UNIVERSITY AT BUFFALO
State University of New York
SCHOOL OF ENGINEERING AND APPLIED SCIENCES
Department of Civil, Structural, and Environmental Engineering

212 Ketter Hall, North Campus, Buffalo, NY 14260
http://www.civil.buffalo.edu/
Fax: 716 645 3733 Tel: 716 645 2114 x 2400

CIE616 – Experimental Methods in Structural Engineering and Structural Dynamics

http://civil.eng.buffalo.edu/cie616

Lecture #9

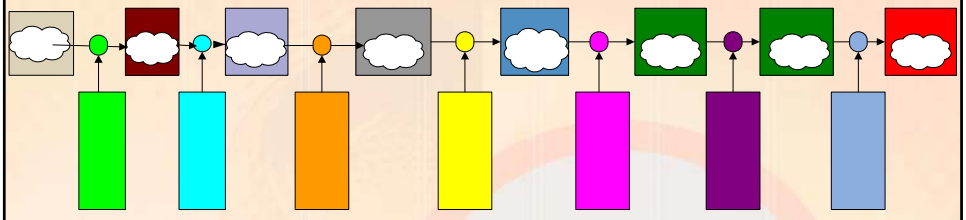
Data Management

Instructors:
Andrei M. Reinhorn P.E. Ph.D.
Clifford C. Furnas Eminent Professor
reinhorn@buffalo.edu
Jason P Hanley, BSCS&M
SEESL-NEES-IT Services Manager

Data Management

- *Data Flow*

1) Sensors
2) Data Acquisition
3) Instruments repository
4) Initial Repository
5) Permanent Repository
6) User interfaces



Data Management

- *Data Storage*
- *Data Organization*
- *Data Documentation*
- *Data Viewing and Retrieval*
- *Examples*
- *Data in SEESL Projects*

Data Management

- *Data Storage*
- *Data Organization*
- *Data Documentation*
- *Data Viewing and Retrieval*
- *Examples*
- *Data in SEESL Projects*

Data Storage

- *Instrumentation storage*
- *Local initial repository*
- *Permanent repository*
- *Transition repository*

Data Management

- *Data Storage*
- ➢ *Data Organization*
- *Data Documentation*
- *Data Viewing and Retrieval*
- *Examples*
- *Data in SEESL Projects*

Data Organization

An organization of Directories and Subdirectories cascaded to include:

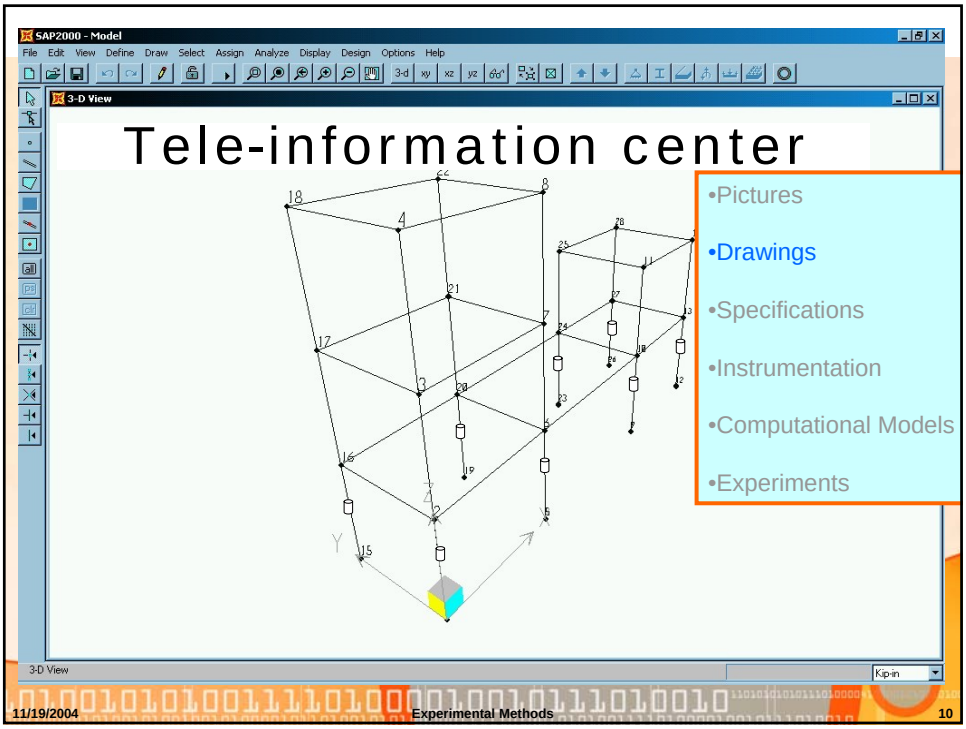
- *Identification of information, producers, etc.*
- *Common information about testing*
- *Common information about the loading apparatus*
- *Testing protocols and schedules identification*
- *Instrumentation identification*
- *Data files*

