December 4-5, 2012

R. Souleyrette

TRB Data and Information Systems

University of Kentucky

What is GIS?

A computer system designed for
Geographically Referenced Data:

- Capture
- Storing/Managing
- Integration
- Analyzing
- Interpreting
- Visualizing

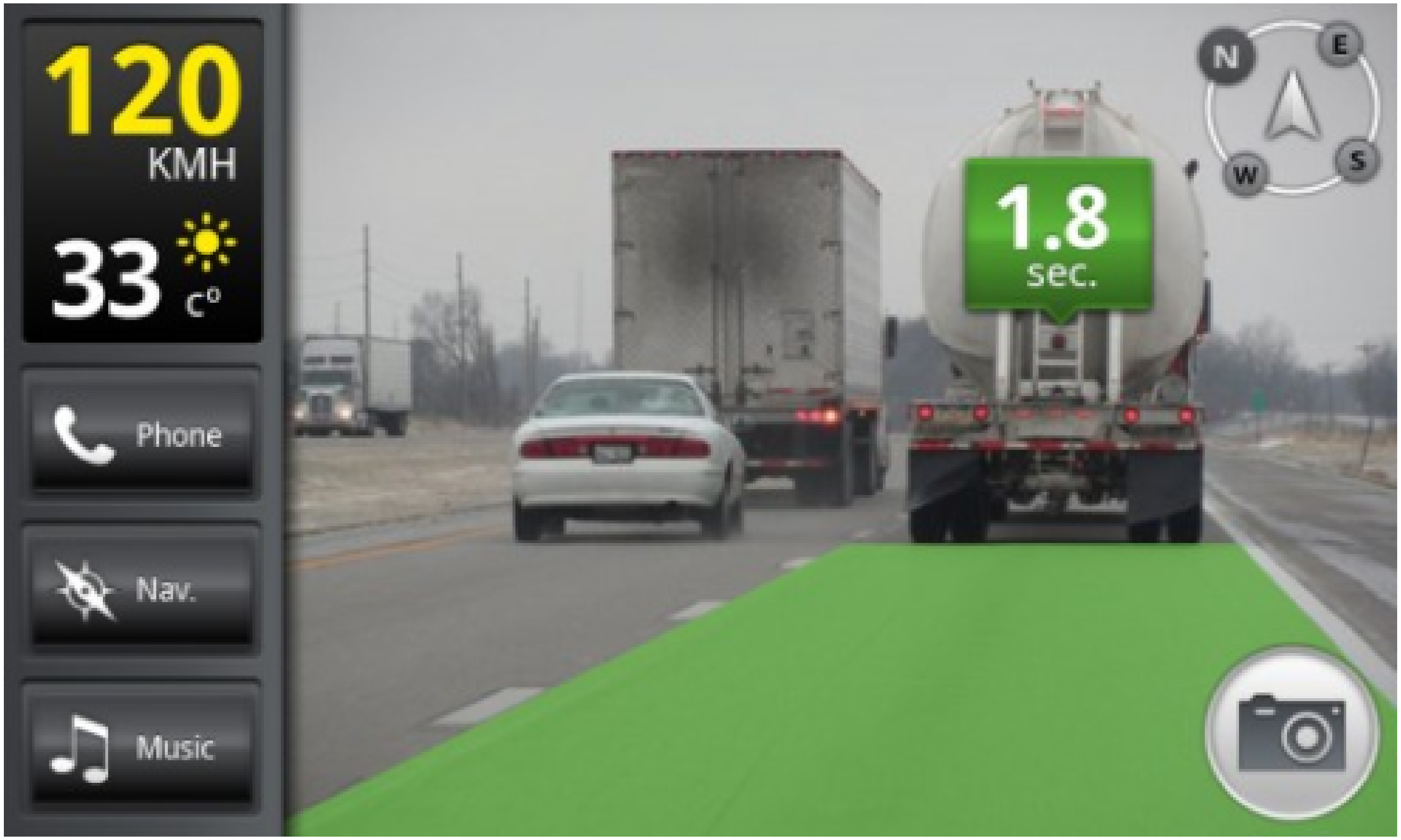
- Relationships
- Patterns
- Trends

- Increase Productivity
- More Informed Decision Making
- Improved Communication
- Improved Record Keeping
- Managing Data Geographically

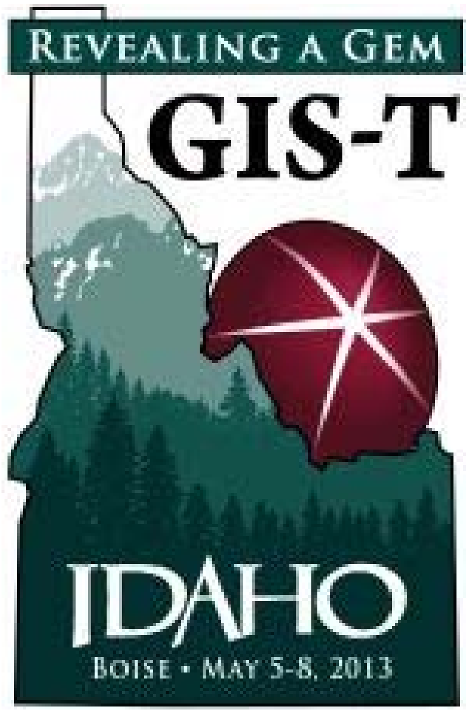
Source:
http://egsc.usgs.gov/isb/pubs/gis_poster/; http://www.esri.com/what-is-gis/overview

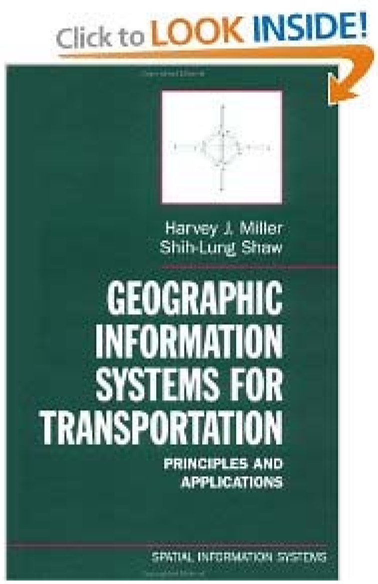
Free Android App Adds Collision Avoidance

by MATT BALL *on* NOVEMBER 1, 2011



GIS-T applications …





Aviation

Use GIS for managing airport facilities, regulating use of airspace, and noise modeling.

Michigan's Lane Mile Inventory

GIS helps the Michigan Department of Transportation efficiently and accurately deliver annual maintenance and capital funds to various regions.

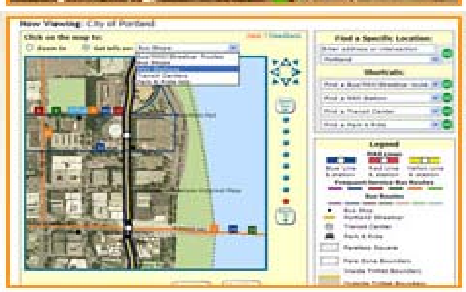
GIS in Transportation, Winter 2012

Ports and Maritime

GIS helps engineers build and manage port facilities and helps planners accommodate community and environmental constraints more easily.

Railways

Rail system operators use GIS to keep accurate inventories of facilities and report safety and performance statistics.

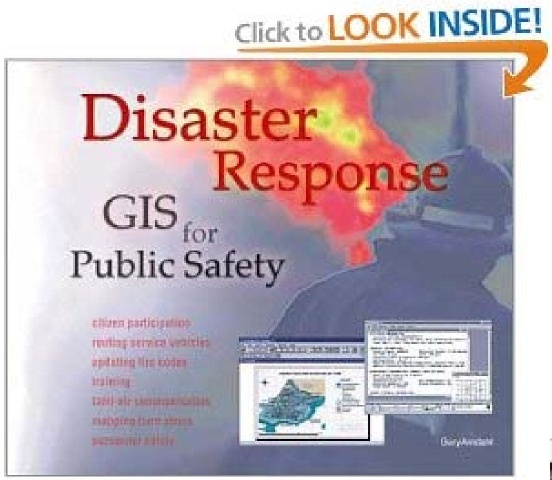


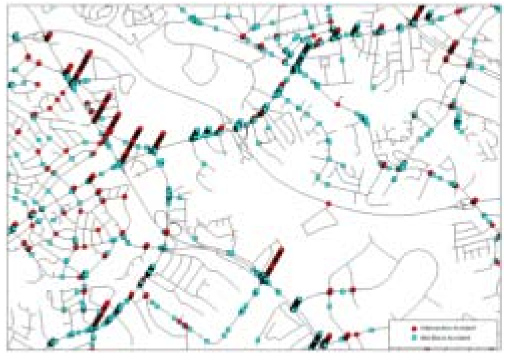
Public Transit

GIS is an excellent tool for analyzing ridership and service, as well as revenue, patterns, and usage, by select populations.

www.esri.com

GIS-TS applications …

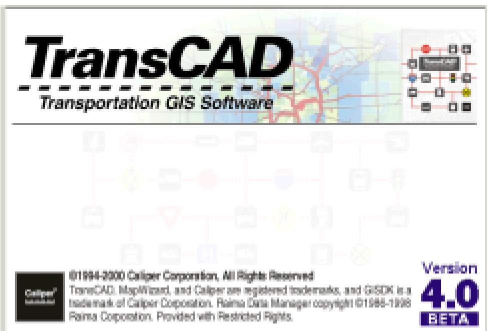


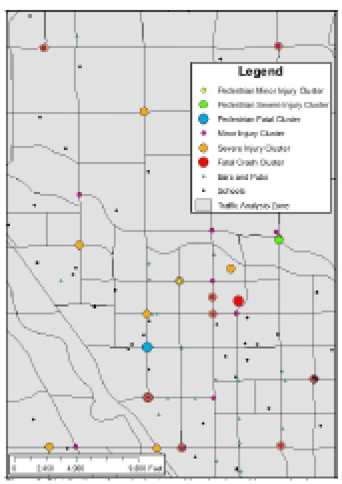


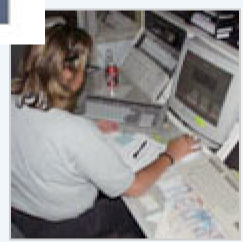
AIMS

Airport and Transit Security

www.intergraph.com

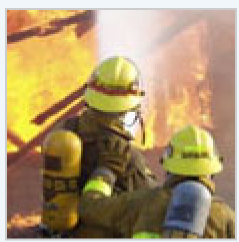






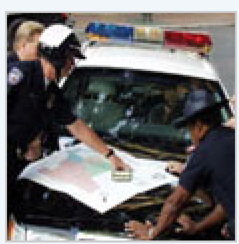
Computer-Aided Dispatch/E911
Putting spatial intelligence at the fingertips of dispatchers and field personnel ensures proper response time. Learn More

Emergency/Disaster Management
GIS is essential for all phases: preparation, mitigation, response, and recovery. Learn More



Fire/Rescue and EMS
GIS helps fire/rescue and EMS protect life and property using information and analysis as a powerful tool. Learn More

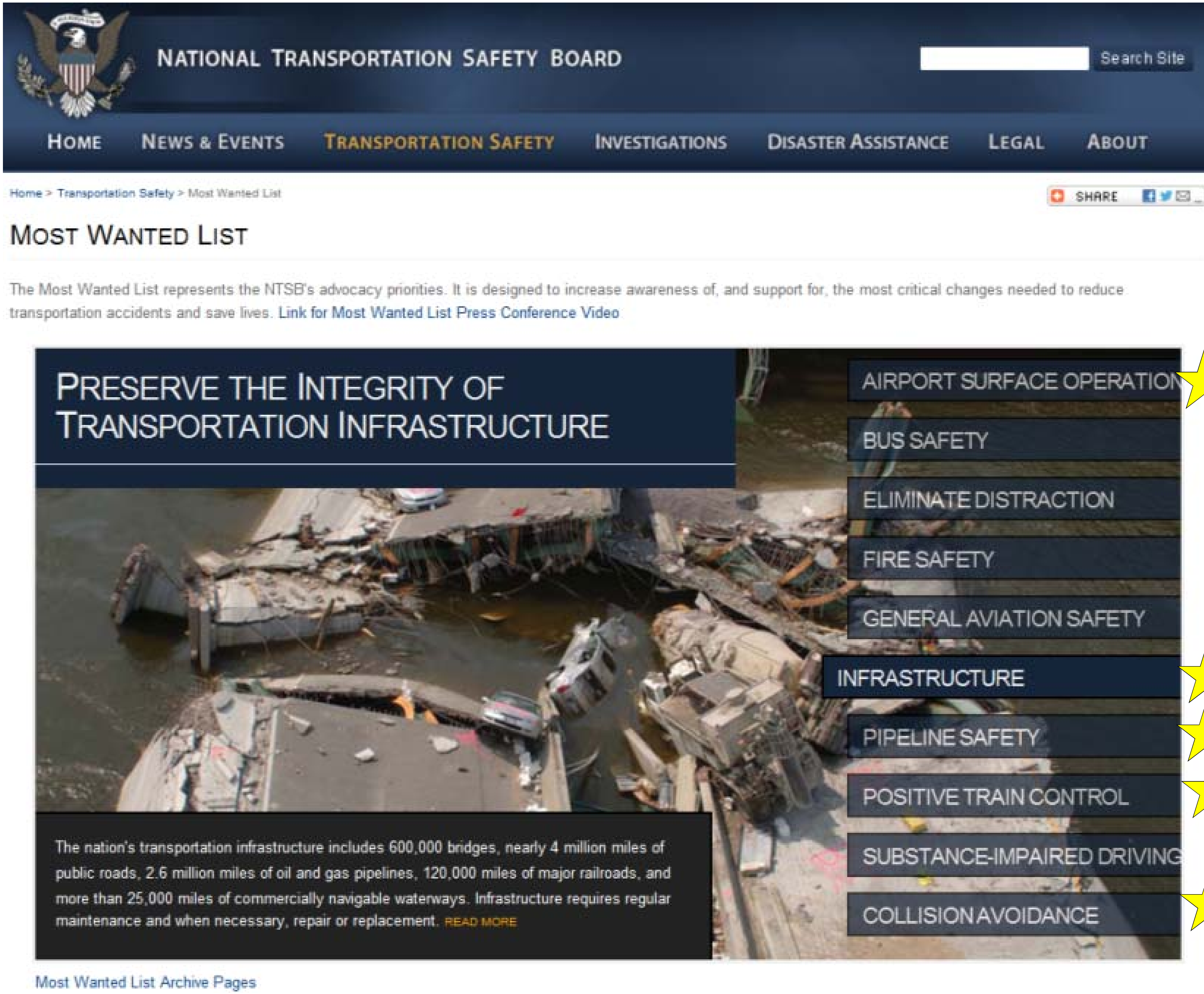
Homeland/National Security
Federal, state, local, and tribal agencies use GIS to support the homeland/national security mission. Learn More



Law Enforcement
Discover how to leverage data collected each day to create intelligence you can use and share. Learn More

Wildland Fire Management
Access to information, increased safety and efficiency, and resource management are realized with GIS. Learn More

www.esri.com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MOST WANTED LIST
The Most Wanted List represents the NTSB's advocacy priorities. It is designed to increase awareness of, and support for, the most critical changes needed to reduce transportation accidents and save lives. Link for Most Wanted List Press Conference Video
PRESERVE THE INTEGRITY OF TRANSPORTATION INFRASTRUCTURE
AIRPORT SURFACE OPERATION
BUS SAFETY
ELIMINATE DISTRACTION
FIRE SAFETY
GENERAL AVIATION SAFETY
INFRASTRUCTURE
PIPELINE SAFETY
POSITIVE TRAIN CONTROL
SUBSTANCE-IMPAIRED DRIVING
COLLISION AVOIDANCE
The nation's transportation infrastructure includes 600,000 bridges, nearly 4 million miles of public roads, 2.6 million miles of oil and gas pipelines, 120,000 miles of major railroads, and more than 25,000 miles of commercially navigable waterways. Infrastructure requires regular maintenance and when necessary, repair or replacement. READ MORE
Most Wanted List Archive Pages

