

# Visualization in Transport Trends, Research, and Opportunities

Michael Manore

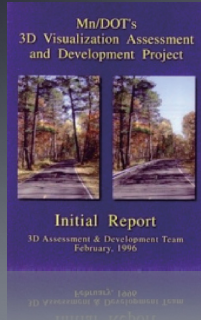
President & Founder

Vispective Management Consulting, LLC

Chair – TRB Visualization in Transportation Committee

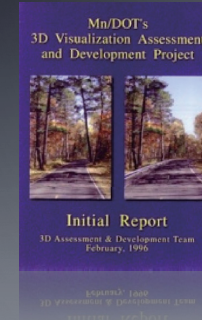
# Background

# The Basics



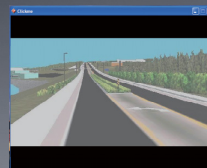
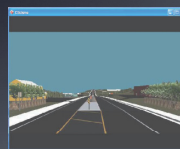
- Create Visualization within Organization
- Assessed
  - Technology
  - Process
  - Talent Needed
  - Workflows
  - Liability
  - Disclaimers

# The Basics



# Beyond Pictures

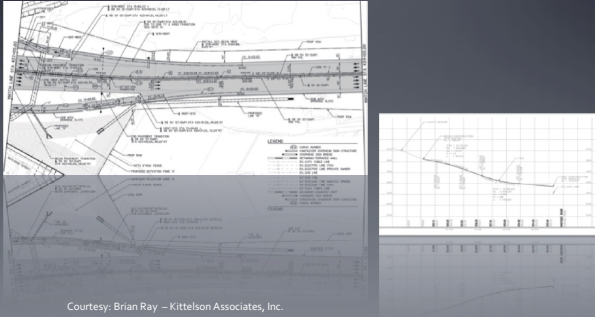
# Beyond Pictures



# Evolution / Trends

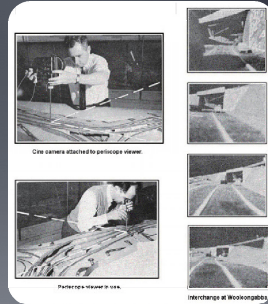
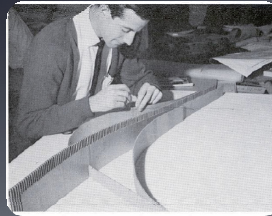


# Traditional Methods



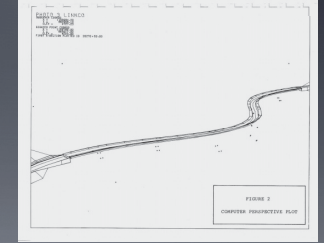
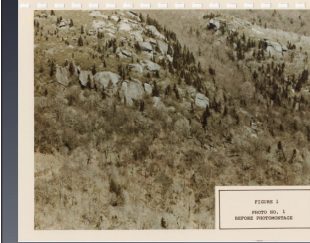
Courtesy: Brian Ray – Kittelson Associates, Inc.

# Visualizing



Courtesy: Mark Taylor – FHWA

# Form (mainframes)



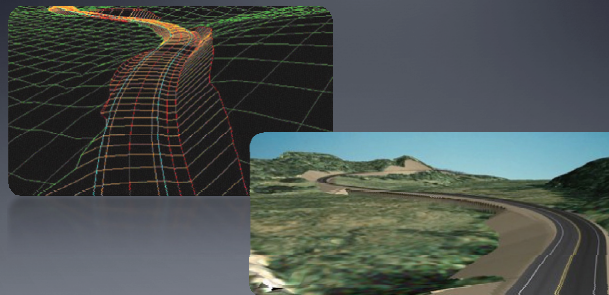
Images courtesy FHWA – Report on Highway Photomontage for Blue Ridge Mountain Viaduct at Grandfather Mountain, North Carolina

# Form (mainframes)



Images courtesy FHWA – Report on Highway Photomontage for Blue Ridge Mountain Viaduct at Grandfather Mountain, North Carolina