What is the purpose of Data: Report Outline

- ***Report Organization*** ***DRAFT FOR TEMPLATE***
- *Summary (executive summary)*
- *Scope and general presentation*
  - *Purpose and objectives of testing - general*
  - *Prototype description*
  - *Scope of testing*
  - *Scaling and model development – similitude information*
  - *Materials and constraints*
- *Test-set-up overview*
  - *Specimen / model description – including materials and component properties*
  - *Loading system – description*
  - *Instrumentation and measurement system + calibration procedures*
  - *Date acquisition + schematic information flow*
- *Test procedures*
  - *Test schedule & repetitions*
  - *Data monitoring & checking*
  - *Test implementation – notes & metadata*
- *Test Results*
  - *Data recording and repository inventory*
  - *Data curation & repository*
  - *Initial test results*
- *Data processing*
  - *Data checking, curation & recovery*
  - *Determination of errors & elimination of errors*
  - *Identification of structural parameters*
  - *Test results from data processing – corrected*
- *Analytical predictions*
  - *Calculated model parameters using principles of engineering*
  - *Calculated response using simplified or sophisticated model*
  - *Calculated response using identified parameters*
  - *Comparison of response of experiment analysis with estimated and with measured parameters*
- *Discussions and recommendations*
  - *Discussion of information as obtained from tests*
  - *Recommendation to reduce gap between computed and tested*

Example Benchmark Model - Task 4.1-4.2 Users networks - MCEER

Tele-information center



- Pictures
- Drawings
- Specifications
- Instrumentation
- Computational Models
- Experiments

Report Organization (Level 1)

- 1. Summary
- 2. Scope and general presentation
- 3. Test set-up overview
- 4. Test procedures
- 5. Test Results
- 6. Data processing
- 7. Analytical predictions
- 8. Discussion and recommendations

Report Organization (Level 2)

- 1. Summary
- 2. Scope and general presentation
- 3. Test set-up overview
  - 3.1 Specimen description
  - 3.2 Loading system
  - 3.3 Instrumentation
- 4. Test procedures
  - 4.1 Test schedule
  - 4.3 Test implementation
- 5. Test Results
- 6. Data processing
- 7. Analytical predictions
- 8. Discussion and recommendations