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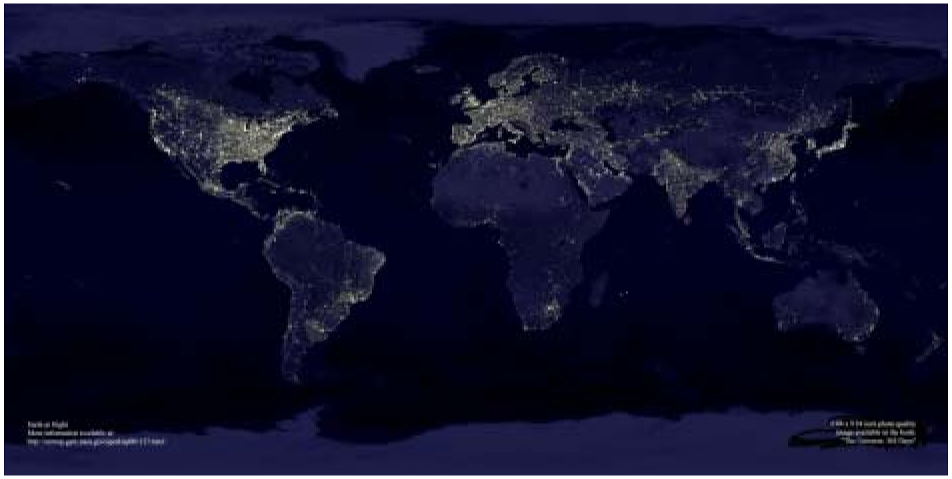
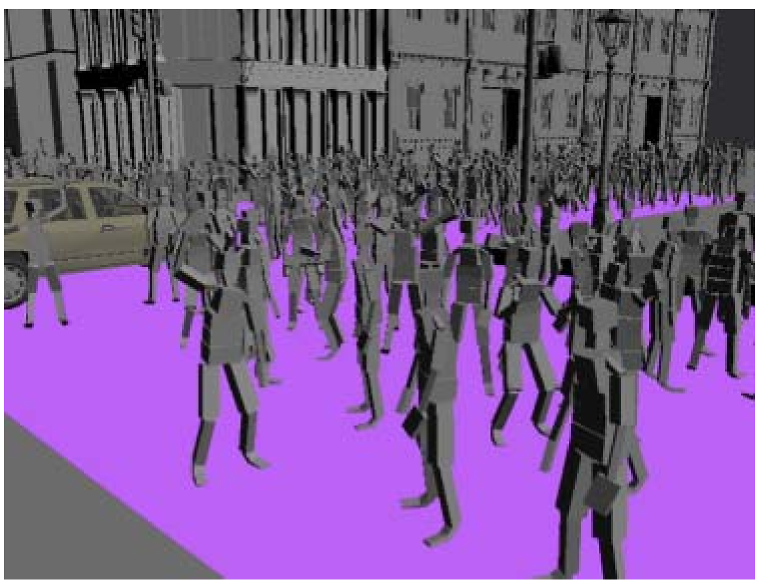
Evolution of GIS-TS



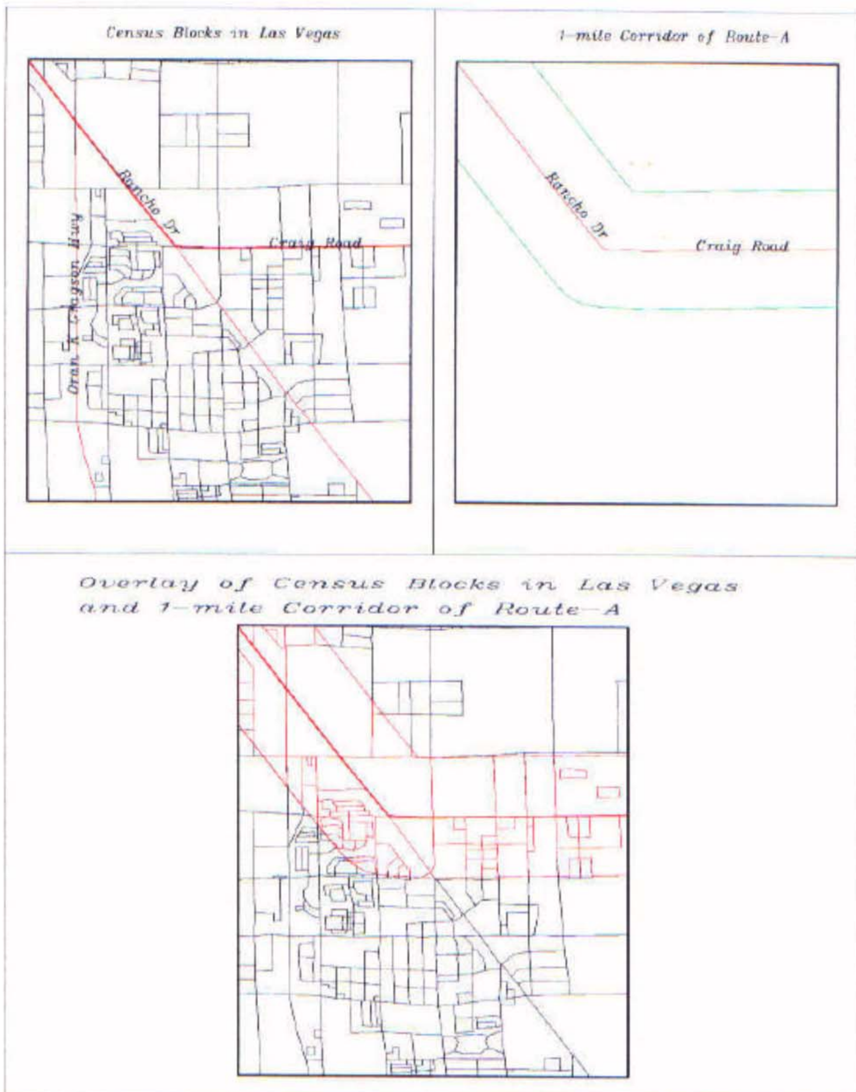
NASA

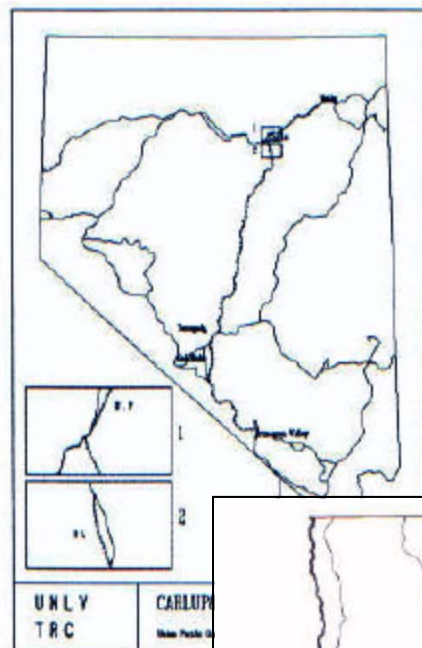
TOMTOM

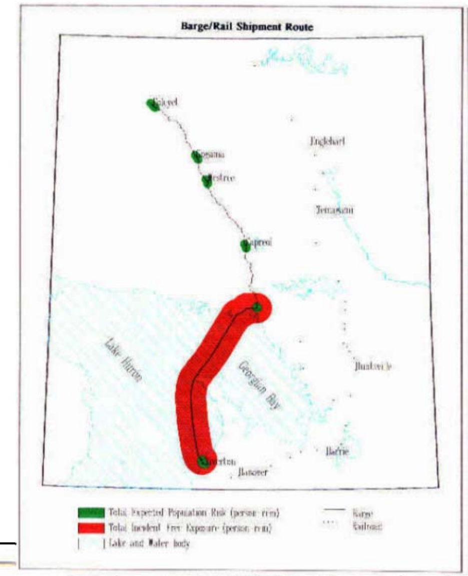


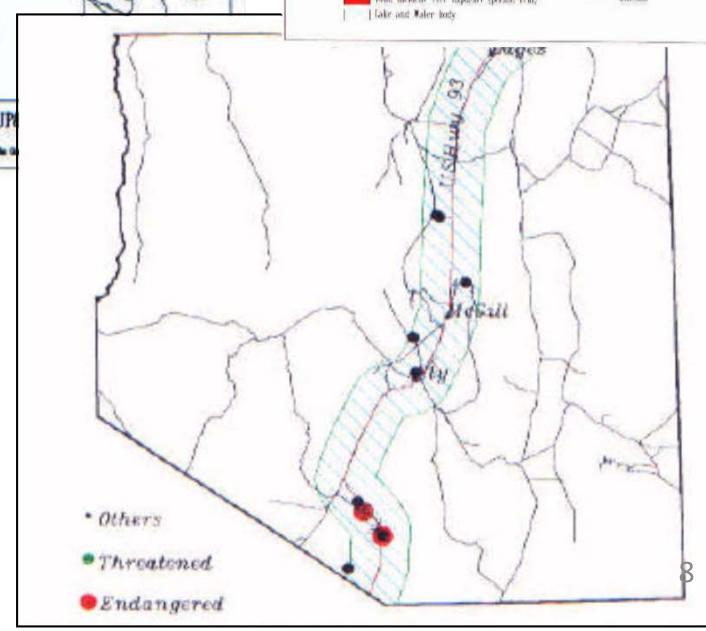
Torrens, P.M.

Yucca Mountain - 1989









1998 GIS-ALAS

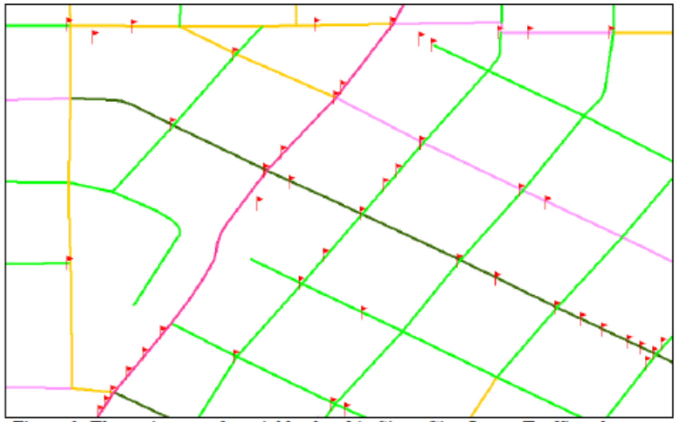


Figure 3: Thematic map of a neighborhood in Sioux City, Iowa. Traffic volumes are reflected in the shading of the roads. Accidents are displayed as flag symbols on the road network. This kind of graphical representation of data was not readily available before GIS-ALAS.

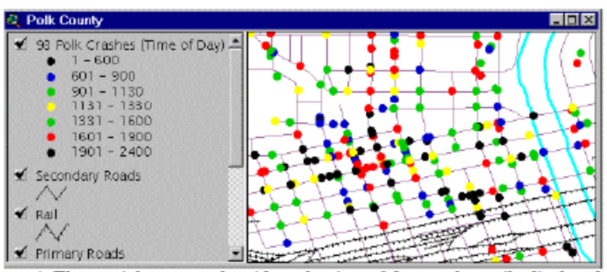


Figure 4: The spatial pattern of accidents by time of day can be easily displayed using the power of a GIS.

AV-ALAS

PC-ALAS

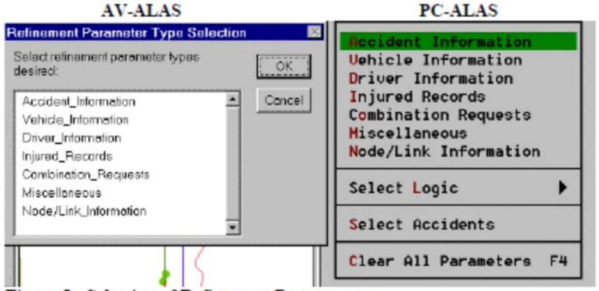
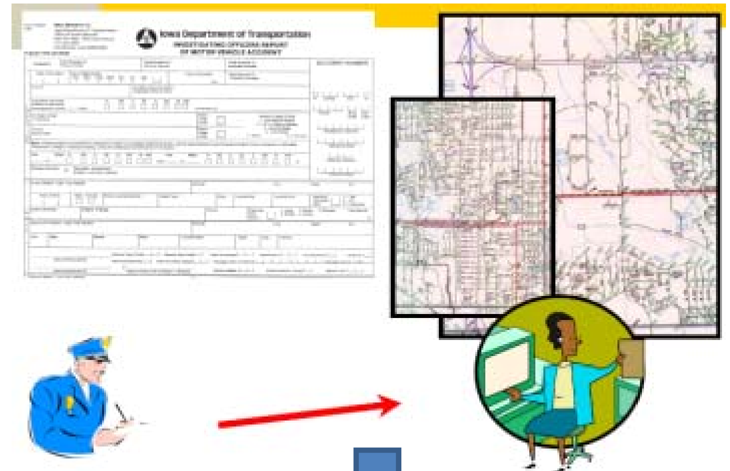
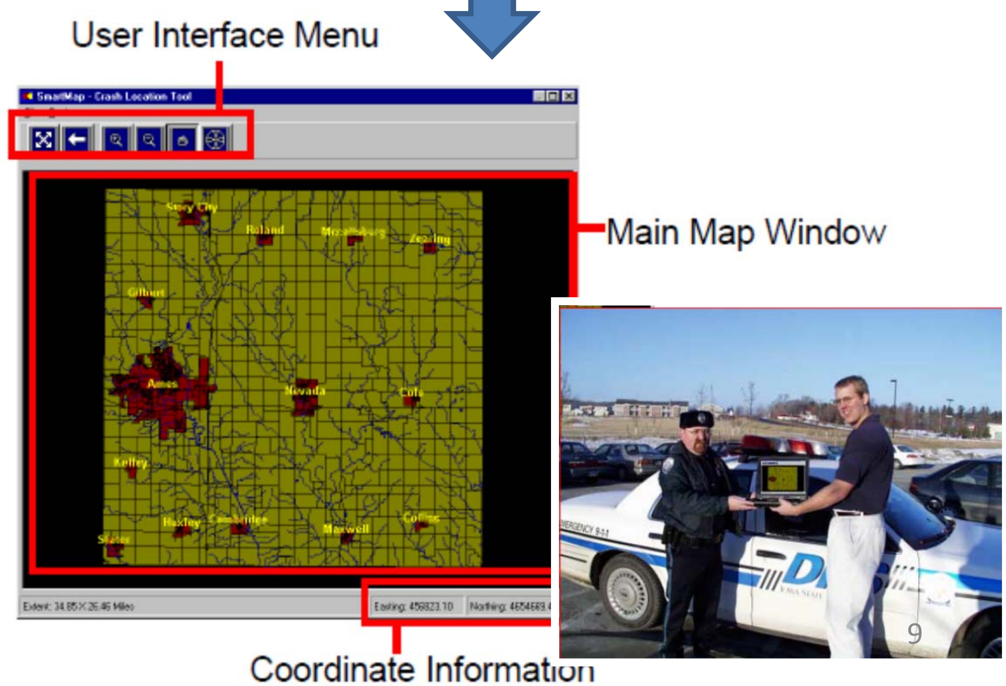


Figure 5: Selection of Refinement Parameters.

