

RECENT EARTHQUAKES & GEER

GEESD IV Sacramento

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Georgia Institute of Technology

Session Outline

- Complimentary efforts...Youd
- GEER...Bray
- Pisco 8/15/07 Response...Rodriguez-Marek
- Niigata Chuetsu-Oki 7/16/07 Response...Kayen
- Panel & Audience Discussion...ALL

Traditional Field Data Collection



Technology for "Smarter" Engineer

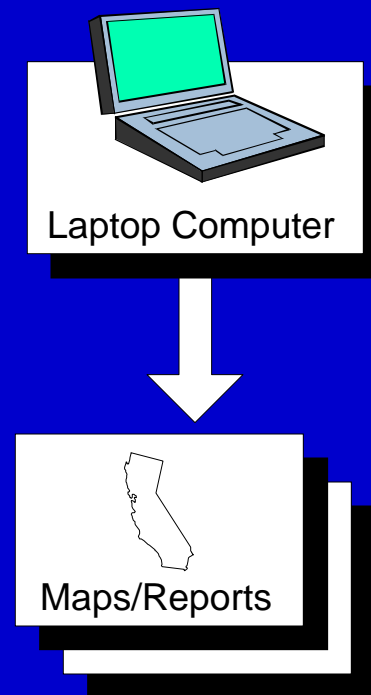
Field Reconnaissance Equipment



Conduit to
Upload &
Link Data



Analysis & Data Reduction Equipment





Example of Technology Usage

- Integrated data acquisition and analysis software
- Record feature and/or area damage
- Links location, photographic and other digital data
- Keeps engineer “within data loop”
- Facilitates consistent/complete data
- Upload data into GIS extension

Example Data Categories

Building

Residential
Commercial
Industrial
Religious
Government
Educational

Lifeline Infrastructure

Water
Sewer
Gas
Telecom
Electrical

Transportation Facility

Road
Rail
Bus
Ferry
Port
Airport

Geotechnical Structure

Dam/Levee
Retaining Wall
Landfill
Embankment
Cut Slope

Earthquake Feature

Landslide
Fault Rupture
Circular Sand Blow
Linear Sand Blow
Ground Cracking
Lateral Spread