# Evolution



Courtesy: Mark Taylor – FHWA

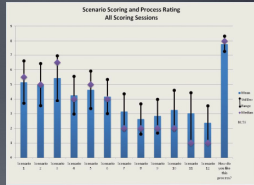
# Expansion / Interconnectivity

<p>Planning</p> <p>PLACEWAYS, LLC</p>	<p>Public Involvement</p> <p>URS</p>	<p>LIDAR / Survey</p> <p>Mark Taylor - FHWA</p>	<p>3D Design</p> <p>Mark Taylor - FHWA</p>	<p>Human Factors</p> <p>ARRIVA</p>
<p>BrIM</p> <p>HNTB</p>	<p>Digital Construction</p> <p>UofMD CATT Lab</p>	<p>Social Networking</p> <p>UofMD CATT Lab</p>	<p>Education &amp; Training</p> <p>UofMD CATT Lab</p>	<p>Data</p> <p>Karl Petty - BTS, Inc.</p>

# Interconnectivity



Images courtesy Professor Ted Grossardt, University of Kentucky – CAVE Project



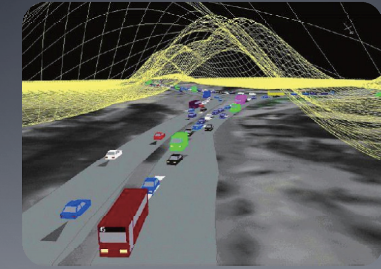
# Interconnectivity



Images courtesy of FHWA – Turner Fairbank

# Micro-simulation

Pollution emissions from traffic on road network - Paramics



# Training

Univ. of Maryland CATT Lab



# What About Data



Courtesy: Karl Petty – Berkeley Transportation Systems

# Freight Data





## Complexity

### DATA:

- Infrastructure Grade = (D) ASCE
- How do we put a face on "D"?
- More than reporting...
- ...**Visual Story** behind the data.



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## Performance Management

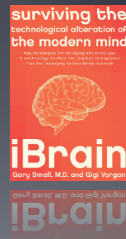


## From Part I – Session 466

- Q: "How do you encourage good performance?"
  - R1: Improve understanding of the situation.
  - R2: Promote the raw discovery that spawns BOLD ideas.
  - R3: Tools that instill a desire to act deliberately.
- Q: "How do we move the masses to the end goal?"
  - R1: Communicate the vision and strategies to get there.
  - R2: Show the results before they are realized.

## Consider

- **Don't just visualize at the end,**
  - Go upstream...to the source of the struggle.
  - Force our data to tell us where it *really* hurts.
- **Leverage our "Digital Natives",**
  - Foster the raw discovery we need
  - Inspire / Engage our future leadership (AP)
- **Make visualization part of the PM process.**
  - Different tools/methods at different stages
  - Start with the decisions...work backwards
  - Put a face to the *vision*
- **Seek the unexpected.**
  - "You get better results when you don't start with a solution." \*