1999 TraCS

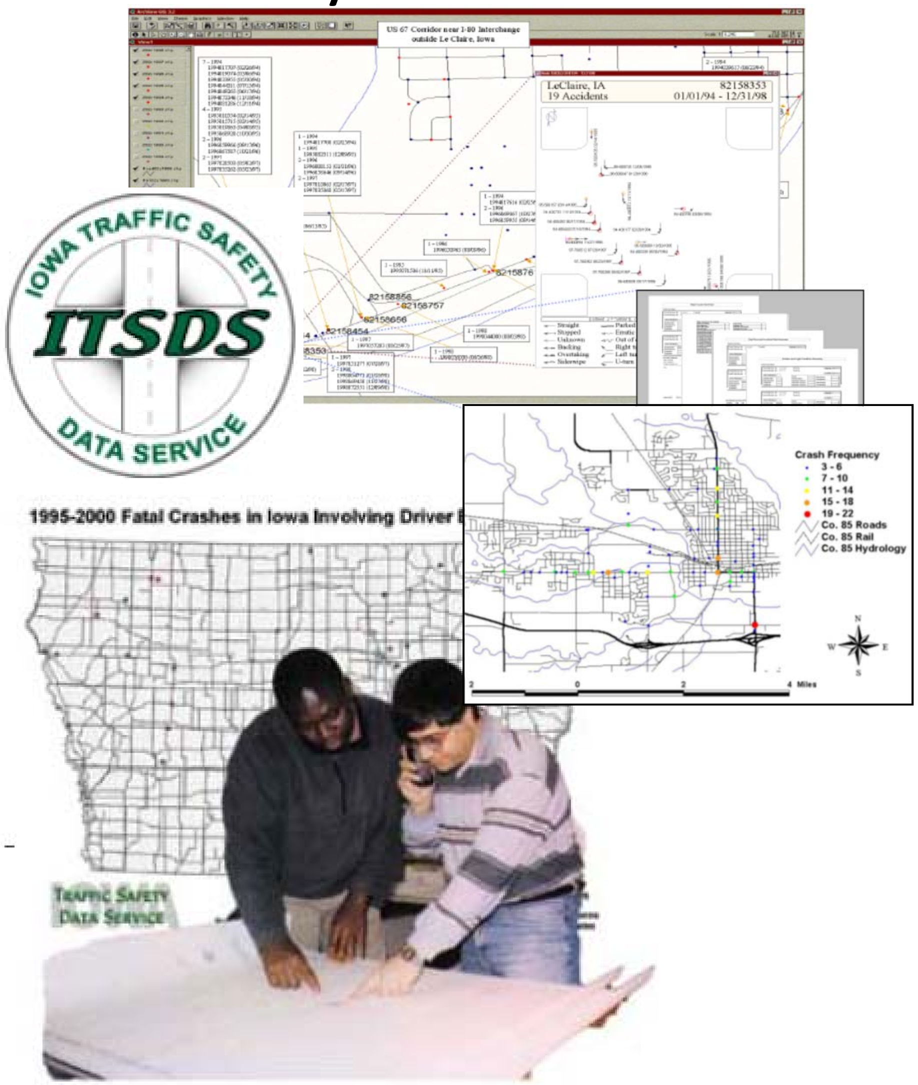




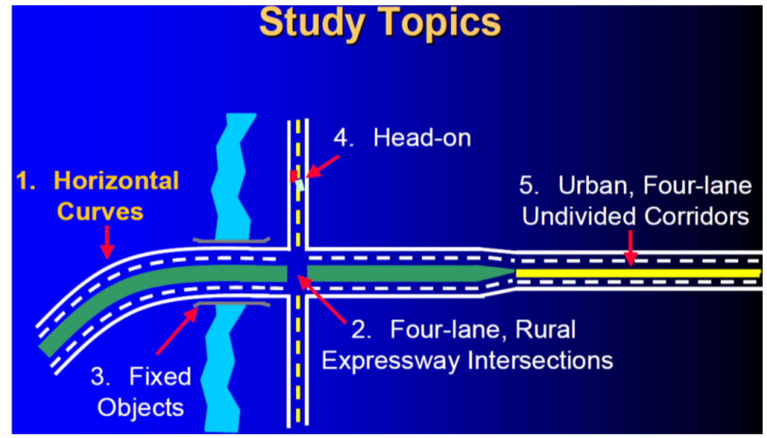
Evolution of GIS-TS applications …

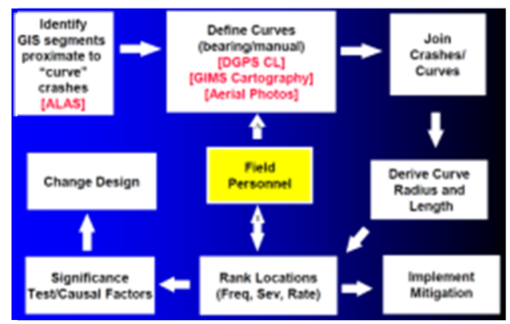
Services, more sophisticated analysis

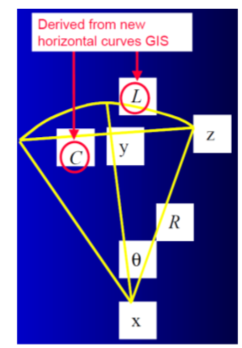
1999 Iowa Traffic Safety Data Service

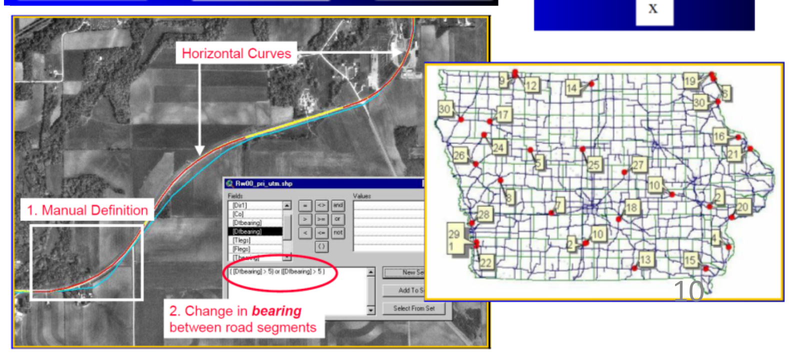


2001 High Crash Locations

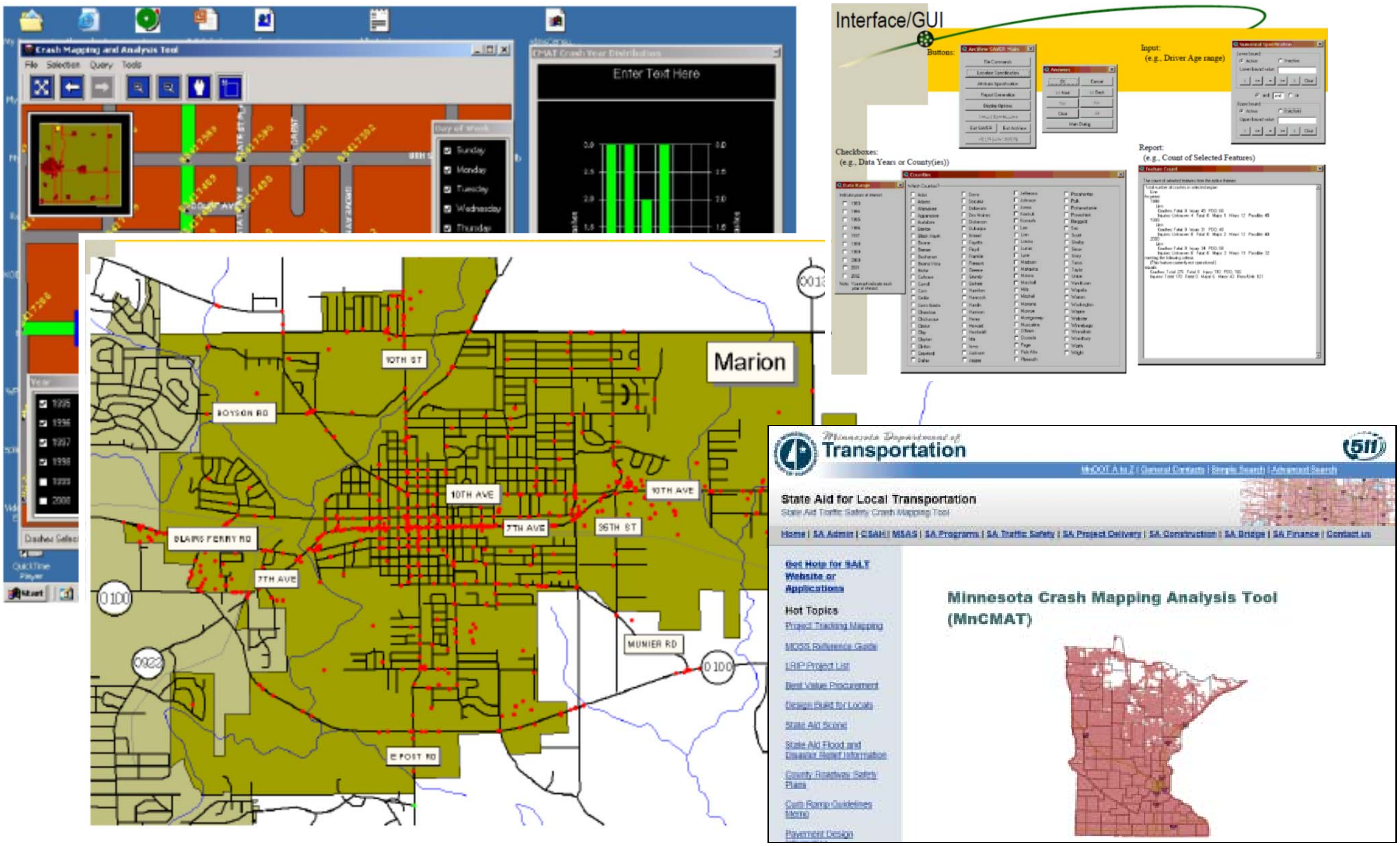




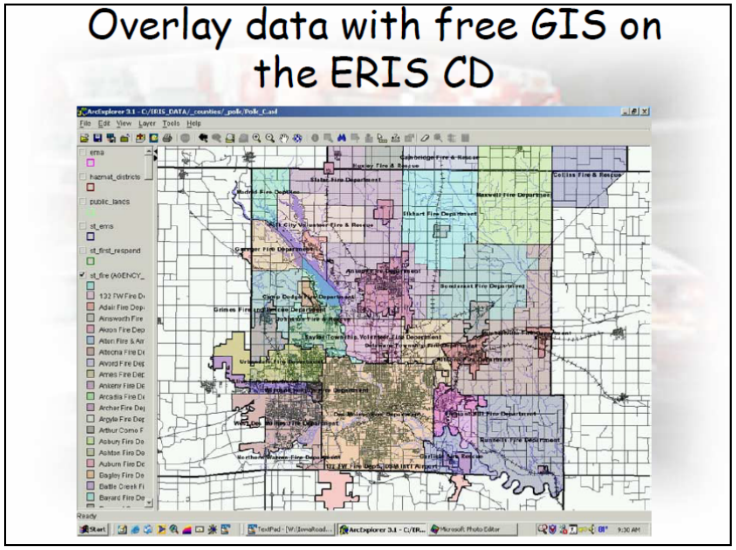


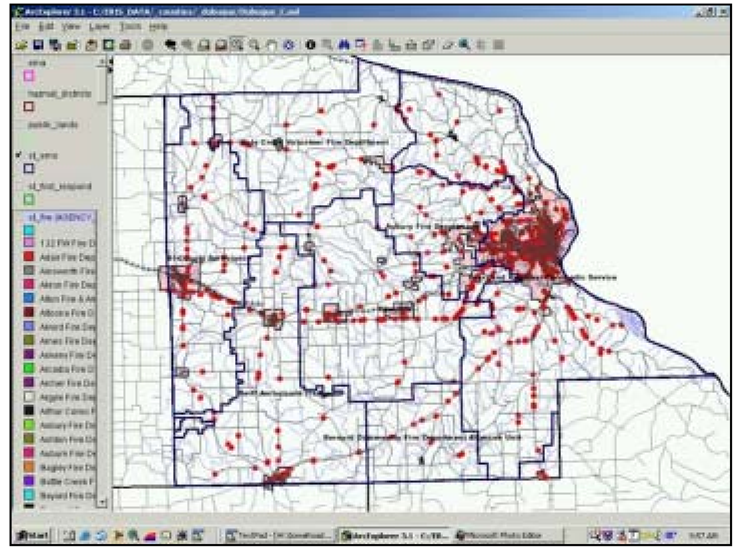


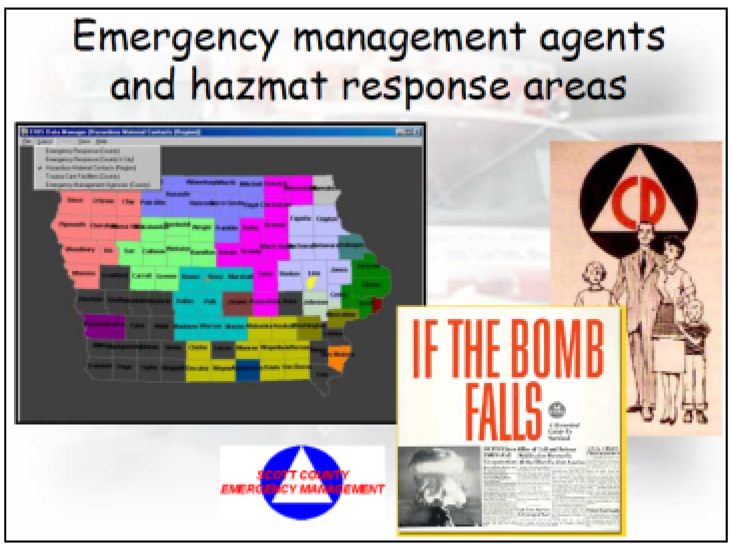
2002 – Crash Mapping Analysis Tool/SAVER