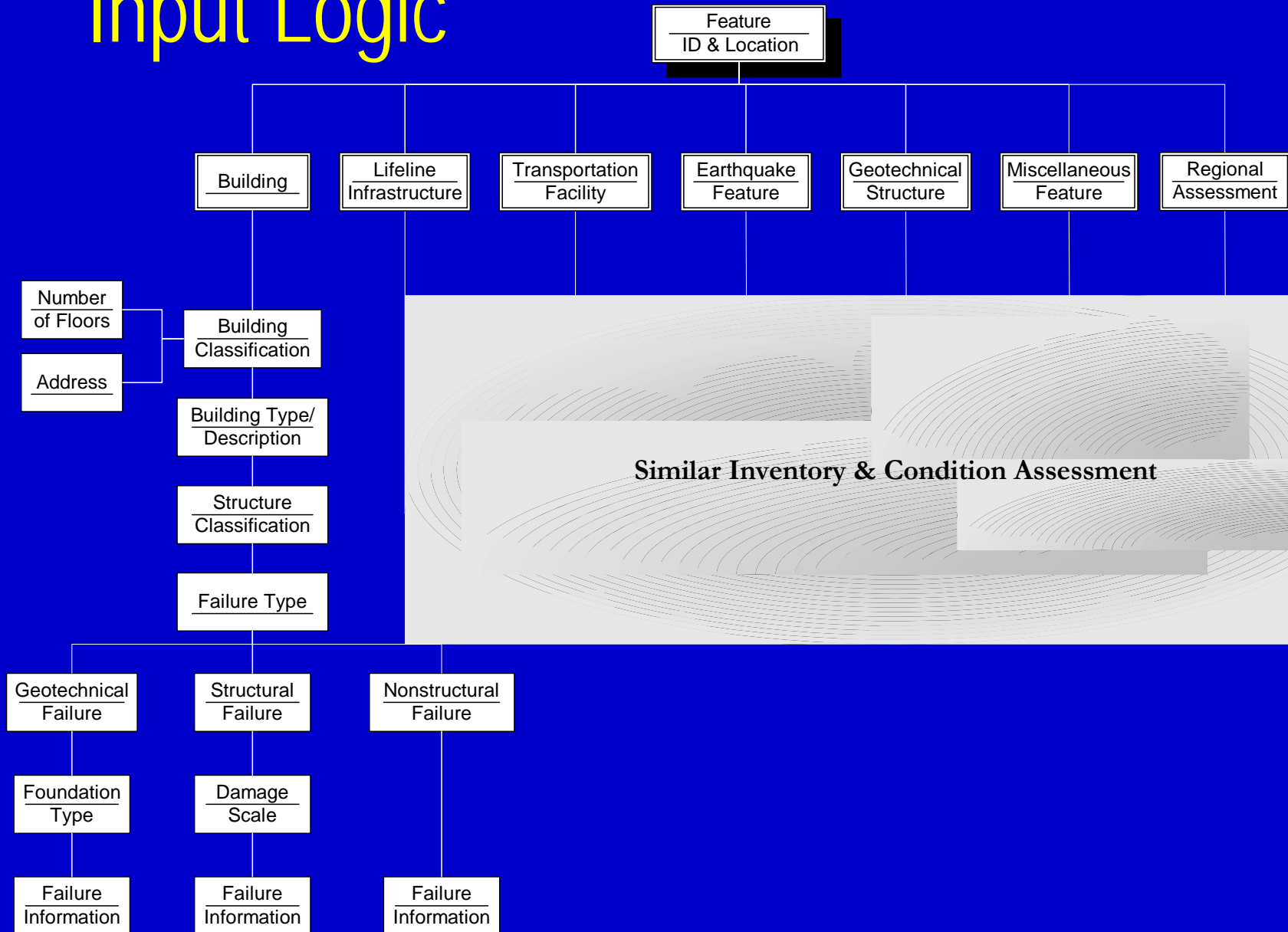
Miscellaneous Feature

Seismograph
Wall

Regional Assessment

Block
Street
District
Village
Town
City

Input Logic



Dam Failure Example



Back-end – (e.g. ArcGIS® extension)

- Rapidly assimilate data from multiple users
- Query data based on information type
 - e.g. Select all 5 story buildings that collapsed from soft story failure
 - e.g. Show location of all sand blow features
- Query individual features
- Create comprehensive maps of damage sites
- Real-time reconnaissance planning
- Integrated transfer of data to “home base”

Example Event Query

Query

Feature Type

- ☐ All
- ☒ Building
- ☐ Lifeline Infrastructure
- ☐ Transportation Facility
- ☐ Geotechnical Structure
- ☐ Earthquake Feature
- ☐ Miscellaneous Feature
- ☐ Regional Assessment

General

☐ User ☐ Date

Feature Classification

- ☒ Residential
- ☒ Commercial
- ☐ Industrial
- ☐ Religious
- ☐ Government
- ☐ Educational