\* From Part I – Session 466

## Building Intelligence into Form



Image Courtesy Tim Davis & Structure Magazine

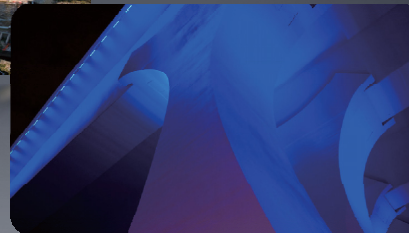


Image Courtesy Figg Bridge

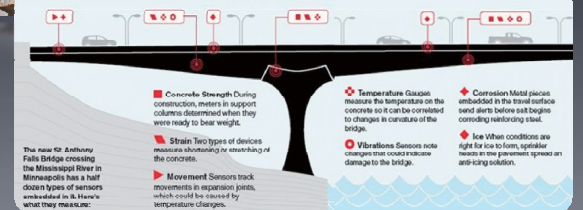
## Intelligent Bridges



Image Courtesy Tim Davis & Structure Magazine

Diagram Courtesy David Foster

### What Makes America's Smartest Bridge So Smart

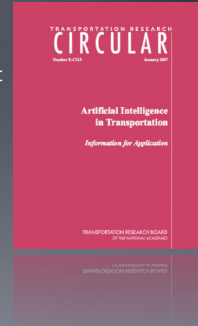


## Digital Infrastructure



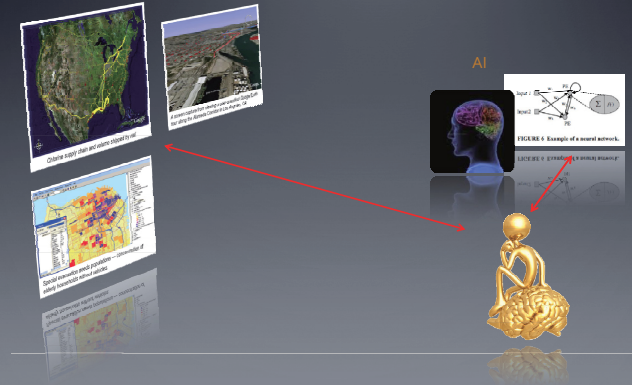
## AI in Transportation

- **AI** refers to methods and approaches that **mimic** biologically intelligent behavior in order to solve problems that so far have been difficult to solve by classical mathematics.
- **Visual Analytics** is the science of analytical reasoning facilitated by interactive visual interfaces<sup>(1)</sup>.

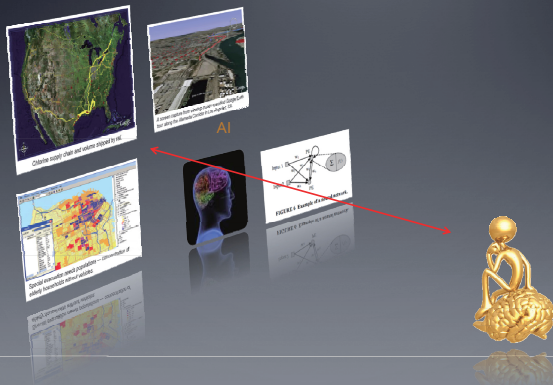


1. J. J. Thomas and K. A. Cook. *Illuminating the Path: The Research and Development Agenda for Visual Analytics*. IEEE press, 2005.

## Security - Vis/VA - AI



## Security - Vis/VA - AI



## Research

## About TRB

- Part of the National Academies
  - Through the National Cooperative Research Program
    - Highways
    - Aviation
    - Rail
    - Maritime
    - Pedestrians & Bicycles
- Over 200 Technical Committees
  - Each with 32 members
  - Representing over 40 countries
- Papers Reviewed Annually - **3,200**
- Annual Meeting - 10,000 attendees
- WEB SITE: [WWW.TRB.ORG](http://WWW.TRB.ORG)





## The Visualization Committee



Education & Training



Ethics & Liability



Knowledge Resources



ROI



VDC



Operations Decision-Making



Executive Decisions



Data



Technology Providers

## Our Scope

- Foster and disseminate collaborative exchange and research that enhances the usable knowledge of visualization methods and technologies for their potential in addressing critical transportation issues of today, as well as promoting innovative approaches to society's transportation needs of the future.
  - Discuss Issues
  - Define Research Needs
  - Annual Calls for Papers
  - Symposia & Workshops
  - Publications

## Leading Areas

- What Tools/Methods and When
  - Visualization req. in 2005 Reauthorization Bill
- Need to evolve thinking
  - From Process-based applications (linear)
  - To Decision-based
- Value in "Discovery-based" Research
  - Especially in Data
- Return On Investment (ROI)
- Mapping into Workflows



## Leading Areas

- Ethics
- Liability
- Use in Education
  - Teaching engineers to be engineers
  - Visual Communication Skills
  - Collaboration Skills
  - Inspire career paths
- Industry Awareness
- Lack of Standards