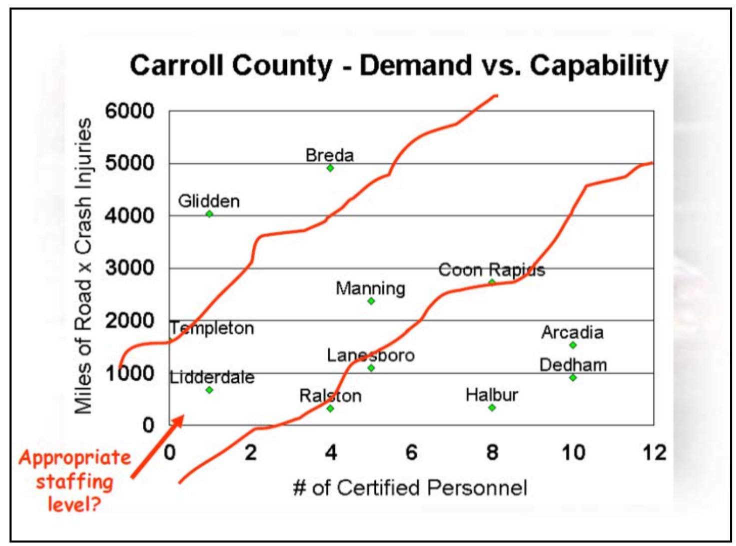


2003 ERIS – Emergency Response Information System

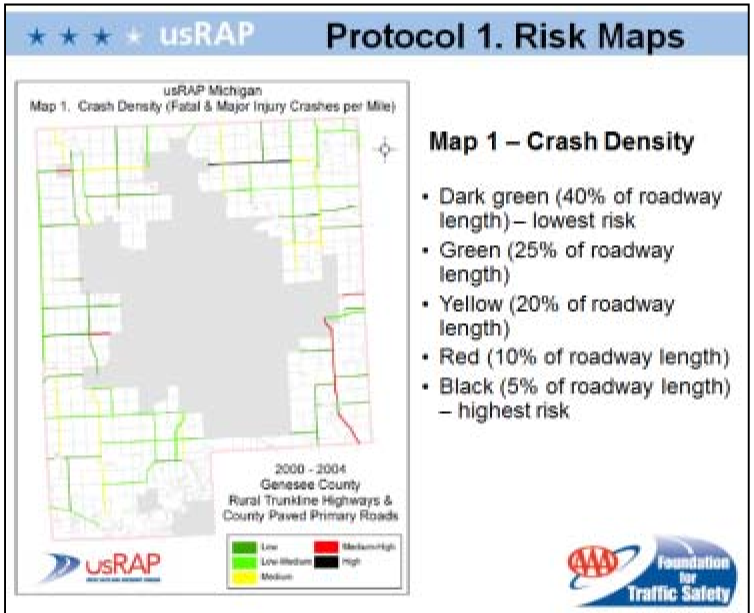


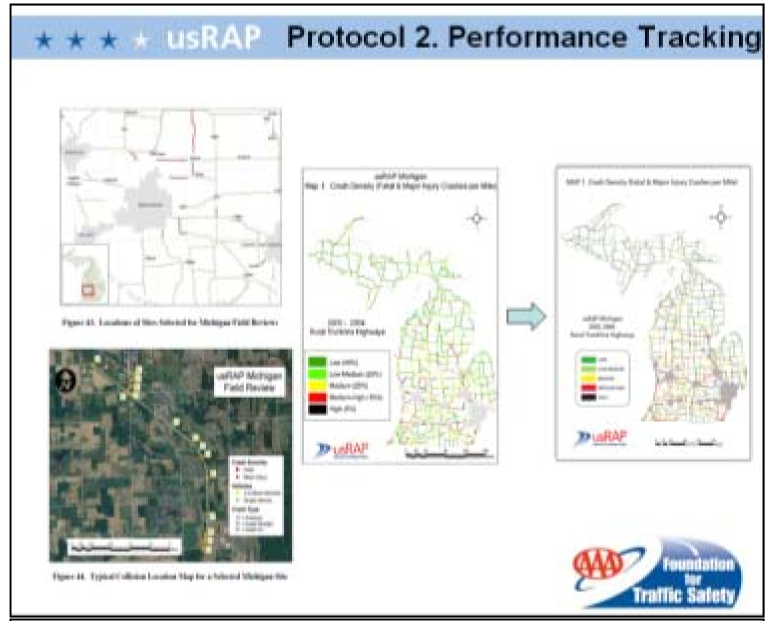


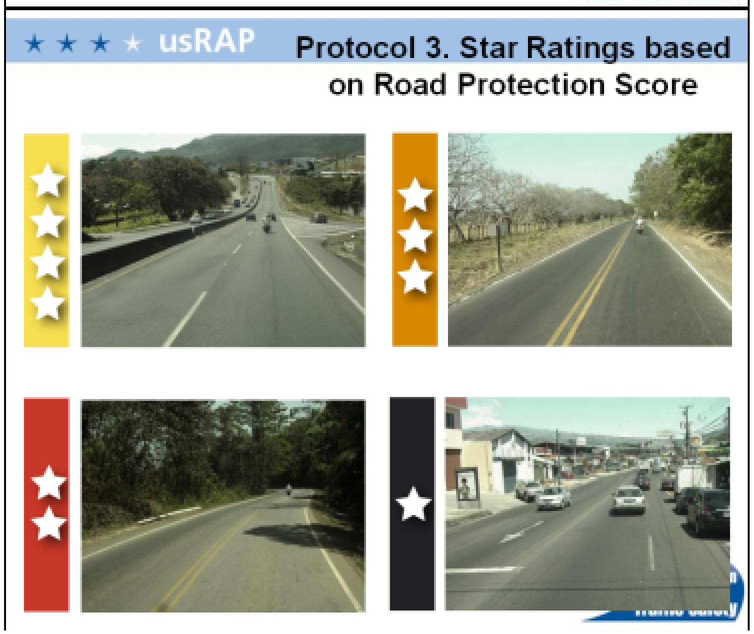


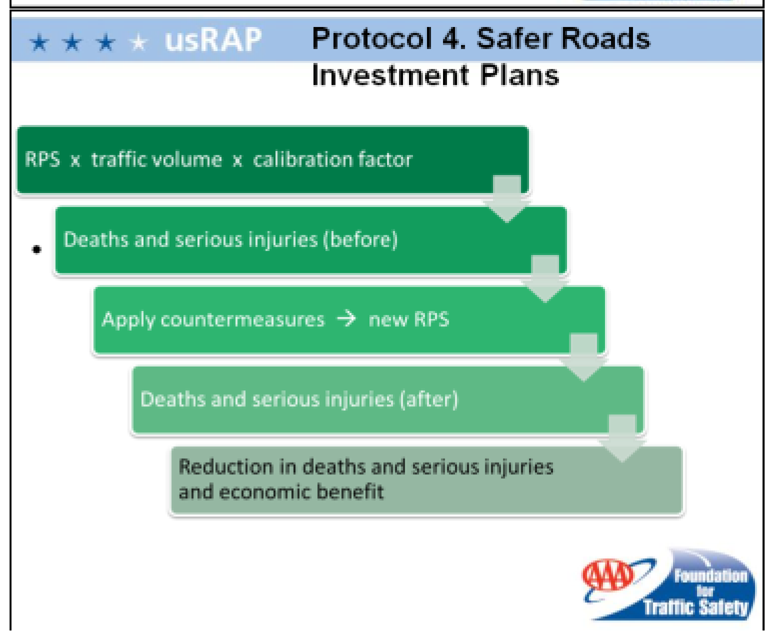


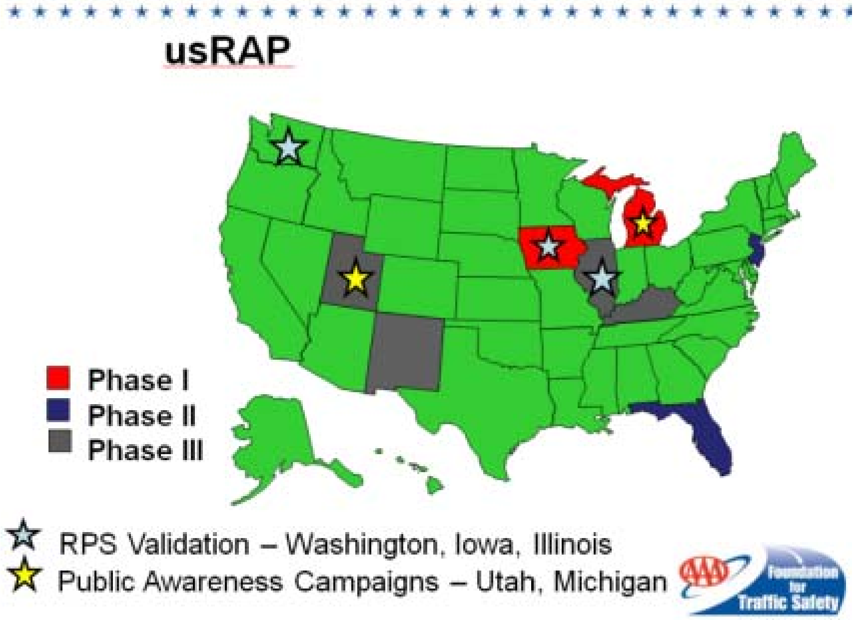
Today – usRAP – US Road Assessment Program





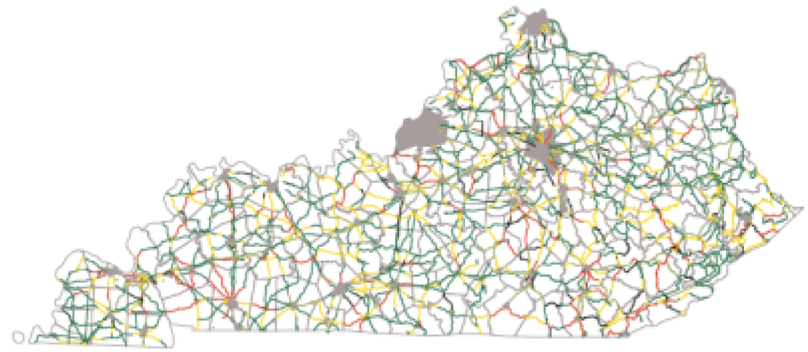


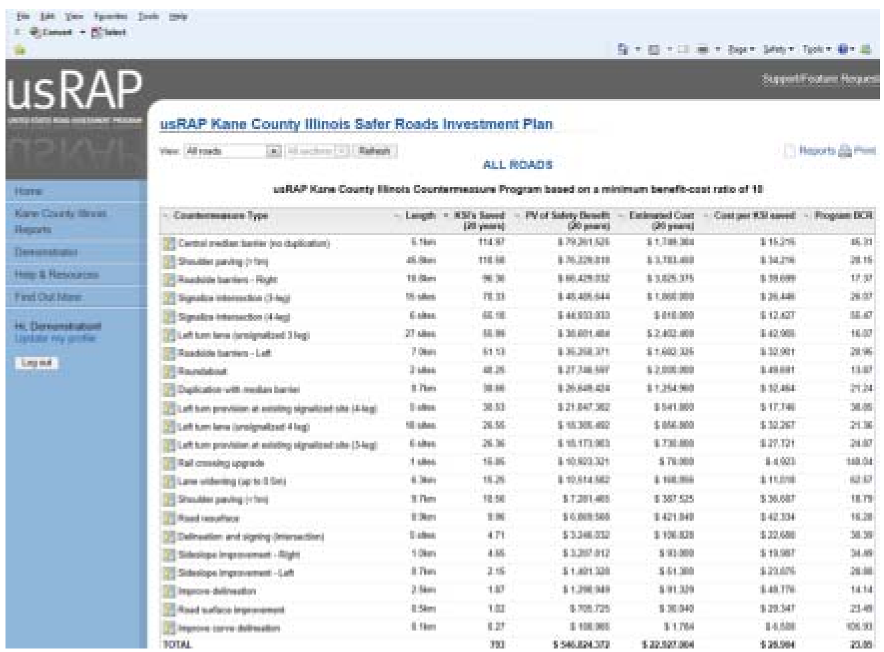




MAP 2. Crash Rate (Fatal and Major Injury Crashes per 100M VMT)

Aggressive Driving Crashes



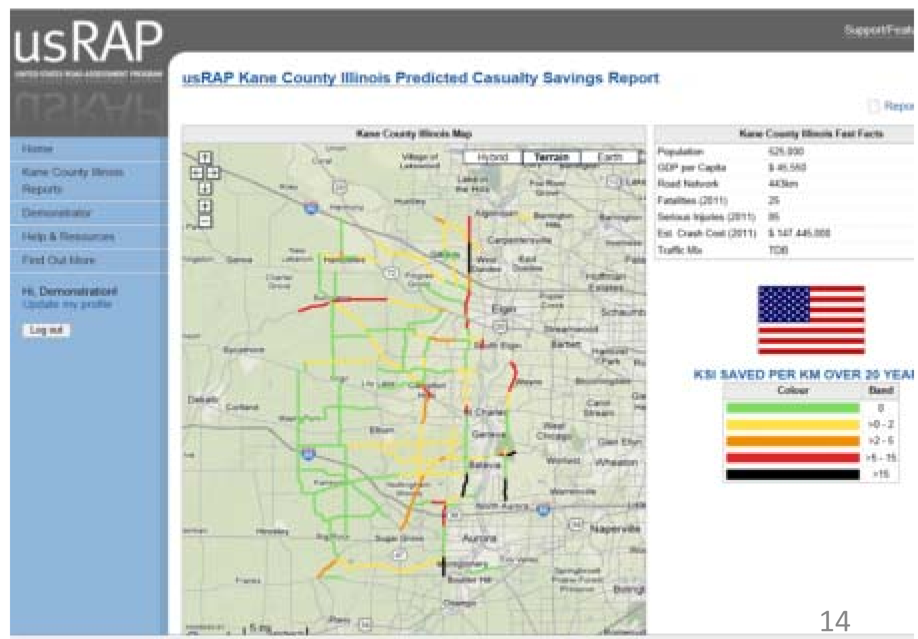


usRAP Kane County Illinois Safer Roads Investment Plan

ALL ROADS

usRAP Kane County Illinois Countermeasure Program based on a minimum benefit-cost ratio of 10

Countermeasure Type	Length	KSI's Saved (20 years)	PV of Safety Benefit (20 years)	Estimated Cost (20 years)	Cost per KSI saved	Program BCR
Central median barrier (no duplication)	5.1km	114.97	$ 79,261,526	$ 1,749,384	$ 15,216	45.31
Shoulder paving (>1m)	45.0km	116.58	$ 76,229,818	$ 3,783,460	$ 34,216	20.15
Roadside barriers - Right	18.0km	96.38	$ 66,429,032	$ 3,825,375	$ 39,699	17.37
Signalize intersection (3-leg)	15 sites	78.33	$ 45,405,644	$ 1,860,000	$ 26,446	26.07
Signalize intersection (4-leg)	6 sites	65.18	$ 44,933,033	$ 816,000	$ 12,427	55.47
Left turn lane (unsignalized 3 leg)	27 sites	55.98	$ 38,601,484	$ 2,402,469	$ 42,905	16.07
Roadside barriers - Left	7.0km	51.13	$ 35,258,371	$ 1,682,325	$ 32,901	20.96
Roundabout	2 sites	40.25	$ 27,746,597	$ 2,000,000	$ 49,691	13.87
Duplication with median barrier	8.7km	38.66	$ 26,649,424	$ 1,254,960	$ 32,464	21.24
Left turn provision at existing signalized site (4-leg)	5 sites	30.53	$ 21,047,382	$ 541,000	$ 17,746	38.05
Left turn lane (unsignalized 4 leg)	10 sites	26.55	$ 18,305,492	$ 856,000	$ 32,267	21.36
Left turn provision at existing signalized site (3-leg)	6 sites	26.36	$ 18,173,963	$ 730,000	$ 27,721	24.87
Rail crossing upgrade	1 sites	15.85	$ 10,923,321	$ 78,000	$ 4,923	148.04
Lane widening (up to 0.5m)	6.3km	15.25	$ 10,514,582	$ 168,856	$ 11,016	62.57
Shoulder paving (<1m)	8.7km	10.56	$ 7,281,465	$ 387,525	$ 36,687	18.79
Road resurface	8.9km	9.96	$ 6,869,568	$ 421,849	$ 42,334	16.28
Delineation and signing (intersection)	5 sites	4.71	$ 3,246,032	$ 106,828	$ 22,680	30.39
Sideslope improvement - Right	1.0km	4.65	$ 3,207,012	$ 93,000	$ 19,987	34.49
Sideslope improvement - Left	0.7km	2.15	$ 1,481,328	$ 51,300	$ 23,875	28.88
Improve delineation	2.5km	1.87	$ 1,298,949	$ 91,329	$ 48,776	14.14
Road surface improvement	0.5km	1.02	$ 705,725	$ 30,040	$ 29,347	23.49
Improve curve delineation	0.1km	0.27	$ 188,985	$ 1,784	$ 6,508	105.93
TOTAL		793	$ 546,824,372	$ 22,927,004	$ 28,984	23.85




AASHTO TIG Pilot States
None scheduled
First Circuit
Second Circuit
Third Circuit
Fourth Circuit
CANADA
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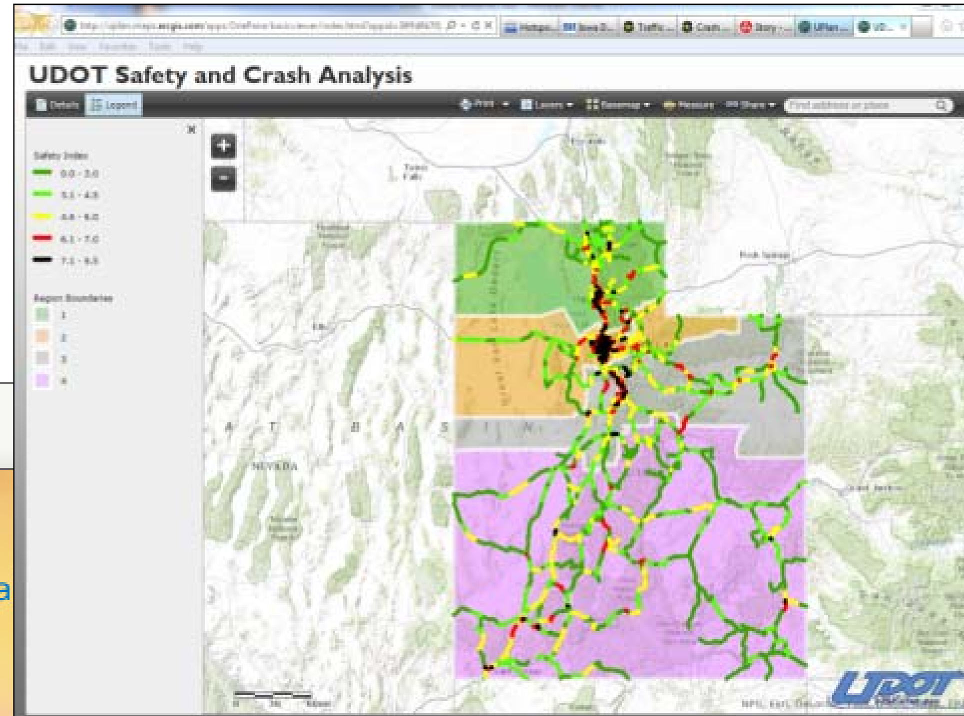
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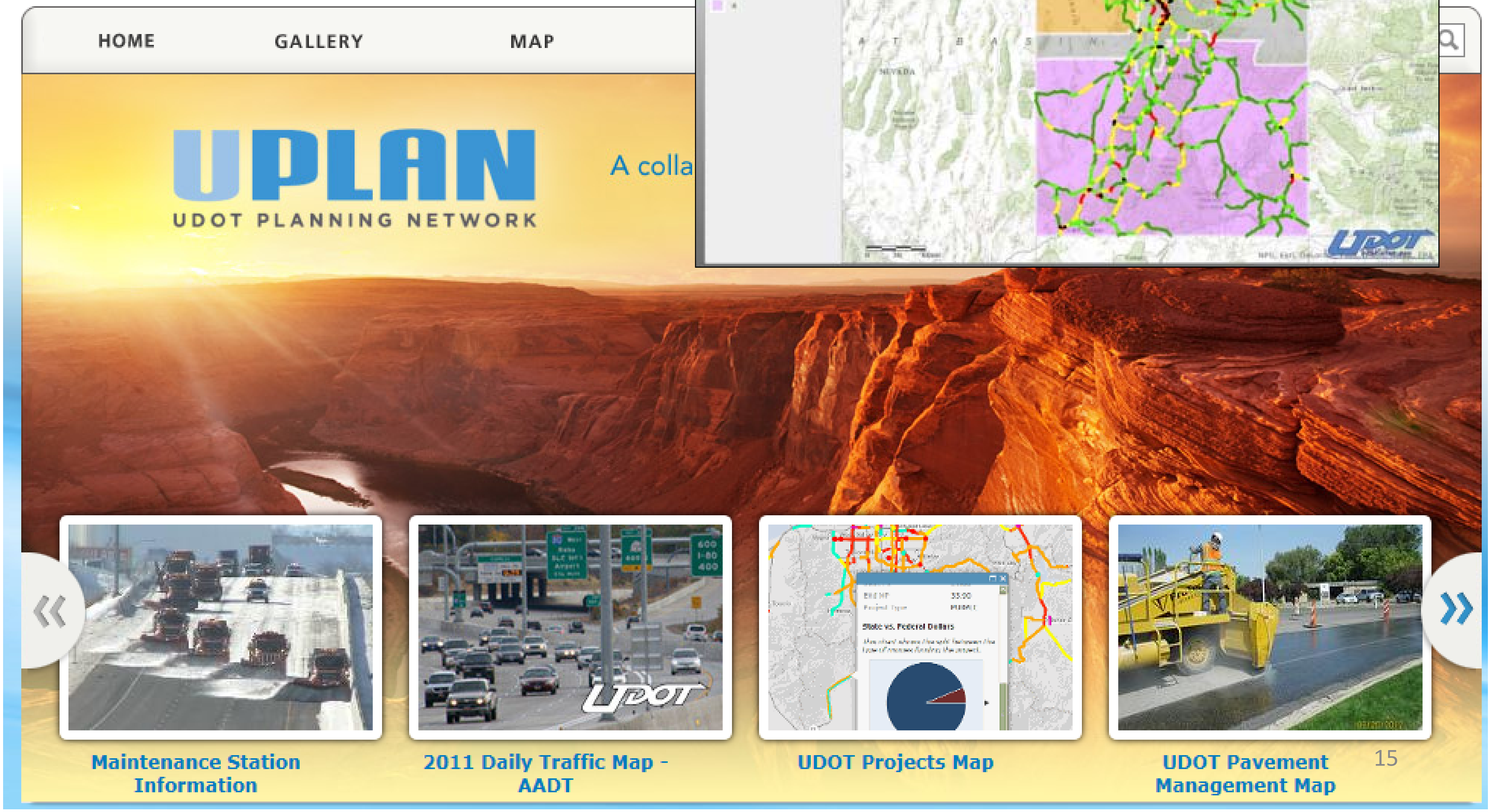
NEVADA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UDOT Projects Map
UDOT Pavement Management Map

