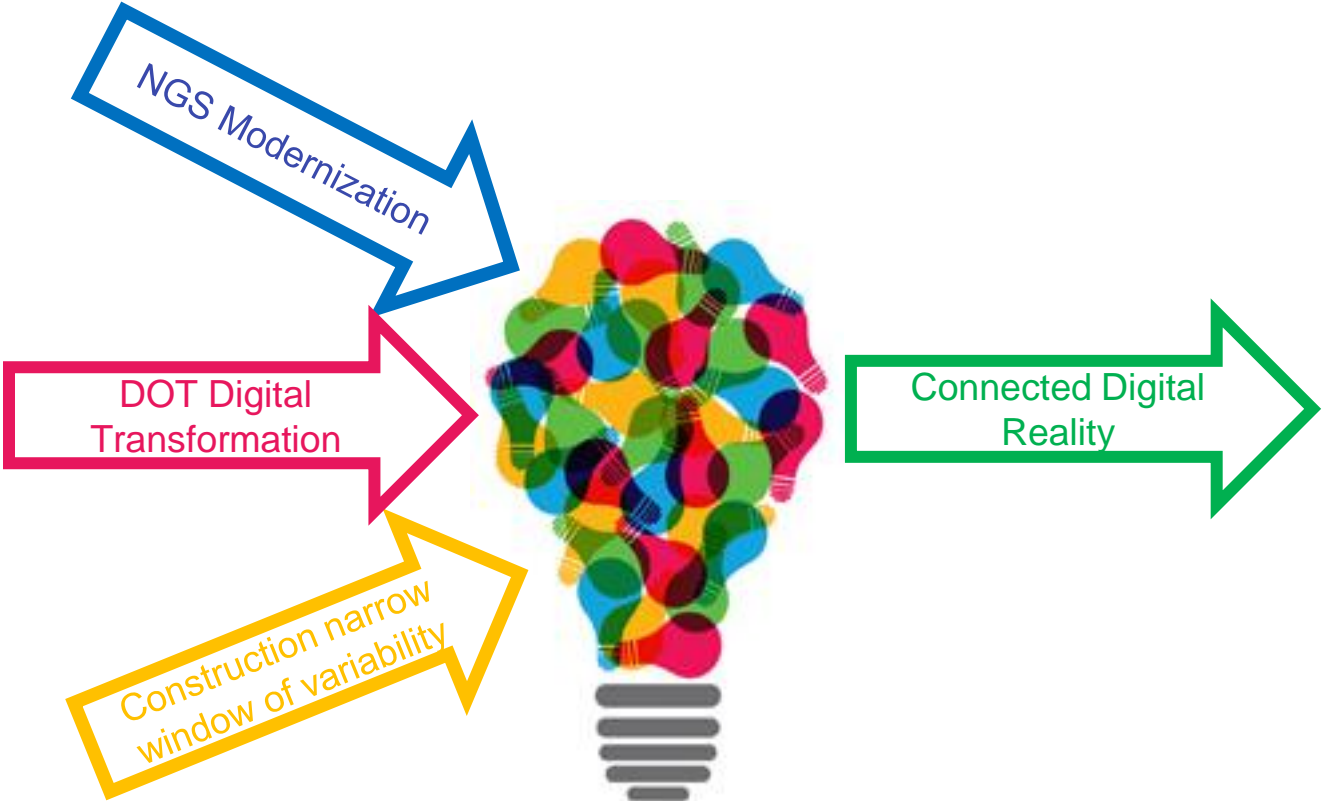
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Solution

Reality Aware Digital Delivery

A Digital Deliverable that:

- Uses 3D Internal Foundation
- **Integrates** 2D + 1D Modeling
- Supports 3D **and** 2D+1D Uses

A <u>Long Term Asset</u> for Designers, Builders, Owner and Operators

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Convergence breeds opportunity to Innovate

NGS Modernization

DOT Digital Transformation

Construction narrow window of variability

Connected Digital Reality

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Implementation ???

"In the long history of humankind (and animal kind, too) those who learned to collaborate and improvise most effectively have prevailed."