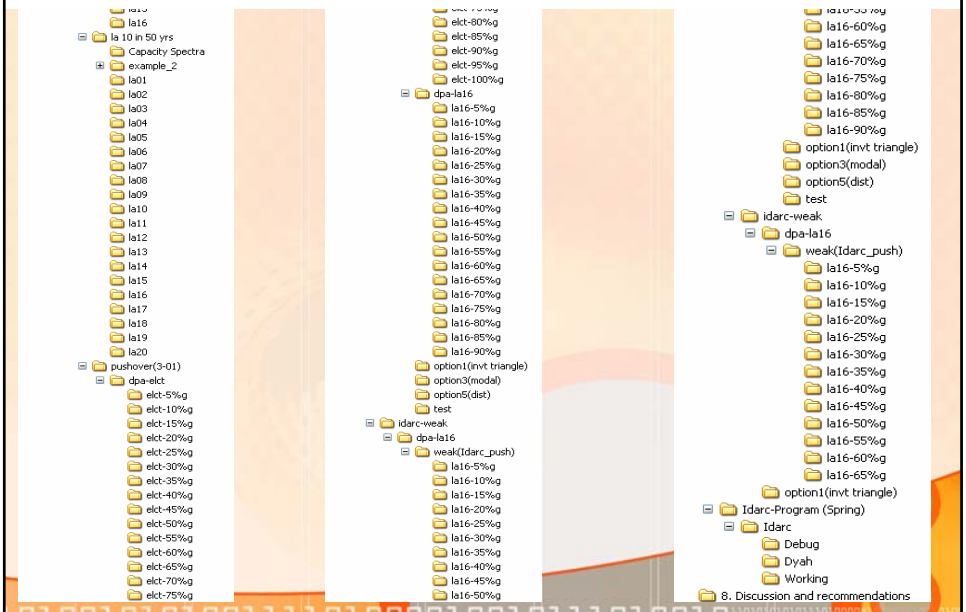
Report Organization (Level 3)

- 1. Summary
- 2. Scope and general presentation
- 3. Test set-up overview
  - 3.1 Specimen description
  - 3.2 Loading system
  - 3.3 Instrumentation
- 4. Test procedures
  - 4.1 Test schedule
  - 4.3 Test implementation
- 5. Test Results
  - Identification (White Noise)
  - Raise Table
  - Test
  - Weight of Structure
- 6. Data processing
  - DADiSP Command Files
  - Identification (White Noise)
  - Raise Table
  - Test
  - Weight of Structure
- 7. Analytical predictions
  - Idarc-calculations
    - Idarc-spring
    - idarc-strong
    - idarc-weak
  - Idarc-Program (Spring)
- 8. Discussion and recommendations

Report Organization (Full)

- 1. Summary
- 2. Scope and general presentation
- 3. Test set-up overview
  - 3.1 Specimen description
    - Drawings
      - parts
      - structure
  - 3.2 Loading system
    - sac ground motions
  - 3.3 Instrumentation
    - Calibrations
      - Load Cell
        - set 1 (A,B,C,8)
          - crosstalk
        - set 2 (3,11,12,7)
          - crosstalk
        - set 3 (9,4,1,3)
        - set 4 (2,14,7,11)
        - set 5 (4,5,9,6)
        - set 6 (12,10,13,2or14)
        - set 7 (2,14,7,11)
        - set 8 (2,14)
- 4. Test procedures
  - 4.1 Test schedule
  - 4.3 Test implementation
    - Pictures
      - Cruciform 11-02-00
      - Dec 18 2000
        - Card
      - Load Cell 9-21 Photos
      - photos
        - Card
          - ALBUM 1
      - Photos 02-23-01
      - Photos 03-19-01
      - Structure
- 5. Test Results
  - Identification (White Noise)
  - Raise Table
  - Test
  - Weight of Structure
- 6. Data processing
  - DADiSP Command Files
  - Identification (White Noise)
    - DADiSP labbook
      - noise3
      - noise4
      - noise5
      - noise6
      - noise7
      - noise8
      - noise9
  - Raise Table
    - DADiSP labbook
      - draise
      - lift3
      - lift4
      - load
  - Test
    - DADiSP labbook
      - LA16040
      - la16005
      - LA1601O
      - la16005
      - la16010
      - LA16015
      - LA16020
      - LA16025
      - LA16030
      - LA16035
      - LA16040
      - LA16040A
      - WN0052
      - WN0102
      - WN0152
      - WN0201
      - WN0202
      - WN02S2
      - WN0302
      - WN03S2
      - WN0401
      - WN0401A
      - WN0402
  - Weight of Structure
- 7. Analytical predictions
  - Idarc-calculations
    - Idarc-spring
      - consecutive-la16
        - la16-5%g
        - la16-10%g
        - la16-15%g
        - la16-20%g
        - la16-25%g
        - la16-30%g
        - la16-35%g
        - la16-40%g
        - la16-45%g
        - la16-50%g
        - la16-55%g
        - la16-60%g
        - la16-65%g
        - la16-70%g
      - dpa-la16
        - la16-5%g
        - la16-10%g
        - la16-15%g
        - la16-20%g
        - la16-25%g
        - la16-30%g
        - la16-35%g
        - la16-40%g
        - la16-45%g
        - la16-50%g
        - la16-55%g
        - la16-60%g
        - la16-65%g
        - la16-70%g
        - la16-75%g
        - la16-80%g
        - la16-85%g
        - la16-90%g
      - pushover
    - idarc-strong
      - elastic
        - la02
        - la14

Report Organization (Full) cont.