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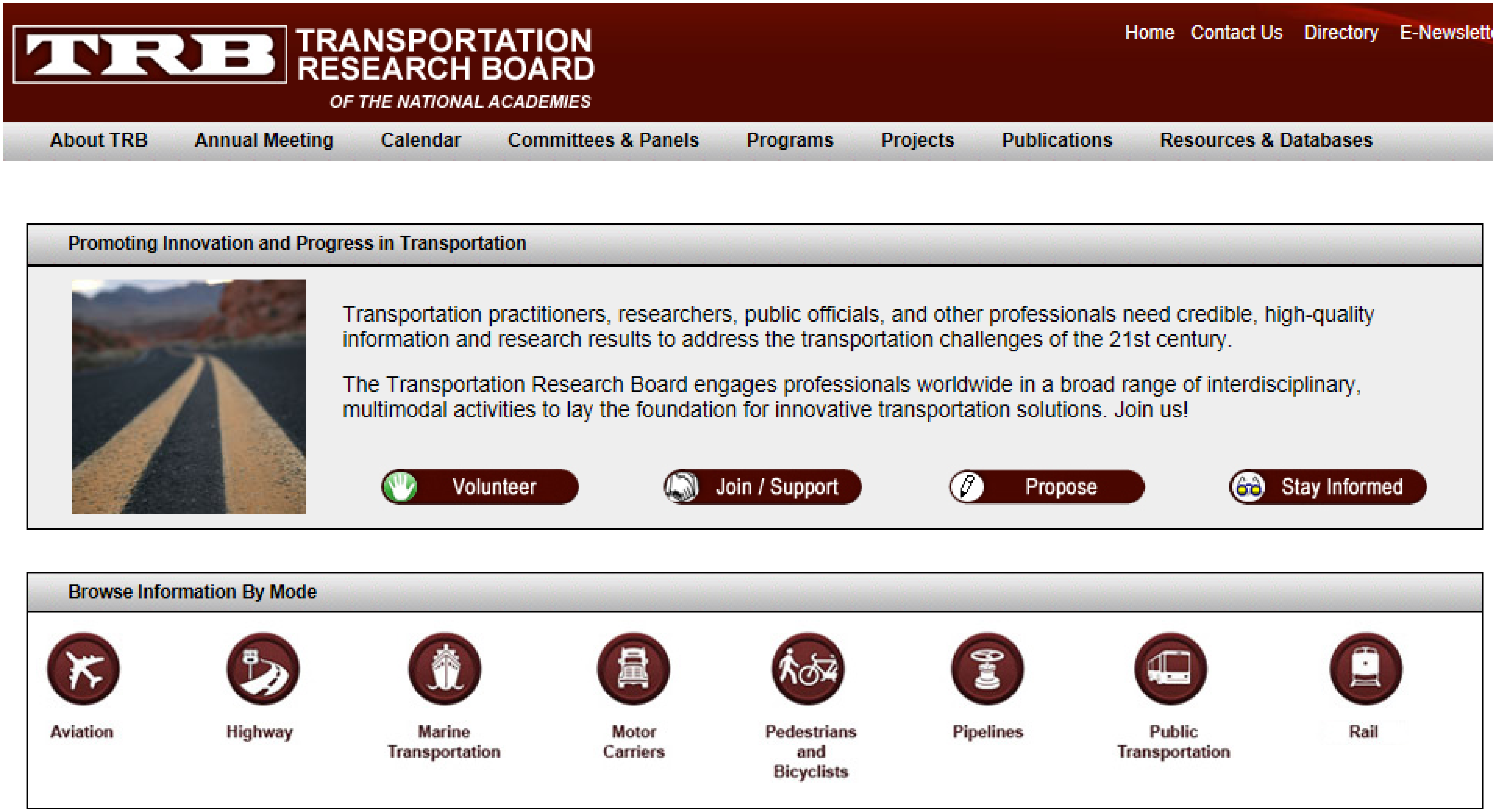
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Pipelines
Public Transportation
Rail

TRB Committees Related to Safety and Human Factors

Standing Committees

Code	Committee Name
ABE60	Accessible Transportation and Mobility
AFB20	Roadside Safety Design
AHB60	Highway/Rail Grade Crossings
AL070	Tort Liability and Risk Management
AN000	Safety and Systems Users Group
ANB00	Section - Safety
ANB10	Transportation Safety Management
ANB20	Safety Data, Analysis and Evaluation
ANB23T	Task Force on Highway Safety Workforce Development
ANB25	Highway Safety Performance
ANB30	Operator Education and Regulation
ANB40	Traffic Law Enforcement
ANB45	Occupant Protection
ANB50	Alcohol, Other Drugs, and Transportation
ANB60	Safe Mobility of Older Persons
ANB70	Truck and Bus Safety
ANB75	Roundabouts
ANB99C	Research on the Health and Wellness of Commercial Truck and Bus Drivers: A Conference
AND00	Section - Users Performance
AND10	Vehicle User Characteristics
AND20	User Information Systems
AND30	Simulation and Measurement of Vehicle and Operator Performance

(Continued from left)

Code	Committee Name
AND40	Visibility
ANF10	Pedestrians
ANF20	Bicycle Transportation
ANF30	Motorcycles and Mopeds
AP099A	Committee for Research on Fatigue in Transit Operations: A Conference
AR070	Railroad Operational Safety
AT040	Transportation of Hazardous Materials
AV090	Aviation Security and Emergency Management
AW040	Marine Safety and Human Factors

Policy Study Committees

Code	Committee Name
B0102	Committee for the Study of Traffic Safety Lessons from Benchmark Nations
B0105	Committee for Review of the Federal Railroad Administration Research and Development Program
B0110	Commercial Truck and Bus Safety Synthesis Program
B0113	Committee for a Review of the En Route Air Traffic Control Complexity and Workload Model
B0115	Committee on Offshore Oil and Gas Platform Inspection Program of the Minerals Management Service: A
E1008	Transportation Safety IDEA Program Committee

TRB Committees Related to Data and Information Technology

Standing Committees

Code	Committee Name
A0030T	Special Task Force on Data for Decisions and Performance Measures
ABC30	Performance Measurement
ABC40	Transportation Asset Management
ABJ00	Section - Data and Information Systems
ABJ10	National Transportation Data Requirements and Programs
ABJ15T	Task Force for the Using Census Data for Transportation Applications Conference
ABJ20	Statewide Transportation Data and Information Systems
ABJ25T	Task Force on the Traffic Monitoring Conferences
ABJ30	Urban Transportation Data and Information Systems
ABJ35	Highway Traffic Monitoring
ABJ40	Travel Survey Methods
ABJ45T	Task Force on Understanding New Directions for the National Household Travel Survey
ABJ50	Information Systems and Technology
ABJ60	Geographic Information Science and Applications
ABJ70	Artificial Intelligence and Advanced Computing Applications
ABJ80	Statistical Methods
ABJ90	Freight Transportation Data
ABJ95	Visualization in Transportation
ABJ99F	Using Census Data for Transportation Applications: A Conference
ABJ99G	Committee for Access to International Transportation Research Information: A Conference
AFB80	Geospatial Data Acquisition Technologies in Design and Construction
ANB20	Safety Data, Analysis and Evaluation

Policy Study Committees

Code	Committee Name
B0002	TRB Information Services Committee
B0114	Committee on Strategies for Improved Passenger and Freight Travel Data
E1002	TRB Long-Term Pavement Performance (LTPP) Committee
E1002-B	Expert Task Group on LTPP Special Activities
E1002-C	Expert Task Group on LTPP Traffic Data Collection and Analysis
E1003	Data Analysis Working Group (DAWG)

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13 matches were found.

ABJ60	Geographic Information Science and Applications
ADB30	Transportation Network Modeling
AFB80	Geospatial Data Acquisition Technologies in Design and Construction
AL050	Environmental Issues in Transportation Law
AT015	Freight Transportation Planning and Logistics
AT035	Military Transportation
AT060	Trucking Industry Research
AT065T	Task Force on the Logistics of Disaster Response and Business Continuity
AT099C	Committee for EU-U.S. Transportation Research Symposium No. 1: Urban Freight Transport-The Last Mile
B0125	Committee for Operating in the Ocean Environment: A Workshop on Offshore Renewable Energy Development
D0887	NCHRP Project Panel on Best Practices in GIS-Based Asset Management
DA0411	ACRP Project Panel on Integrating GIS into Emergency Management at Airports
DF040	NCFRP Project Panel on Improving Export Freight Logistics

TRB GIS/Safety Key Committees (DRAFT)

Data

- ABJ10 National Data
- ABJ20 Statewide Data
- ABJ30 Urban Data
- ABJ35 Traffic Monitoring
- ABJ40 Survey Methods
- ANB20 Safety Data, Analysis and Evaluation ★

Passive Data Collection

Volunteer Geodata

Smart maps

- ABJ50 IT — Software, Systems, Hardware
- ABJ60 GIS (GISA) ★
- ABJ70 Artificial Intelligence
- ABJ80 Statistics

Spatial statistics

- ABJ90 Freight Data
- ABJ95 Visualization

Example of Volunteer Geodata

Challenges

GRT Corp

MANAGEMENT ISSUES:

1. Education - How to get top management to understand the magnitude of GIS without getting them turned off before the system is completed:

    a. Training for executives and managers
    b. Training for Legislators
    c. Good definition of GIS
    d. Define benefits of GIS
    e. Define needs
    f. How will quality be maintained

2. Organization - What changes should be made to organizational structure related to GIS:

    a. GIS / DBA ?
    b. Where/Who should control

3. External Coordination:

    a. FHWA role
    b. Standards
    c. Reporting
    d. Goals - FHWA/State/Local

DATA NEEDS and DATA ACQUISITION ISSUES:

40 issues received were reviewed and analysis reduced issues to the following 5 major categories:

1. Data Standardization

2. Data Accuracy

3. Data Sharing - Federal, State, Local governments

4. Create interface among separate data bases (created at different scales, resolutions, etc.)

5. Optimize data collection and maintenance techniques

TECHNOLOGY ISSUES:

1. Technology Transfer:

    a. General information of what's going on in GIS
    b. Dialogue between DOT's and Vendor Community

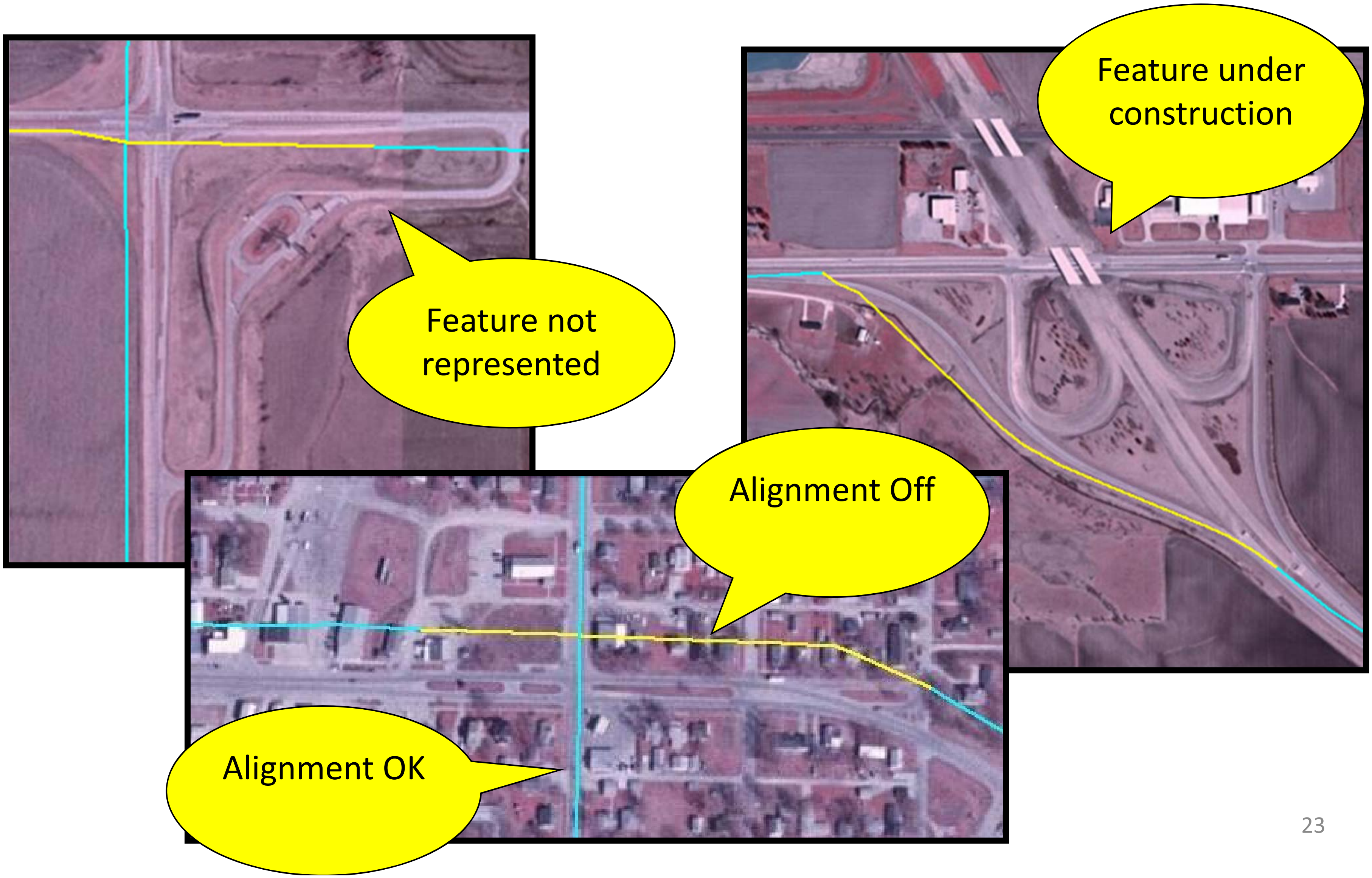
2. Integration Issues:

    a. Multiple hardware platforms
    b. Integrating - CADD, Image, Spatial Data, Workstations, Mainframe, Non-Spatial Data

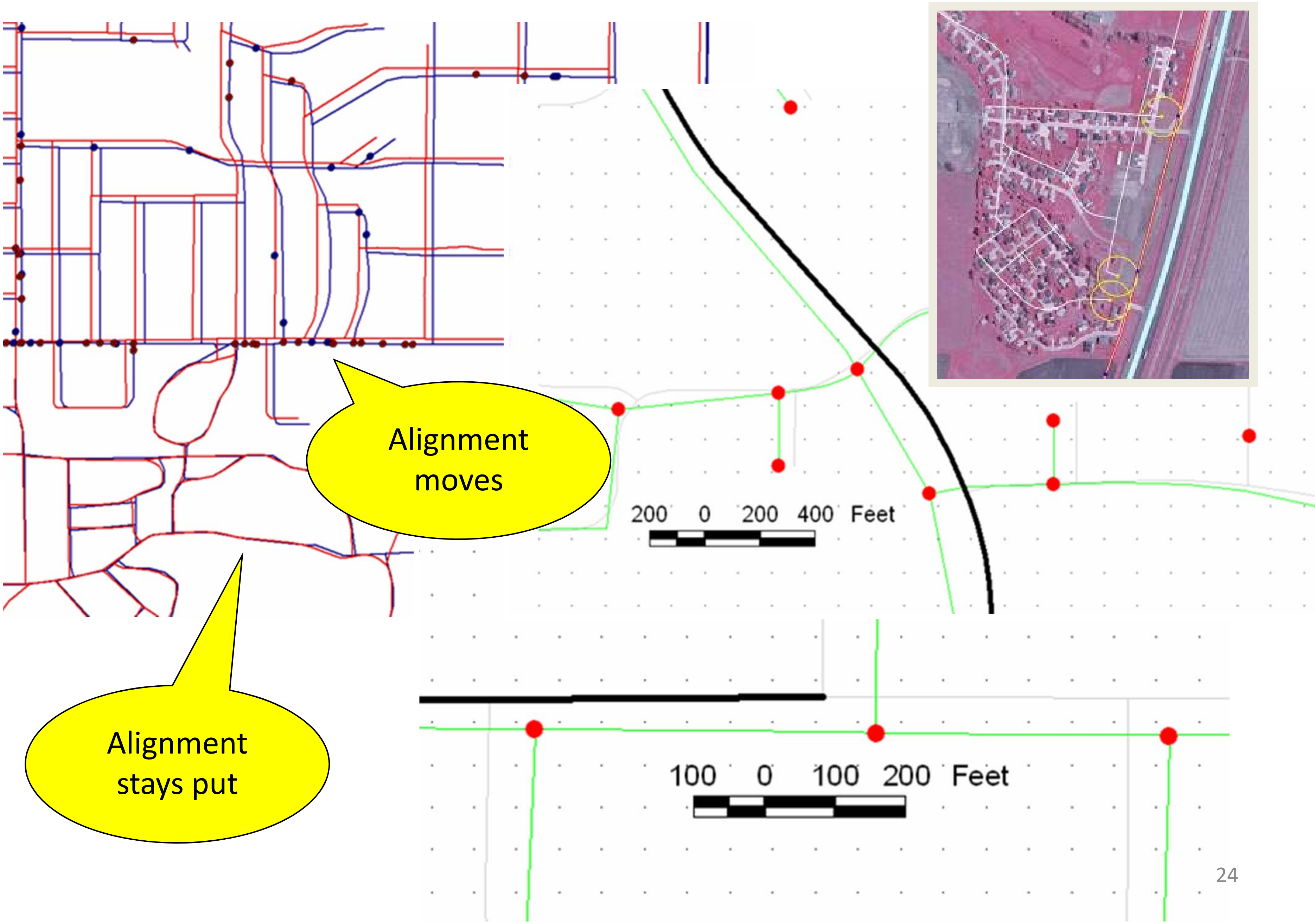
1989 A.D.