- Perhaps not a direct quote but highly paraphrased
from Charles Darwin's works

"The path of least resistance and least trouble is a mental rut already made. It requires troublesome work to undertake the alternation of old beliefs. Self-conceit often regards it as a sign of weakness to admit that a belief to which we have once committed ourselves is wrong. We get so identified with an idea that it is literally a "pet" notion and we rise to its defense and stop our eyes and ears to anything different."
- John Dewey

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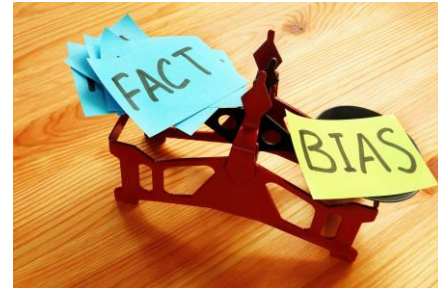
Impact

A Smooth Road Ahead
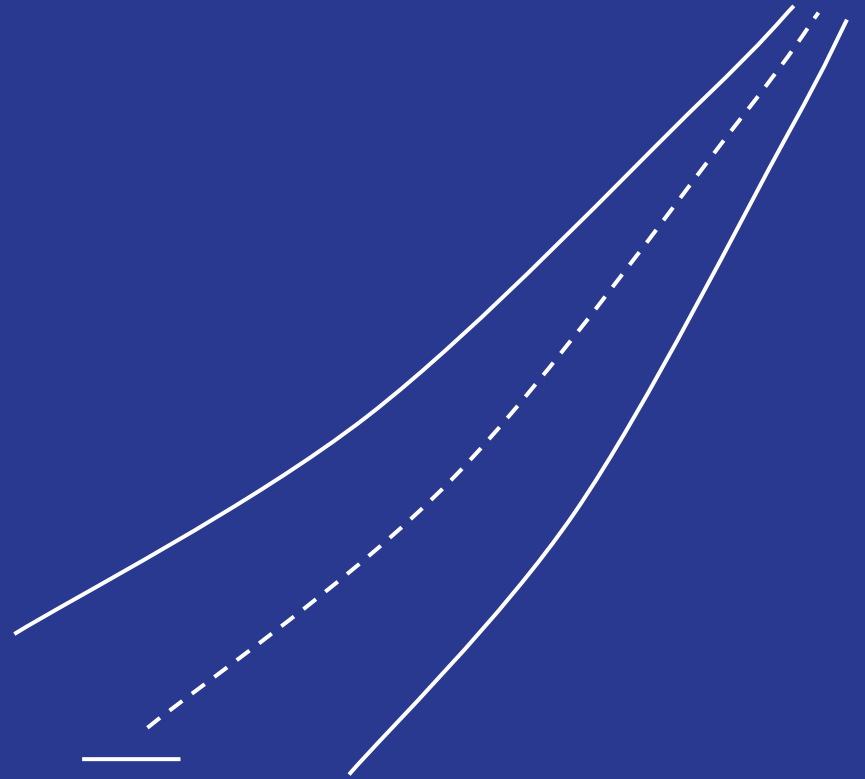
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Thank You !

Joe Bima

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Beyond 3D (x,y,z) Design Model

Beyond 3D (x,y,z) terminology/concepts forward
- Construction industry co-opted
  - 4D to equate to schedule
  - 5D to equate to cost
- Construction/physical reality
  - Introduce time = 4D (t,x,y,z) but different from the "4D" above
  - Introduce energy field (gravity) = 5D (t,x,y,z,g) but not the "5D" above

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Beyond 3D (x,y,z) Design Model

Beyond 3D (x,y,z) terminology/concepts forward
- Construction/physical reality and Digital Twin forward perhaps
  - "SpaceTime with Gravity Field" = Digital Reality (t,x,y,z,g)
  - Provide a model of Euclidean/Cartesian spacetime with an embedded scalar gravity field as an approximation to full curvilinear general relativistic spacetime

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Beyond 3D (x,y,z) Design Model

Beyond 3D (x,y,z) terminology/concepts forward
  Days of just coordinate triplets (x,y,z) needs to be done
- Must move forward with demanding additional information as a part of the 3D model … metadata
  - Reference frame
  - Quality metrics (accuracy and uncertainty)
  - Recognize time dependencies movement over years and decades)
  - Recognize gravity (vertical and level) separate from geometric coordinates

Get rid of unnecessary complications
- Map projections

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3D Model vs Physical Reality

3D(x,y,z) vs Reality(t,x,y,z,g)

Designers

Understand:
- Geometry
  (Positions and Sizes)
- **Time**
- **Gravity**

Current Delivery Models

Provides:
- Geometry
  (Positions and Sizes)

Missing:
- **Time**
- **Gravity**

Constructors

Operate In/With:
- Geometry
  (Positions and Sizes)
- **Time**
- **Gravity**

Need

A geodetic model that backfills hole in current data delivery process - an independent solution that preserve full physical information - including time and gravity as well as positions and sizes - and transfers that full information to all participants, across all disciplines, and over all phases of project lifecycle. This can be implemented as an ancillary geodetic network model implemented as a cloud service geodetic digital twin.