## Joint Subcommittee

- Virtual Design & Construction (VDC) Joint Subcommittee
  - Visualization / 3D Modeling
  - 4D Modeling (schedule-linked simulations)
  - Integrated Project Delivery
  - BIM
  - Economic Impact
  - Risk Management
  - Business Metrics
  - Analysis Methods (model-based)
- Barriers & Benefits



Image courtesy Mr. Kevin Gilson, URS Corporation

## The Larger Context



## Critical Issues

• **CONGESTION:** increasingly congested facilities across all modes;



• **ENERGY, ENVIRONMENT, AND CLIMATE CHANGE:** extraordinary challenges;



## Critical Issues

• **INFRASTRUCTURE:** enormous, aging capital stock to maintain;



• **FINANCE:** inadequate revenues;



## Critical Issues

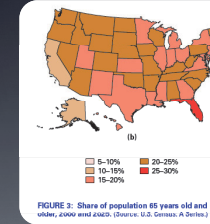


FIGURE 3: Share of population 65 years old and older, 2000 and 2002. (Source: U.S. Census Bureau.)

• **EQUITY:** burdens on the disadvantaged;



• **EMERGENCY PREPAREDNESS, RESPONSE, AND MITIGATION:** vulnerability to natural disasters and terrorist strikes;

## Critical Issues

• **SAFETY:** insufficient improvement;

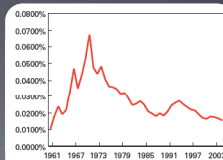


FIGURE 4: Public-sector transportation research and development as a percentage of gross domestic product.

• **INSTITUTIONS:** 20th century institutions mismatched to 21st century missions; and

## Critical Issues

• **HUMAN AND INTELLECTUAL CAPITAL:** inadequate investment in innovation.



## Our Research Challenge



## Our Research Challenge

- Has been:
  - Almost entirely **anecdotal**
  - A **side-note** to other research
  - **Ad-hoc** / randomly funded at best
- This is changing:
  - New Direction for Committee
  - Develop a **National Visualization Research Program**
    - As a **Whole**, and in **Parts**
  - Joint Initiatives
    - Inspire **Stewardship**

## Summarization & Opportunities

## Barriers

Doug Walker – Placeways, LLC  
2006 TRB Visualization Symposium



## Past Perceptions

- Expensive
- Dependant on “Specialists”
- Used mostly for large & complex Projects
- Cumbersome Learning Curve
- No Understanding regarding Return-On-Investment
- Lack of any Standards
- Requires heavy, non-linear (Creative) skills

## Growth Curve for Visualization

- Complexity (of our issues and projects)
- Understand larger context of a problem (interconnectivity)
  - Interconnected **systems**
- Scarcity of Funds (improve efficiencies)
- Impatience with the limits of traditional processes
- Public Demands (better communication & involvement)
- Younger generations savvy in 3D

## Opportunity

- More than visualization & simulation...
- ...Doorway to more interconnected:
  - Thinking
  - Decision-making
  - Discovery
  - Efficiencies
- Bridging Islands of Process



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## Opportunity

- Ease of use
- "Democratize"
- Speed to Productivity
- Comfort with non-linear processes
- Less **Passive**
- More **Active**



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## Research (Initial List)

- In Engineering Education
- Mapping 3D/Vis/VR in Planning, Design, Construction
- Human-in-the-Loop
  - **Performance-based Design**
- Driving Sims + Web for Public Involvement
- Access Management
  - **Conveying to business owners & engineers**



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## Research (Initial List)

- Environmental
- Assets & Safety
  - **Geometry + Crash Data**
- Distracted Driver Training
  - VR-Drive?
- Cognitive Implications
  - **"Decision Performance"** *MManore*
  - **Driver Experience**
    - *Affecting Performance*
  - **Community Experience**



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## Info

- **Web Site:** [www.trbvis.org](http://www.trbvis.org)
- **Networking Site:** [trbvis.ning.com](http://trbvis.ning.com)
- **2011 Vis Symposium:** Autumn, 2011 Wisconsin - USA

Monona Terrace Conference Center  
Image - Mr. Chris Benson  
Madison, WI



## Thank You