Some not-so
“simple”
questions

Where are the roads? (Incorrect or incomplete cartography)



Where are the roads? (Improving cartography)

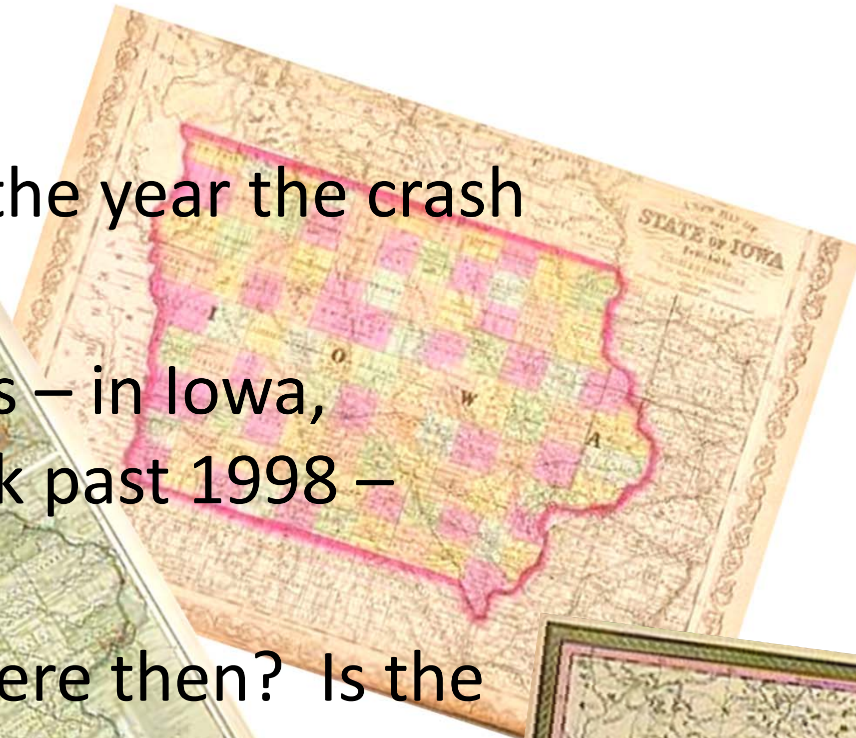


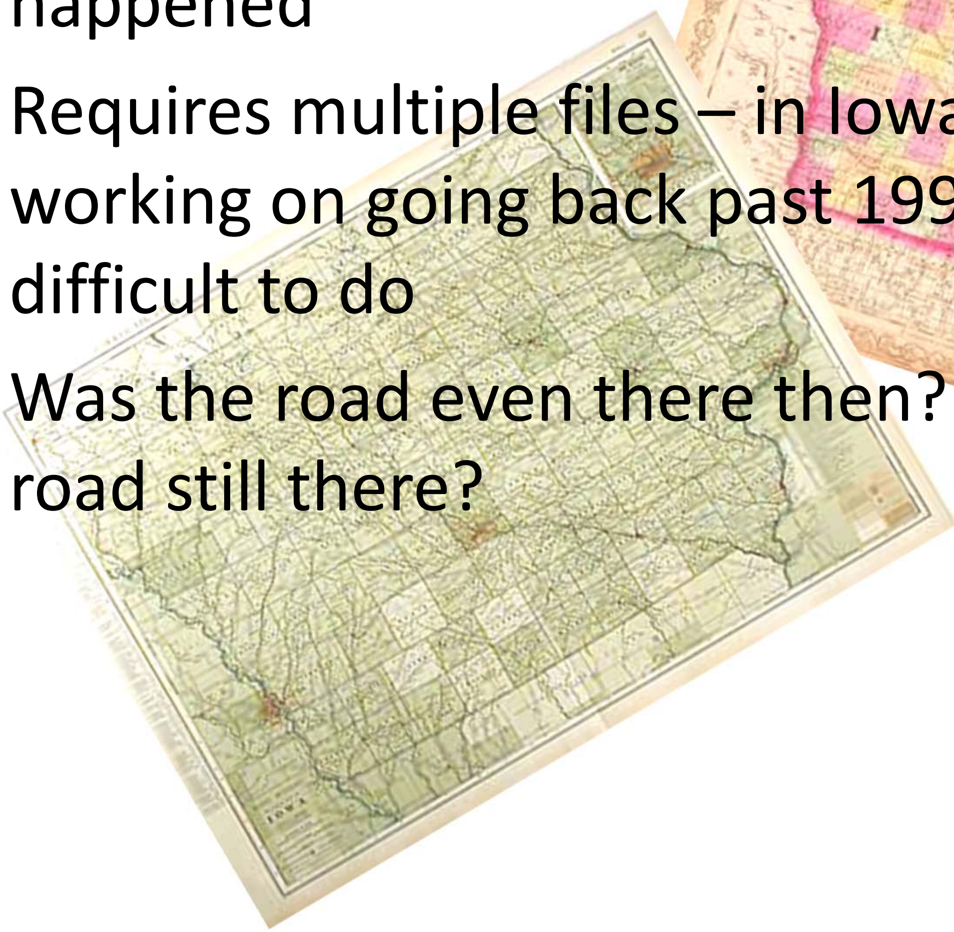
Where are the crashes?

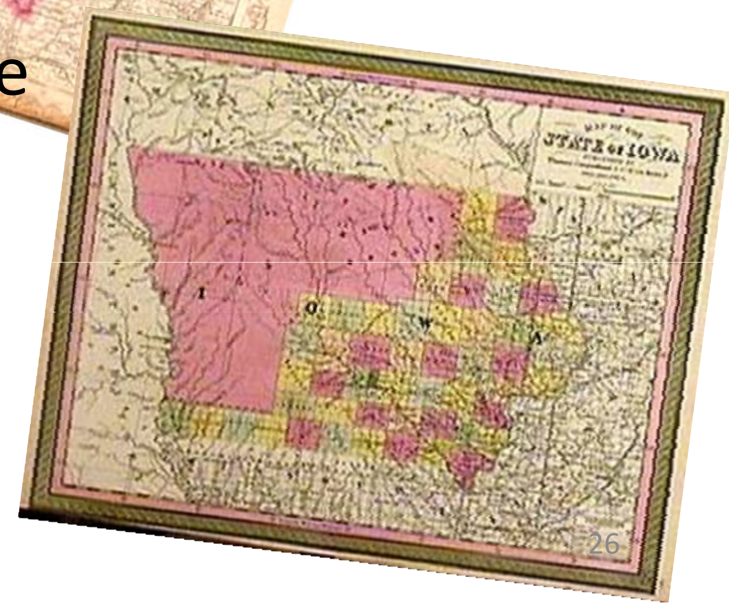
- Crashes are not necessarily point events
- Some crashes may be located using different methods and degree of accuracy
  - Temporal (e.g. link node to lat long)
  - Spatial (e.g., state police v. local)
  - Techno (GPS v. smart map)

What's "the" traffic volume on "the" road?

- Need traffic level for the year the crash happened
- Requires multiple files – in Iowa, working on going back past 1998 – difficult to do
- Was the road even there then? Is the road still there?

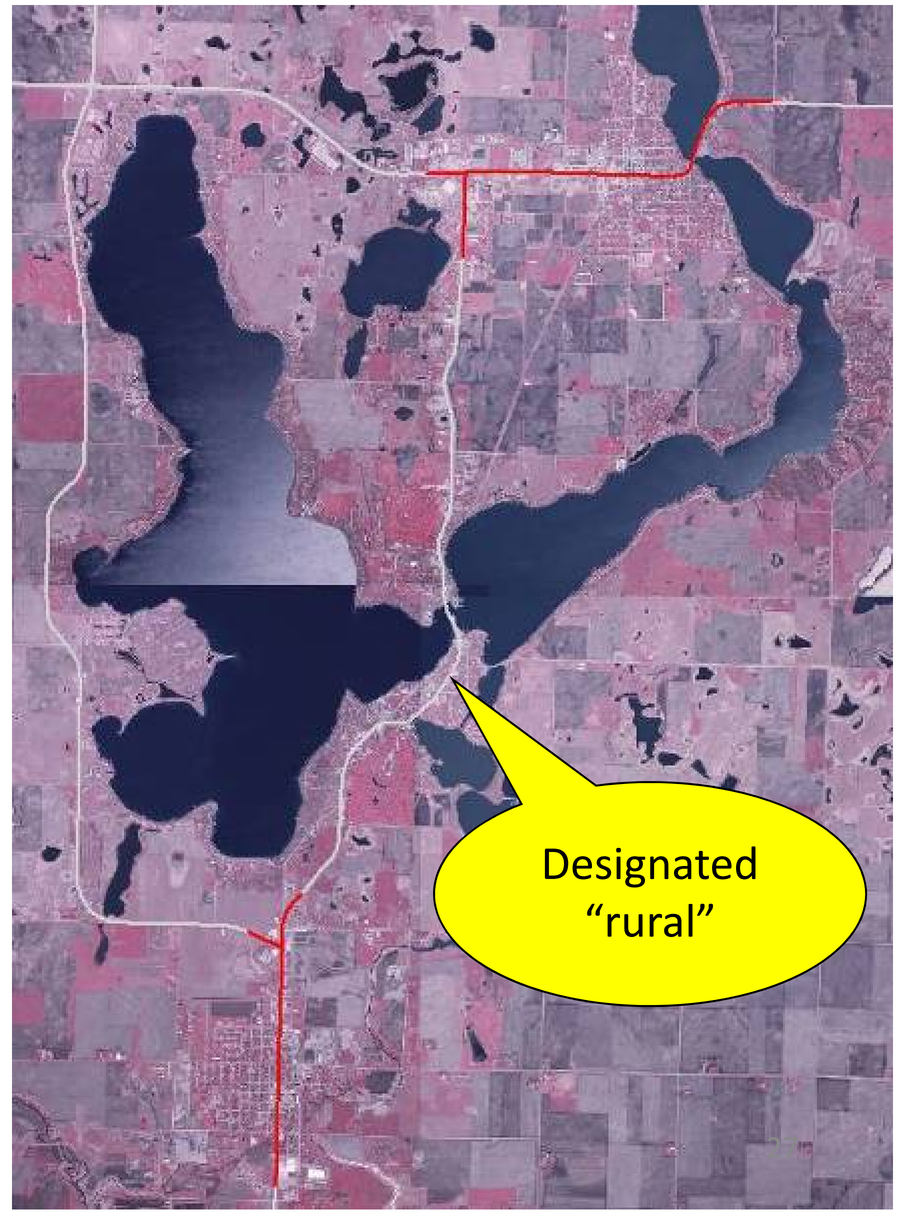






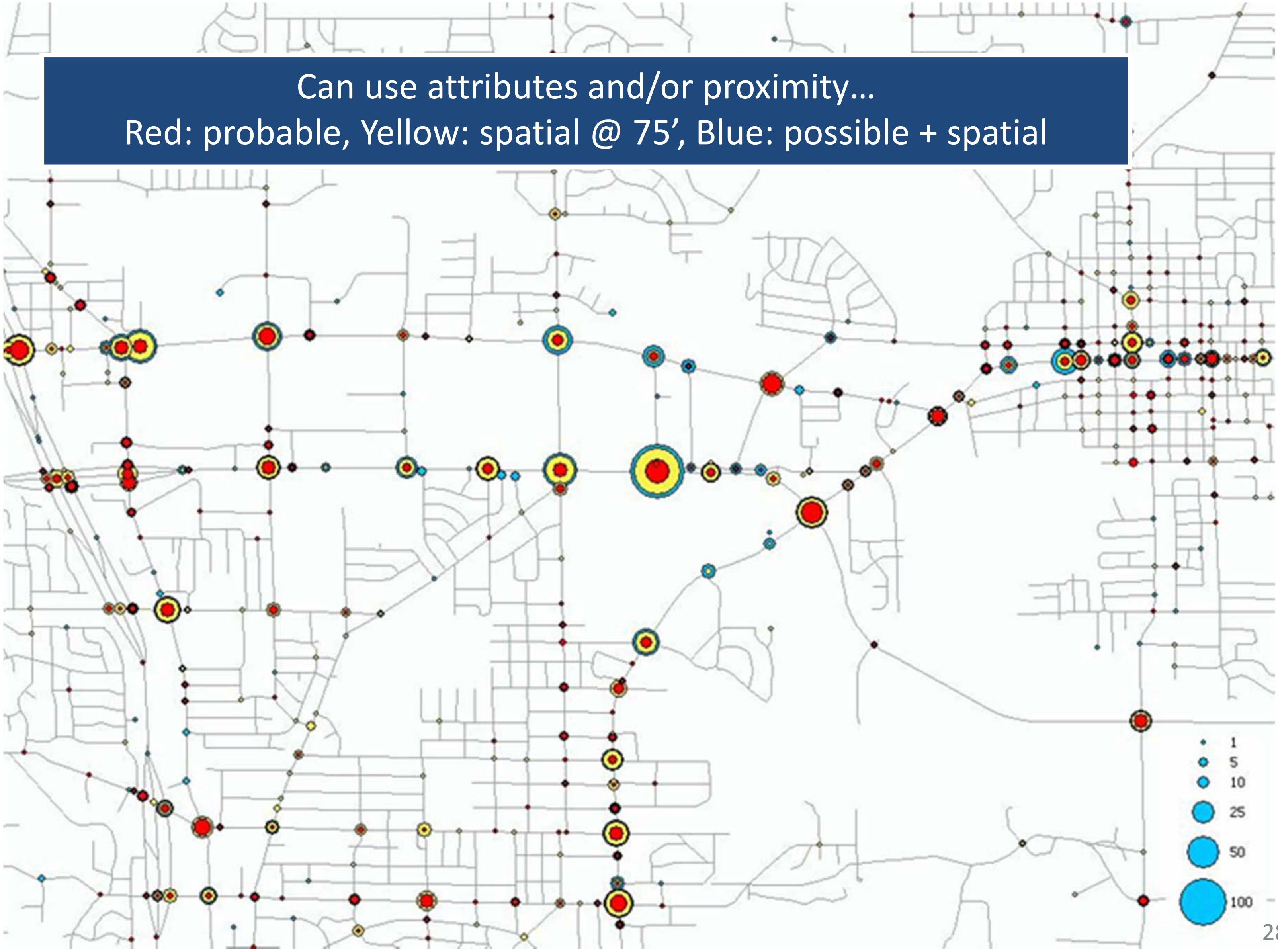
How to segment the road system?

- Requirements
  - Logical breaks (engineering and public)
  - Relationship to inventory data
  - Long enough for manageability and presentation
  - Short enough to reflect important changes
  - Clear and understandable to use
- Facility location and type
  - What is rural/urban? Character is important …



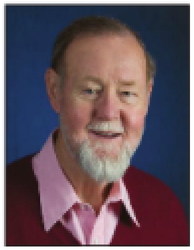
What is an intersection crash?