Data Organization

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- *Instrumentation identification*
- *Data files*

Data Management

- *Data Storage*
- *Data Organization*
- *Data Documentation*
  - *Data Formats*
  - *Metadata*
  - *Data Model*
  - *Mapping to Data Model*
  - *Comparison with Data Organization*
- *Data Viewing and Retrieval*
- *Examples*
- *Data in SEESL Projects*

Data Documentation

- *Data is the set of results produced by a numeric simulation or the readings from sensors in a physical test.*
- *To fully describe what this data means, more information is required, such as*
  - *Simulation or physical loading input files*
  - *Specimen description, figures, and photos*
  - *Instrumentation layout and calibration sheets*
  - *Description of test procedures*
- *This is called Data Documentation and refers to the **Data about Data** collected during an experiment.*

Data Formats

- *Word Processing files*
  - *Abstract, Project description & design*
- *PowerPoint files*
  - *Project proposal & description*
- *AutoCAD files*
  - *Structural drawings using AutoCAD of AutoDesk Inc.*
- *Flat file text (single and multi columns) files*
  - *Ground motions, Raw data, Calibration data*
- *Excel files*
  - *Data, Graphs, Calibrations, Test schedules – from Data acquisition*
- *JPEG files*
  - *Specimen & test set-up pictures*
- *VIDEO files*
  - *Video observations*
  - *Video data*
- *DADiSP files*
  - *Processed data and visualization files – using DADiSP of DSP Corp.*
- *IDARC files*
  - *Numerical simulation input files & output data of simulation of inelastic behavior – generic program developed at Univ. at Buffalo*

What is Metadata?

- ***Metadata*** *is the term used to describe the process of Data Documentation. It is the information that is recorded to describe this data.*
- *Metadata can be used to help identify what a piece of data is and provide information on what the meaning of that data is.*
- *It is not always clear whether something is data or metadata, but the difference is that the first is the result of some experiment while the latter is used to describe what the conditions actually were for the experiment.*

Examples of Metadata

- *Every piece of literature in the library has some metadata associated with it.*
  - *Name, Author, Keywords, etc…*
- *This allows you to find what you are looking for more easily.*
- *It also allows others to find to find this information more easily by tagging the data (the literature) with information to describe it.*

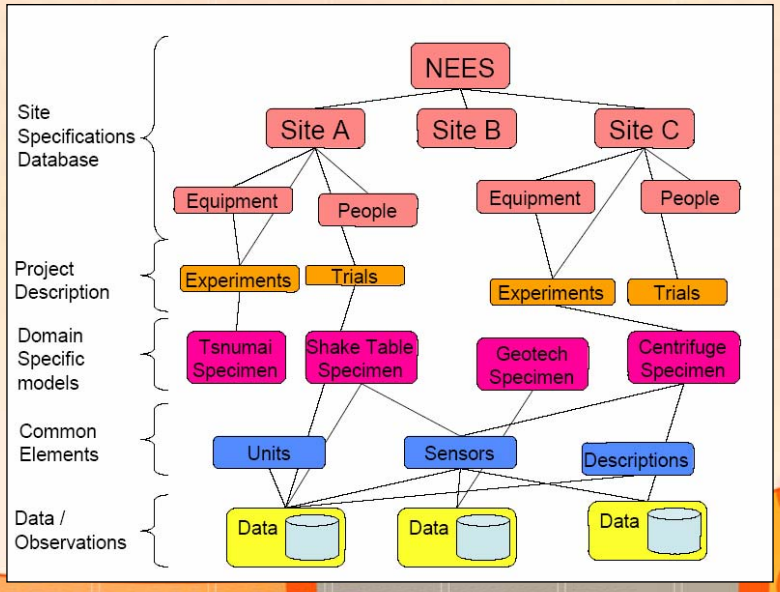
Example of Metadata – a search from our library