Number of Floors

- ☐ All
- ☐ =
- ☐ >=
- ☐ <=

OR

☒ >= & <=

Structure Type

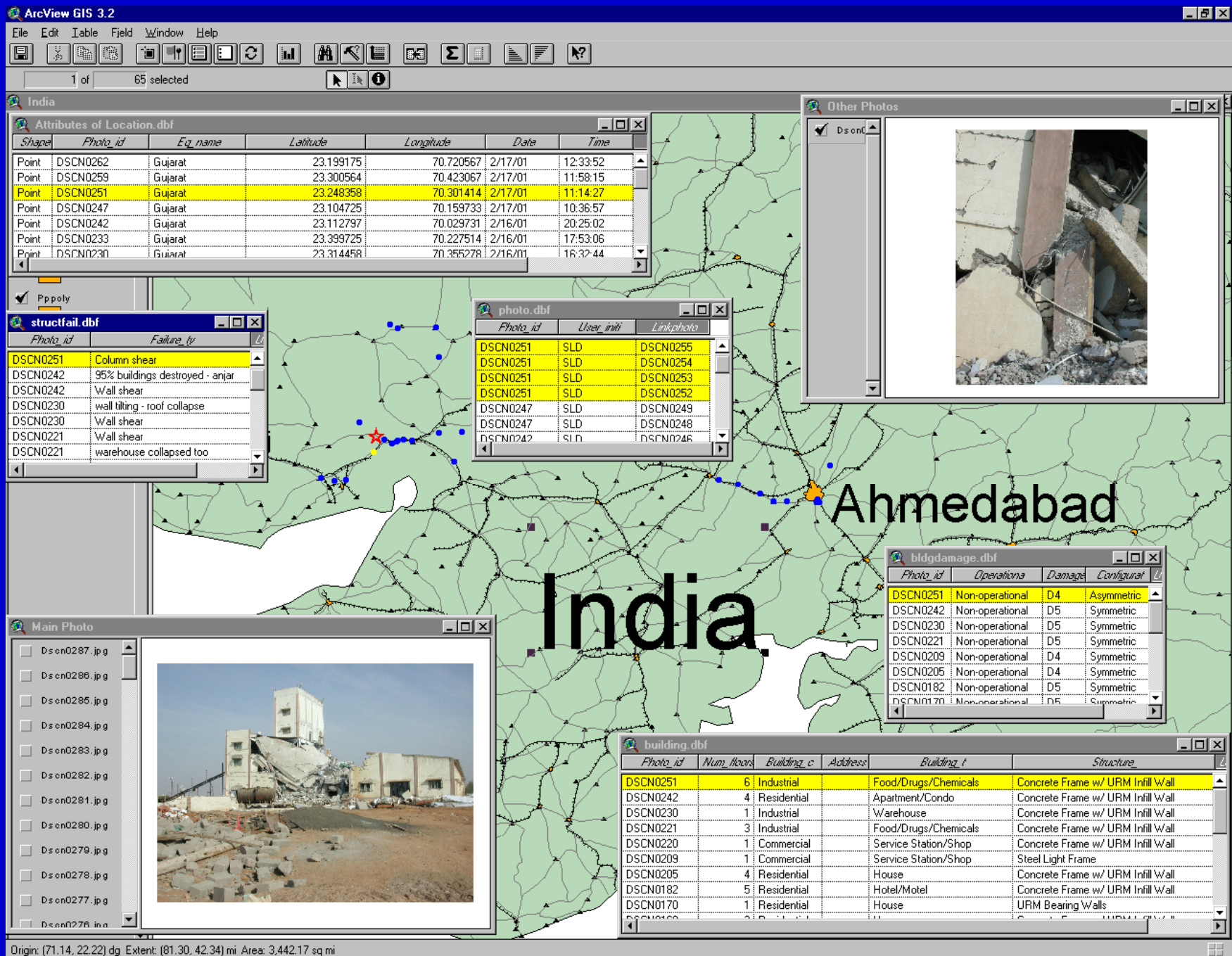
- ☐ Wood - Light Frame
- ☐ Wood - Commercial Industrial
- ☐ Steel Moment Frame
- ☐ Steel Braced Frame
- ☐ Steel Light Frame
- ☐ Steel Frame w/ Conc Shear Walls
- ☐ Steel Frame w/ URM Infill Walls
- ☐ Reinf Conc Moment Resisting Frame
- ☐ Concrete Shear Walls
- ☒ Concrete Frame w/ URM Infill Wall
- ☐ Precast-Conc Tilt-up Walls
- ☐ Precast-Conc Frm w/ Conc Shear Walls
- ☐ RM Bear Wall w/ Wood or Metal Diaph
- ☐ RM Bear Wall w/ Precast Conc Diaph
- ☐ URM Bearing Walls
- ☐ Mobile Home

Failure Type:

- ☐ All
- ☒ Structural
- ☐ Geotechnical
- ☐ Non-Structural

- ☐ Insufficient reinforcement
- ☒ Column shear
- ☐ Column rotate
- ☐ Plastic hinge
- ☐ Plastic deform
- ☐ Slide off found.
- ☐ Shear wall crack
- ☐ Shear wall bend
- ☐ Shear wall joint
- ☐ Brace yielding
- ☐ Brace buckling
- ☐ Connection
- ☐ Wall buckling
- ☒ Wall shear
- ☒ Soft story
- ☐ Found. shear
- ☐ Weld damage
- ☐ Spalls/cracks
- ☐ Short column
- ☐ Racking

of records selected.