Can use attributes and/or proximity…
Red: probable, Yellow: spatial @ 75’, Blue: possible + spatial



ArcNews Fall 2012

The 50th Anniversary of GIS



Roger Tomlinson

Some events, like birthdays, weddings, and graduations, are easy to mark on the calendar. Others, like the beginning of a social movement or a language—or the invention of GIS—are harder to pinpoint. However, the confluence of three pivotal events in 1962 and 1963 makes this as good a time as any to celebrate a half-century of GIS.

The first event was the establishment of the Canada Land Inventory (CLI) in 1962. CLI set out to produce about 1,500 maps of land use and land capabilities at 1:50,000 scales. Though the maps were tional manual methods, Roger T employed by Spartan Air Servi convinced the head of CLI that c be used to automate map analysis. CLI invited Tomlinson to define the functional requirements of what would later be called the Canada Geographic Information System. His carefully considered use of the qualifier "geographic" caught on and has created opportunities and challenges for the discipline of geography ever since.

In August 1963, just as Tomlinson delivered his feasibility report to CLI, Edward Horwood of the University of Washington organized the First Annual Conference on Urban Planning Information Systems and Programs. Within a few years, that event became the annual conference of a new organization called the Urban and Regional Information Systems Association (URISA). Urban and Regional Information

Tomlinson, R. F. 1962
Computer Mapping:
An Introduction to the Use of Electronic Computers
in the Storage, Compilation and Assessment of
Natural and Economic Data for the Evaluation of
Marginal Lands

The title page of Roger Tomlinson's 1962 paper that started the work on GIS in the Government of Canada.

grant from the Ford Foundation, Fisher later founded the Laboratory for Computer Graphics at Harvard, where he oversaw an important strand of the evolution of computer mapping into GIS.

Whether we choose these milestones or others as the origins of GIS, the fact remains that GIS has come a long way, baby, in a relatively short period of time. Its impact extends far beyond the hundreds of thousands of GIS professionals at work around the world. The recent Penn State-Public Broadcasting video series *Geospatial Revolution* (geospatialrevolution.psu.edu) dramatizes the far-reaching impacts of GIS and related technologies on how we think, act, and interact. At its 50th anniversary, GIS has itself become a kind of movement and

A Geographic Information Syste[m]
for Regional Planning

R. F. Tomlinson

Department of Forestry and Rural Developme[nt]
Government of Canada

As a tool in its program of rural development, Canada is developing a computer-based information system for the storage and manipulation of map-based land data. The system and its capabilities are described.

Canada, like many countries, faces an immense problem in both understanding and guiding the development of its land, water, and human resources. One of the major agencies created specifically to implement policy to attack this problem is the Rural Development Branch of the Department of Forestry and Rural Development. A primary task facing this agency is to assemble social (demographic), economic, and land data for an integrated analysis to enable problems of rural development to be specified, development programs to be implemented, and their effectiveness evaluated.

Parallel with the gathering of data has been the development, by the Regional Planning Information Systems Division of the Branch, of interrelated computer-based information systems to handle and analyse the data. The Geographic Information System, for the storage and manipulation of land data is the most developed of these systems. Its design and development started in 1963, implementation began in 1965, and is now in its final stages; routine use is scheduled

and federal resource policy and regional planning, will generate an estimated 30,000 map sheets, at various scales. The Inventory has currently produced 7000 map sheets, of which 3000 have been prepared for computer input. The maps contain an average of 800 distinct areas on each sheet, and have been found to contain as many as 4000. Additionally, other types of maps covering watersheds, climate, geology, administrative boundaries, and land titles are generated by other agencies.

The need for a computer-based system, whereby map and related data can be stored in a form suitable for rapid measurement and comparison, is apparent as soon as the magnitude of the problem of handling large numbers of maps is appreciated. Lack of trained personnel makes it impossible to examine such large amounts of data manually in any sensible time, much less to provide a meaningful analysis of the content. A situation can be reached where the amount of data precludes its use. The end product of countless hours of survey can remain unused, with the result that administrators do not receive information necessary for a sound basis to decision making.

The first known published use of the term *Geographic Inform[ation]* August 1968.

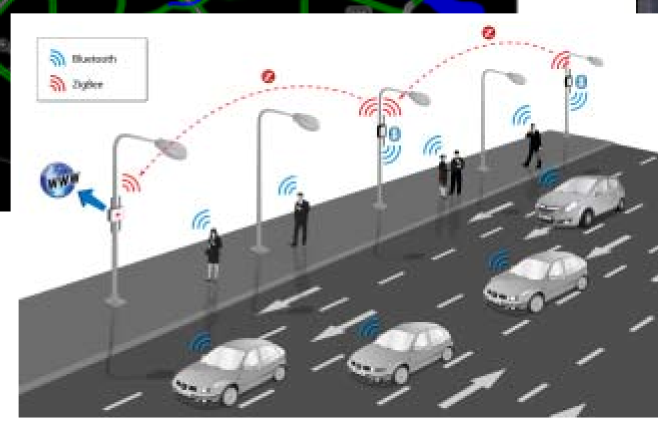
For more information, contact David DiBiase ... Tomlinson, Roger. 1998

"A situation can be reached where the amount of data precludes its use."
- Tomlinson, 1962

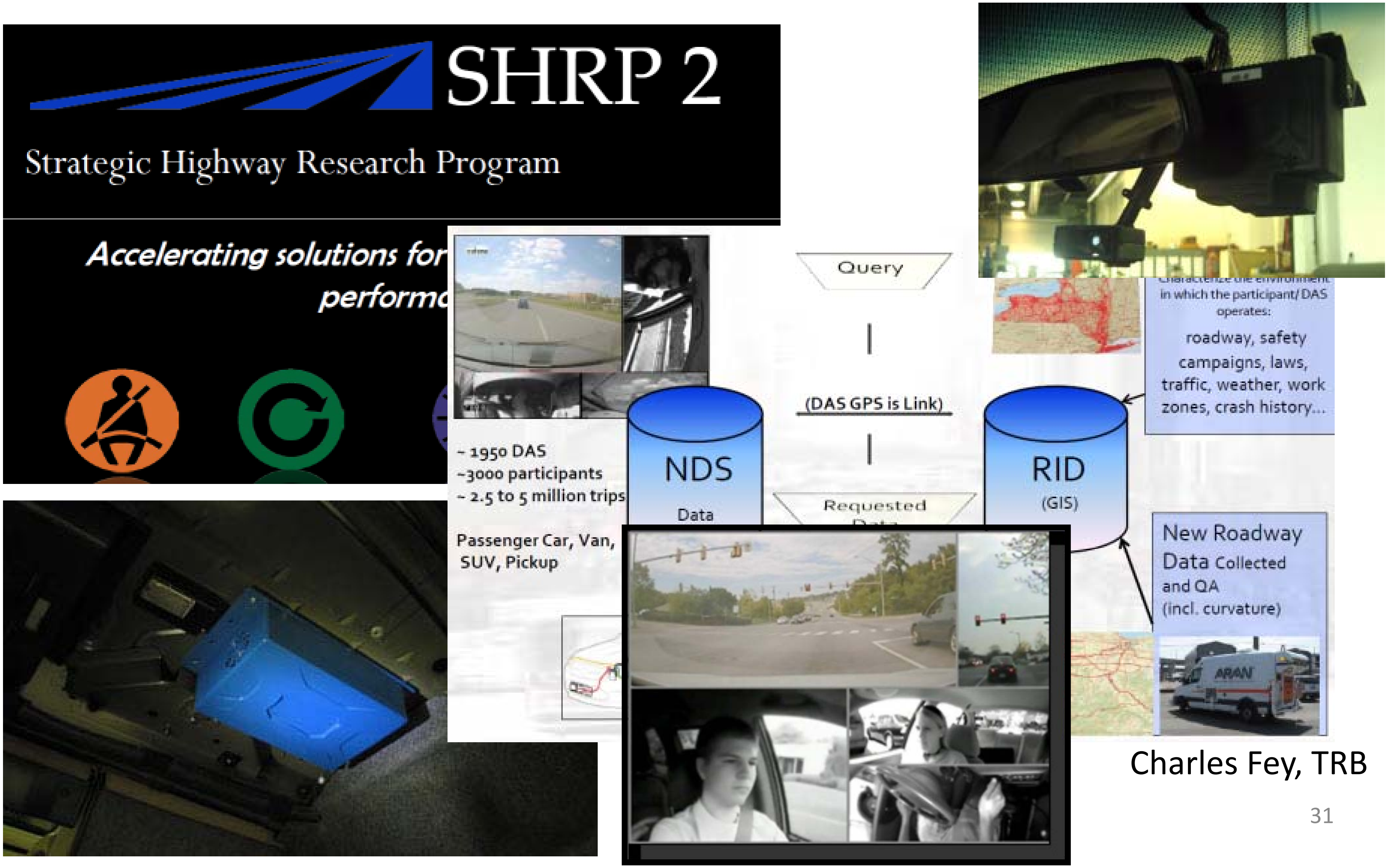
Big data: Sensors

TranStar Traffic Uses Bluetooth for Real-Time Monitoring

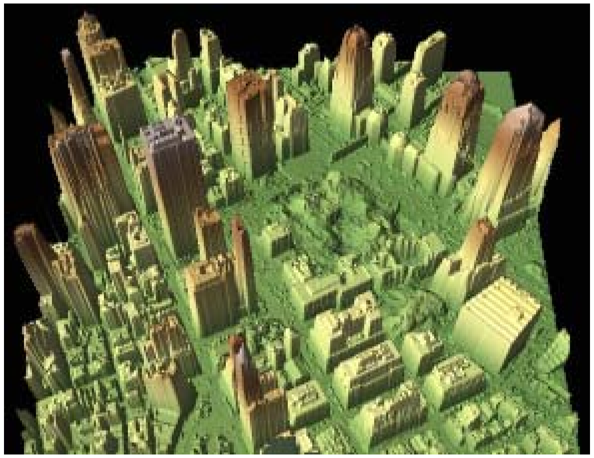
by MATT BALL *on* AUGUST 22, 2011



Big Data: SHRP2



Charles Fey, TRB



Big Data: Scanners

28 December 2011 Last updated at 23:56 ET

Share

Motorway crash closures to be cut by 3D laser scanners

New technology is to be employed to cut down the time that motorways are closed after crashes, the government says.

There were more than 18,000 full or partial motorway closures in 2010

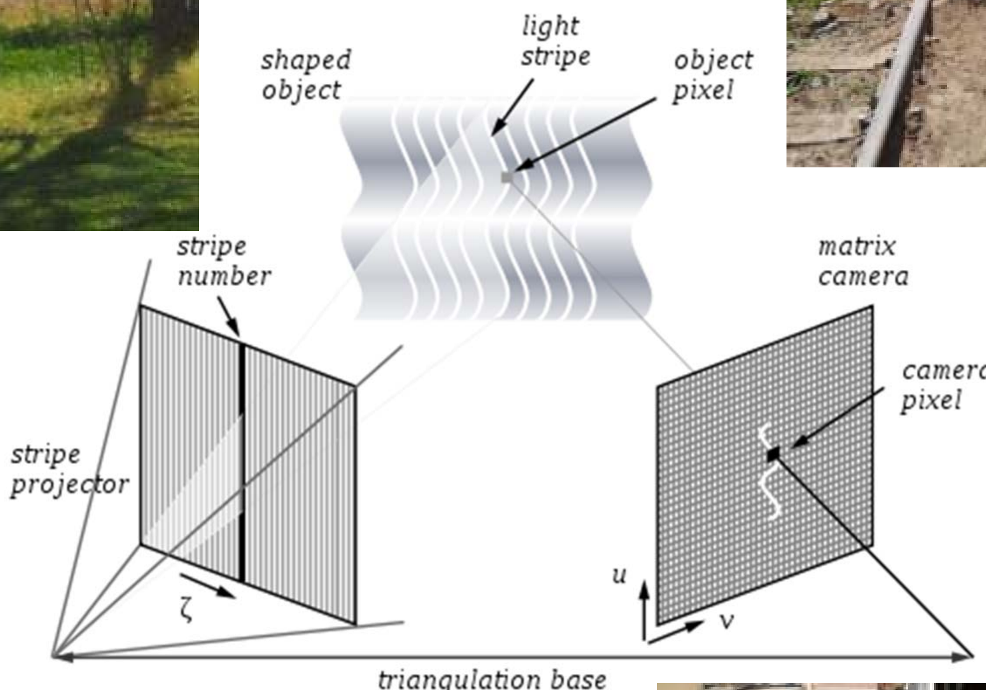
A £2.7m deal will allow 27 police forces across England to get 3D laser scanning technology.

This quickly makes a 3D image of the crash site, instead of investigators surveying multiple sections of a scene.

Roads Minister Mike Penning said the technology will benefit drivers "by reducing incident clear up times by 39 minutes on average".

Related Stories


ROUGH
CROSSING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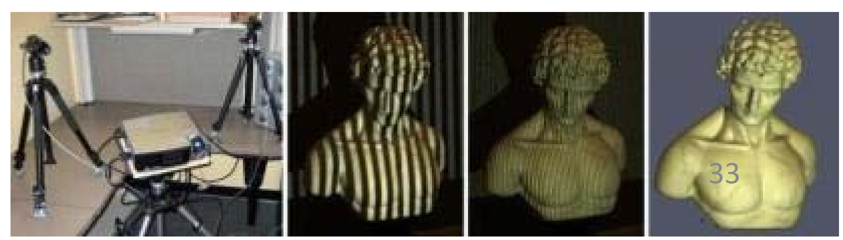


L&N Magazine

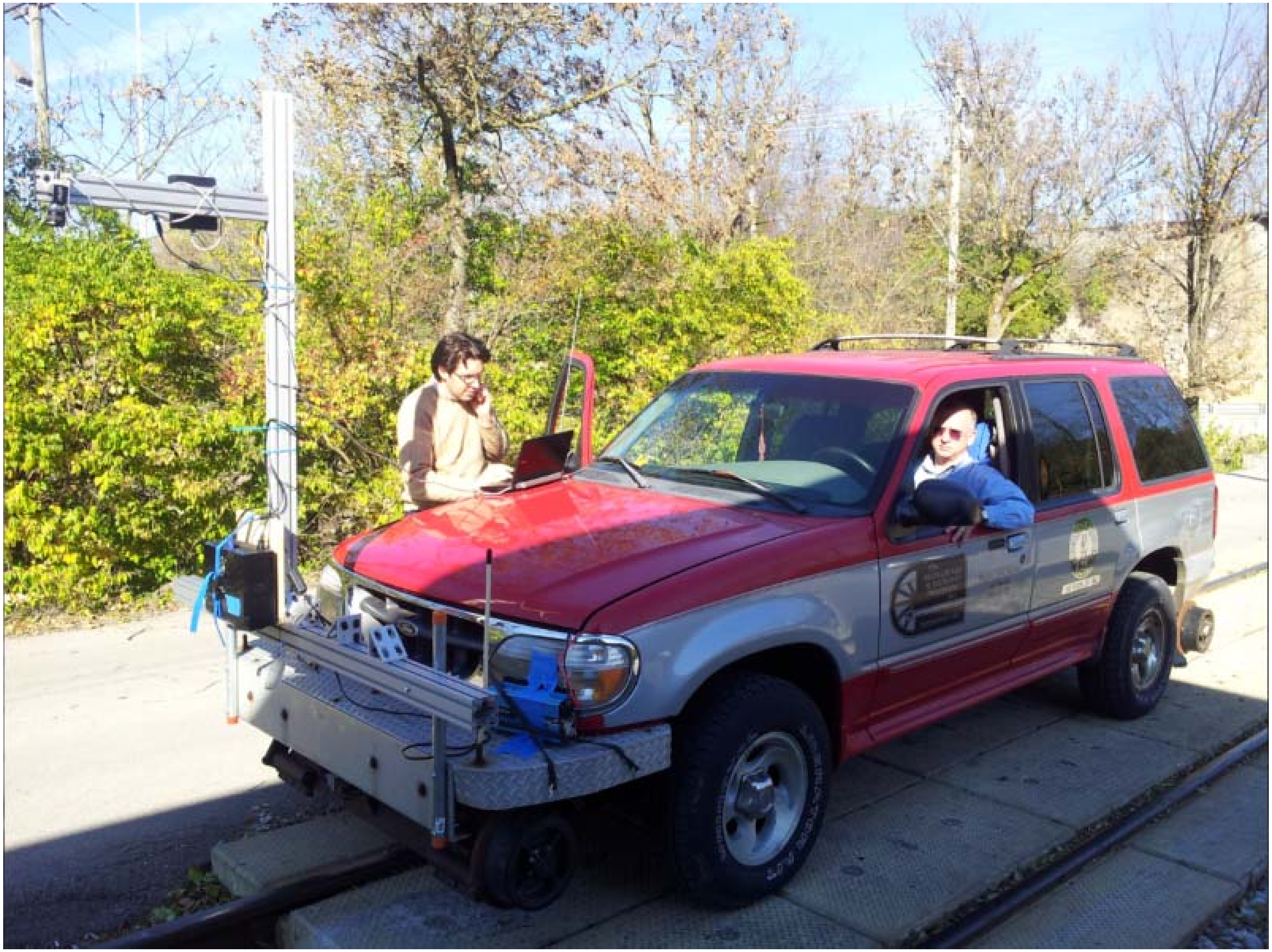
Portion of First Railway in West Is Kept on University Grounds