Feature Query

ArcView GIS 3.2a

File Edit View Theme Graphics PQuake Window Help

Scale 1:546,285 70.49 24.64

Earthquake Features Map

- ✓ Epicenter.dbf
- ✓ Earthquake Fe
- ✓ Railroads
- ✓ Roads
- ✓ Metropolitan A
- ✓ Dnnnet
- ✓ Rrlne
- ✓ Rdline
- ✓ Pppoly
- ✓ Bardet dams.c
- ✓ Bardet sand bl
- ✓ Dnnnet
- ✓ Country.shp

India

Great Rann of Kachchh (Desert)

Little Rann of Kachchh (Desert)

Ahmedabad

Click

Feature Information

Information

D Dscn0192 User ID SLD Earthquake Name Gujarat

e 23.4129 Longitude 70.6406 Date 9/9/2001 Time 16:32:32

Description

Type Geotechnical Structure Dam Type Gravity Material Earth

cation Dam Height 50 Length 200

Width 3 Upstream Slope Downstream Slope

Failure Description

Failure Types

Upstream Failure Type Slope Stability Length 100 Width 30 Inclination Scarp Height 3

Photographic Information

Show Main Photo Show All Photos

Notes



Show Photo

What About “Event Planning”

Soft Story Failures



Example of Technology Usage

- Utilized for rapid pre-event screening of buildings with a potential soft story for municipal program.
- Software based on a form that city engineers created
- Types of data recorded
 - Building/structure properties
 - Usage (know where to search for survivors)
 - Vulnerabilities
 - Possible solutions/retrofit
- Upload field data into Access database

Soft Story Example

The image displays four Palm m505 PDAs arranged horizontally, each showing a different screen of a data entry application. Arrows connect the 'Next >>' button of one screen to the '<< Back' button of the next screen, illustrating a sequential workflow.

Address Information

APN: 030 5364895
Team ID: Scott Deaton
Primary Address
#:3693 Name: Windy Ct
Secondary Address
#:n/a Name: n/a
Digital Photo ID: 408
Building File Name: 030 5364895.jpg

<< Back Next >>

Building Properties

Prototype Designation: I
Year Constructed: 1961
Bldg Plan Shape: L
Stories: 5
Total Sqr. Footage: 14000
Residential Units: 16
Building ground floor height varies more than 1/2 story: **Y** **N**
☒ Miscellaneous Notes:

<< Back Next >>

Structural Properties

Elements	GF	SS
Wood:	A P U	A P U
RM:	A P U	A P U
RC:	A P U	A P U
Conc Col:	A P U	A P U
Steel:	A P U	A P U
Steel Pipe:	A P U	A P U
Stucco:	A P U	A P U
PT Slab:	A P U	A P U
Masonry Vnr:	A P U	A P U

<< Back Next >>

Ground Floor Usage Class

Ground Floor Use:

- ☒ Residential
- ☐ Commercial
- ☒ Storage
- ☐ Parking
- ☐ Laundry

<< Back Next >>

Soft Story Example (cont.)

The image shows four Palm m505 PDAs arranged horizontally, each displaying a different screen of a software application. The screens are connected by arrows, indicating a sequential flow from left to right.

- Screen 1: Vulnerability**
 - Confidence discerning structural sys.: **Good** Fair Poor
 - # Sides Visible: 3 / 4
 - Vertical Discontinuity Weakness:**
 - Lack of stiffness (soft): **Serious** Moderate Minimal
 - Lack of strength (weak): **Serious** Moderate Minimal
 - Navigation: << Back, Next >>
- Screen 2: Contributions to Vulnerability**
 - Plan Geometry: Major **Significant** Minor None
 - Torsional Irregularity: Major **Significant** Minor None
 - Overall Vulnerability: **Severe** Considerable Moderate Negligible
 - ☐ Earthquake Weakness Description
 - Navigation: << Back, Next >>
- Screen 3: Solutions**
 - Recommend detailed evaluation: **Y** N
 - Recommend seismic retrofit: **Y** N
 - Will the building need to be vacated during retrofit? **Y** N How long? 12 weeks
 - Will parking spaces need to be eliminated? **Y** N U How many? 2 of 22
 - ☐ Deficiency description for retrofit
 - ☐ Enter retrofit strategy description
 - Navigation: << Back, Next >>
- Screen 4: Retrofit Elements**
 - ☐ Moment Frames
 - ☒ New Shear Walls
 - ☐ Column Strengthening
 - ☐ Braced Frames
 - ☐ Strengthen Existing Shear Walls
 - ☒ New Foundations
 - ☐ Other:
 - Navigation: << Back, Next >>

Beyond Handheld Systems

Next Generation...