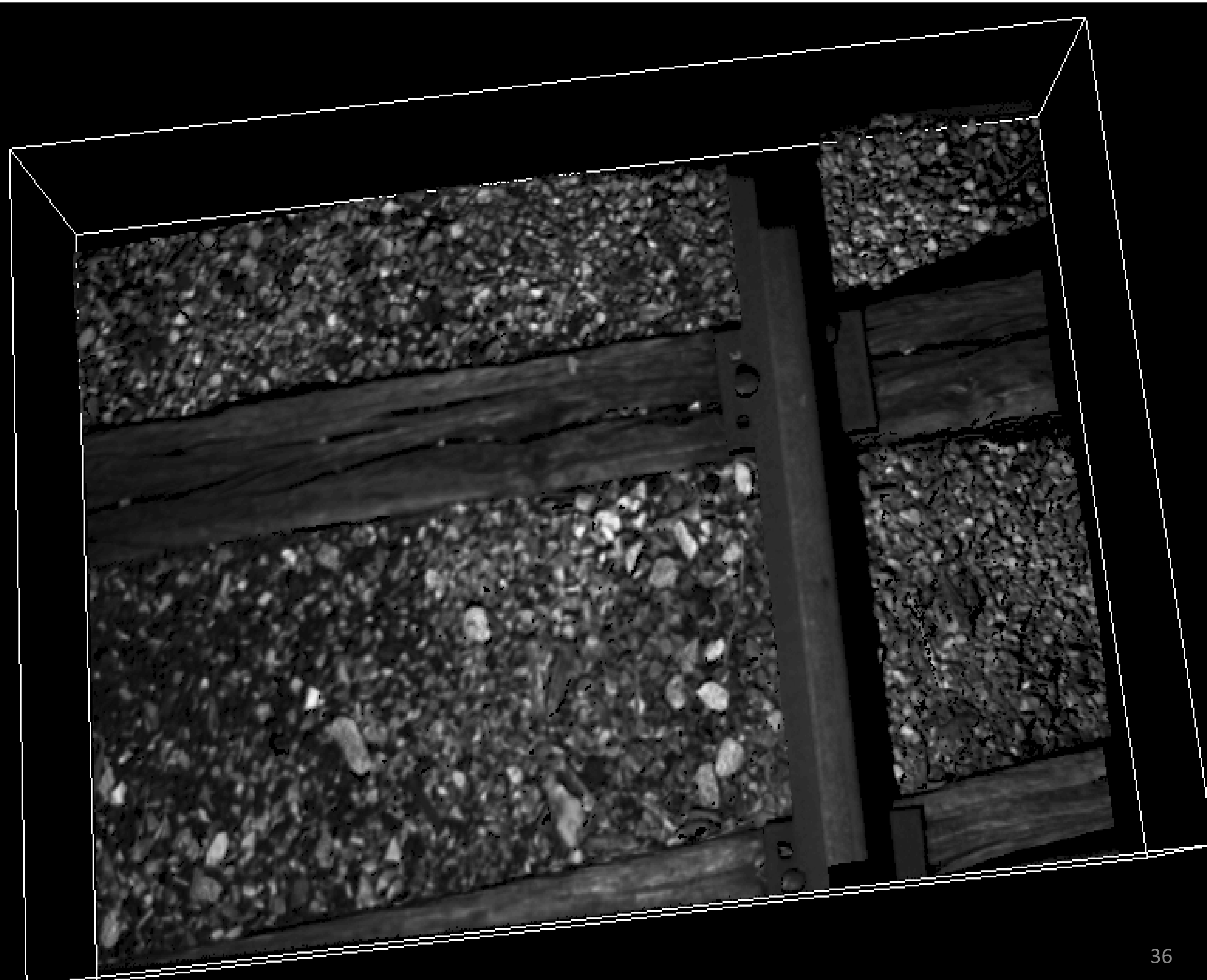
Tracks of Old Lexington and Ohio Railroad Are Embedded in Concrete on Lawn in Front of Mechanical Hall; Dedication of Historical Monument Was Held on May 30, 1916

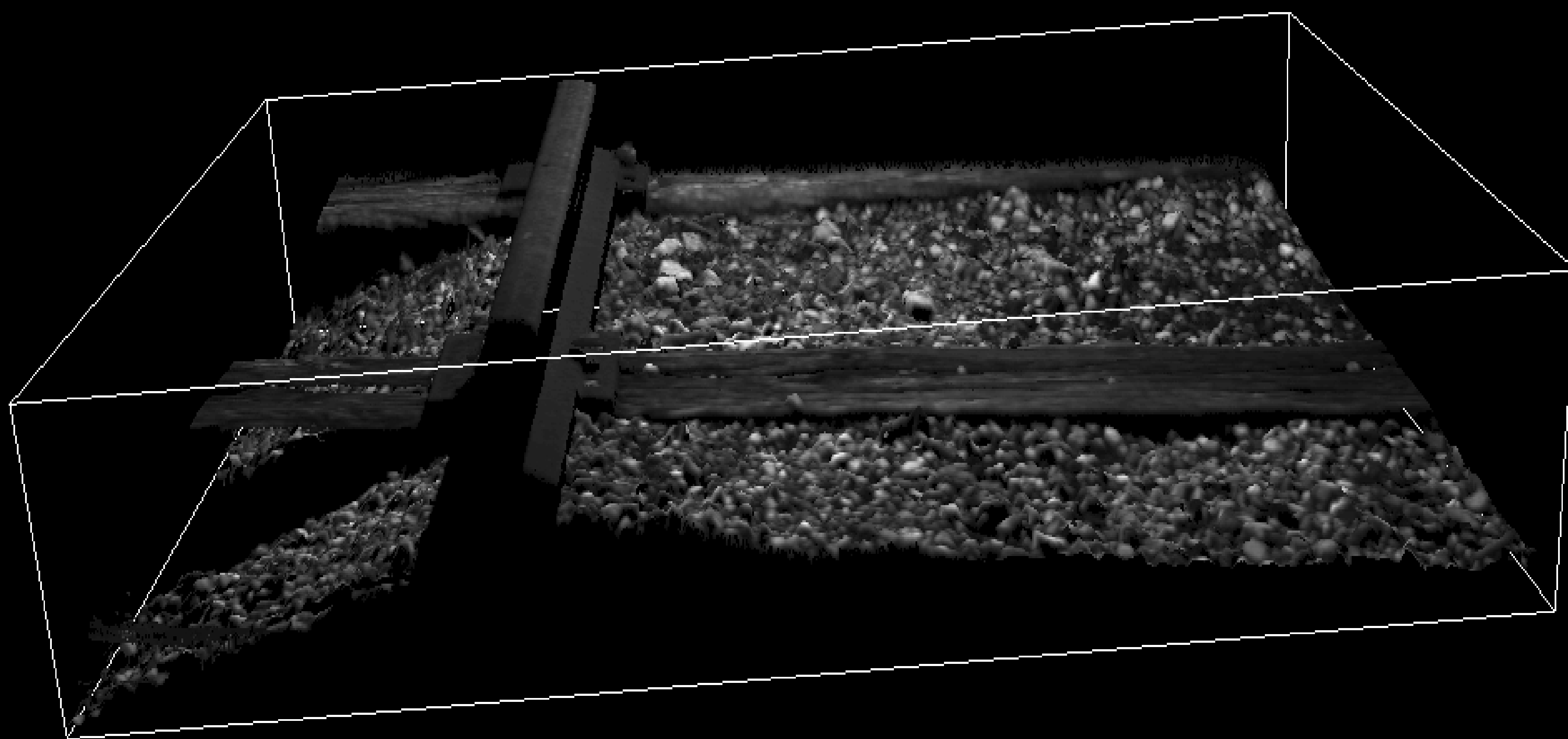
Unknown to a large number of students of the summer session there is on the university campus a portion of

year a group of citizens set to work to obtain a charter from the legislature for a railroad from Lexington

ling the restoration of a part of the original track of the Lexington & Ohio Railroad, at the University of Ke
left to right: J. G. Metcalfe (now Superintendent, Ky. Division); W. H. Anderson (superintendent of Ky.
ased); F. B. Carr, general agent, Lexington; J. H. Kastle, Lexington; F. L. Salisbury, Lexington; Judg
rtis Dougherty, Lexington; Dean Paul Anderson, Lexington; H. S. Barker, Lexington; J. P. Nelson, Le
gton; G. H. Campbell, Baltimore, Md., (B. & O. R. R.); Wm. Gibson, Pittsburg, Pa., (Penna. R. R.);
trainmaster on E. K. Division); D. F. Crawford, Pittsburg, Pa., (Penna. R. R.); Col. W. H. Polk, Lexin
ngton.

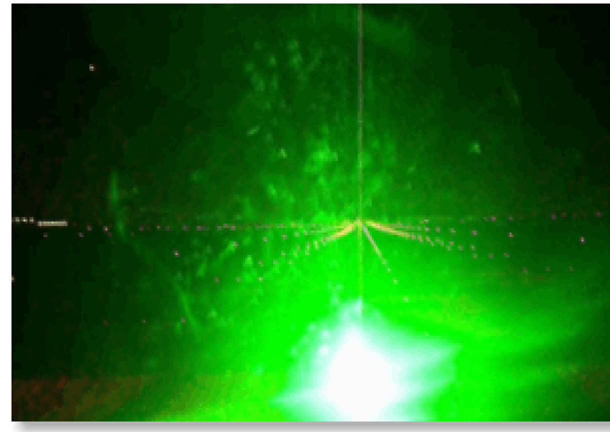






1831 to 2012

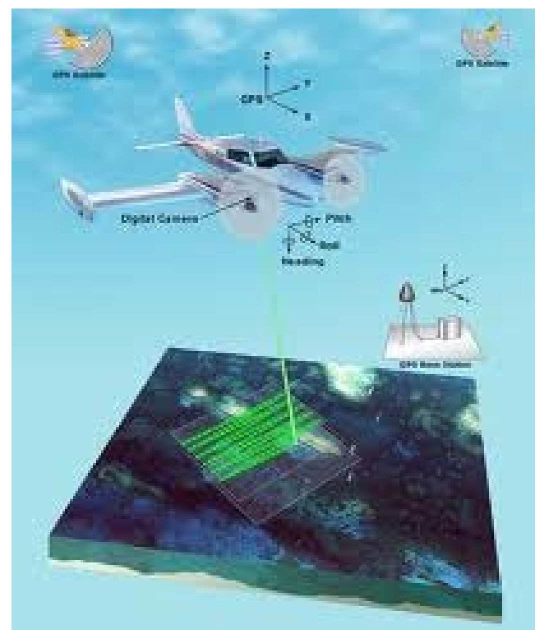
Sometimes, the cure is worse that the disease …



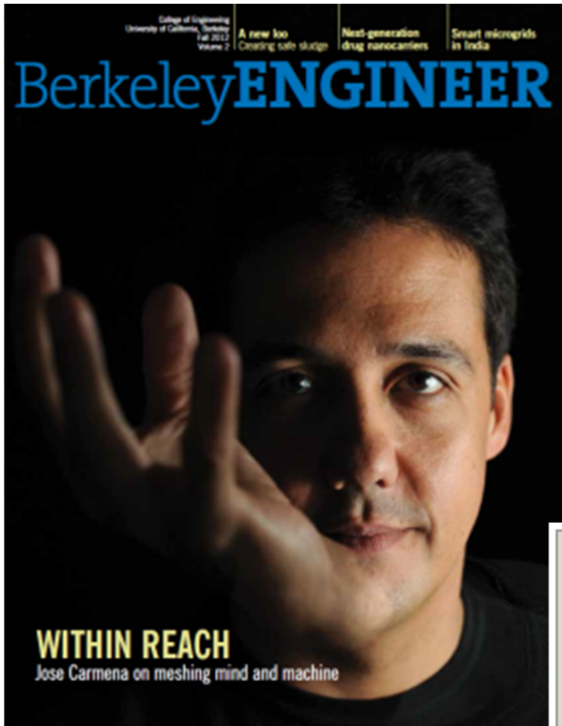
NGAC Meeting Addresses Transportation and Laser Regulation

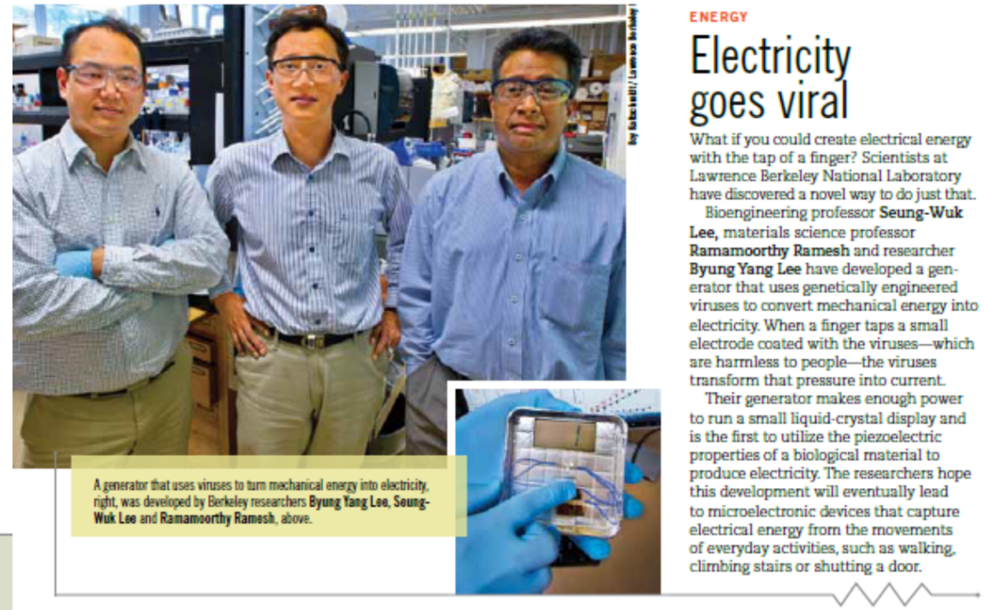
by MATT BALL *on* JUNE 20, 2011

The National Geospatial Advisory Committee (NGAC) met June 8-9, in Washington, D.C. On the agenda were discussions on transportation for the nation, Census address and road features and parcels, and parcel data on tribal lands. There was also concern about the impact on lidar mapping technologies from new Federal Aviation Administration regulations that ban the pointing of lasers at aircraft.



Challenges, or Opportunities?





ENERGY

Electricity goes viral

What if you could create electrical energy with the tap of a finger? Scientists at Lawrence Berkeley National Laboratory have discovered a novel way to do just that.

Bioengineering professor **Seung-Wuk Lee,** materials science professor **Ramamoorthy Ramesh** and researcher **Byung Yang Lee** have developed a generator that uses genetically engineered viruses to convert mechanical energy into electricity. When a finger taps a small electrode coated with the viruses—which are harmless to people—the viruses transform that pressure into current.

Their generator makes enough power to run a small liquid-crystal display and is the first to utilize the piezoelectric properties of a biological material to produce electricity. The researchers hope this development will eventually lead to microelectronic devices that capture electrical energy from the movements of everyday activities, such as walking, climbing stairs or shutting a door.

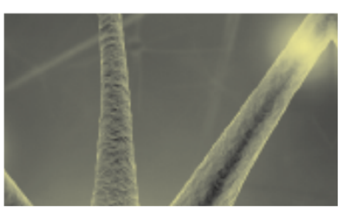
A generator that uses viruses to turn mechanical energy into electricity, right, was developed by Berkeley researchers **Byung Yang Lee, Seung-Wuk Lee** and **Ramamoorthy Ramesh**, above.

PUBLIC HEALTH

A new loo

Aiming to improve sanitation services in developing countries, the Bill and Melinda Gates Foundation challenged engineers to make toilets clean, affordable and sustainable for the 2.5 billion people—40 percent of the world's population—who lack access to modern latrines. In response, environmental ... postdoctoral ... ed a toilet ... s a two- ... creta to ... ting waste, ... without endangering humans or the environment. Their goal is for each toilet to cost less than $50.

Over the next year, the researchers plan to refine their design, test it under actual use conditions and investigate ways to incorporate their solution into existing waste management systems. The display model, shown here, was designed to be transparent to show the toilet's inner components.



Thank you

Accomplishments

- Technology
- Applications
- Innovation

Challenges

- Making sense of big data
- Supporting decisions
- Privacy
- Finance data programs
- Coordination

NATIONAL TRANSPORTATION SAFETY BOARD
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