DATA COLLECTION



AIRBORNE



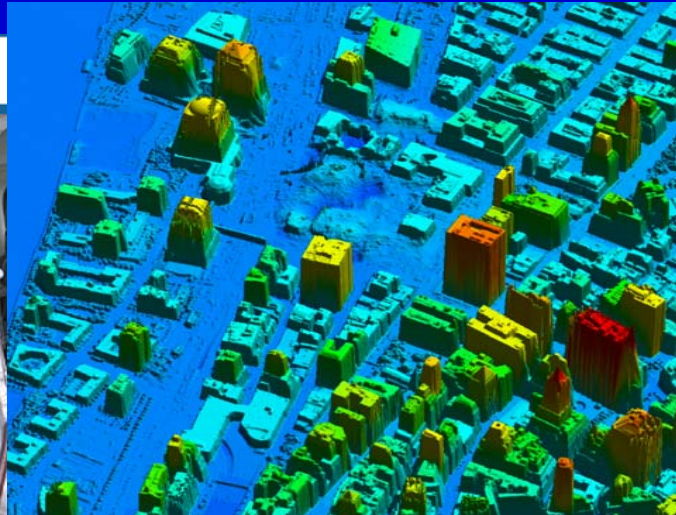
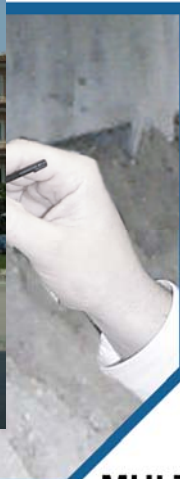
MULTI-SCALE
DIGITAL
INFORMATION
SYSTEM

HIGH-MOBILITY

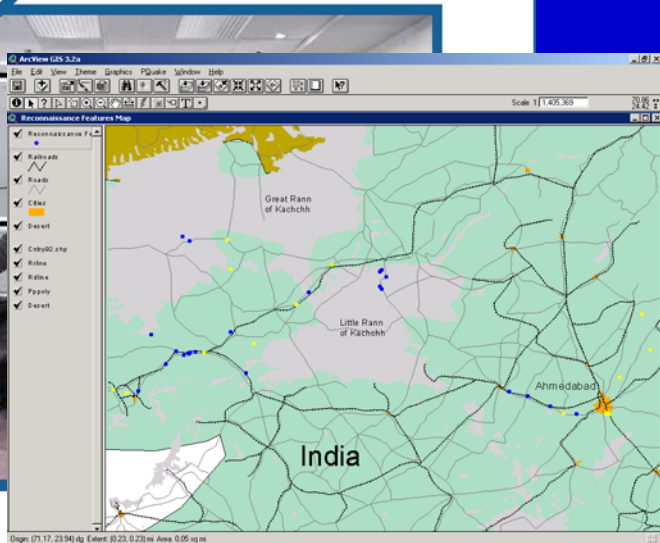
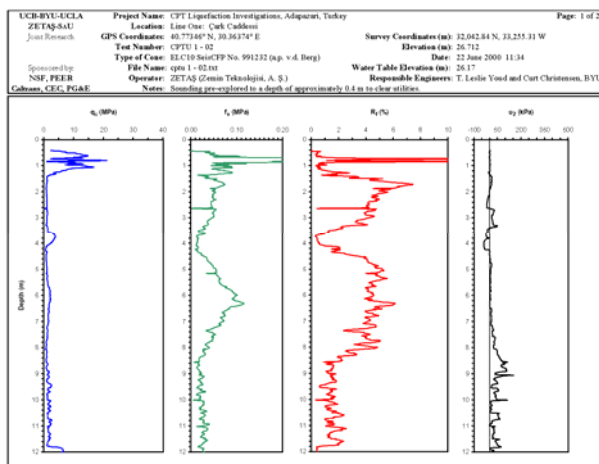


TELE

Next Generation...



**MULTI-SCALE
DIGITAL
INFORMATION
SYSTEM**



Important Future Role of Technology

- Opens up new opportunities for integration of geo-reconnaissance studies in education and research
- Ability to involve larger "Response Team" than those operating in immediate earthquake zone
- Ability to access areas that may have been isolated by event damage
- Ability to "virtually take" students to field and show them consequences of poor engineering and/or unanticipated loading conditions

Research & Development Issues

- Data collection protocols and standards
- Platform issues
- Multi-scale system integration
- Tele-reconnaissance
- Information compression and transmission
- Simulation analysis and feedback

Conclusions

- All geo-engineering studies rely on information.....
- Digital technologies offer key to ensuring information of highest quality in sufficient quantity is available in a timely manner.....
- Urgent need to develop protocols for data collection and information archiving.....
- Geo-earthquake engineering education can be significantly enhanced by adoption of these technologies into practice.....

Thank you.