TITLE: Hysteretic models for cyclic behavior of deteriorating inelastic structures
AUTHOR: M. V. Sivaselvan and A.M. Reinhorn
SUBJECTS: Hysteresis, Structural analysis, Mathematical models

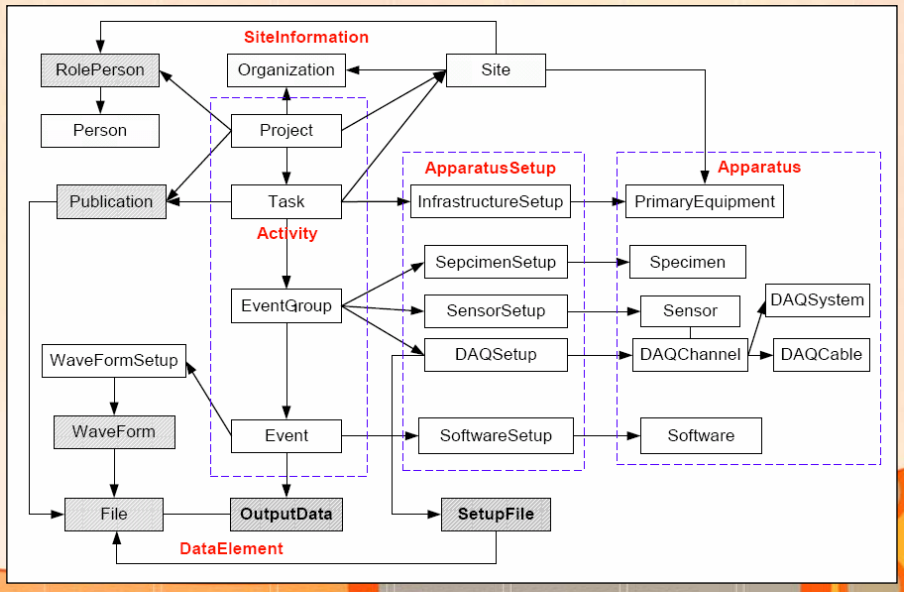
A Data Model for Metadata

- *Metadata needs to recorded in some format.*
- *A **Data Model** is the specification of this format used to represent the metadata. It gives a structure to this metadata and creates relationships between different pieces of metadata.*
- *It is a standardized format so metadata created by others can be searched, viewed, and reused in the same way.*
- *A data model allows tools to be written to this standard that allow users to visualize and analyze this metadata is without worrying about which format it is in.*

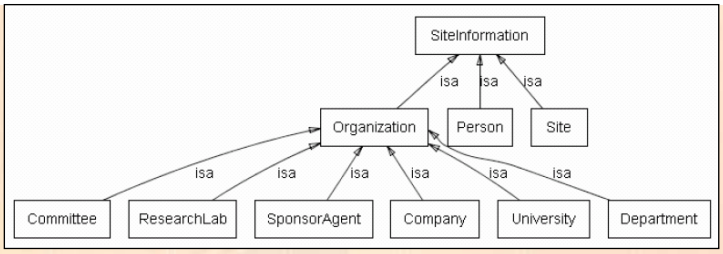
Overview of the Data Model



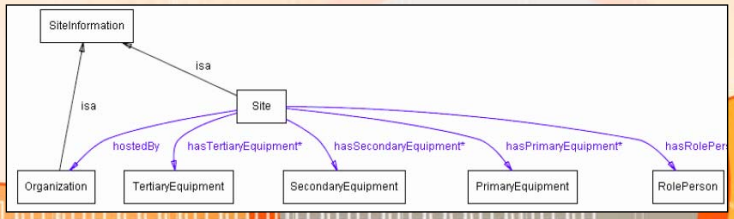
NEES Reference Data Model



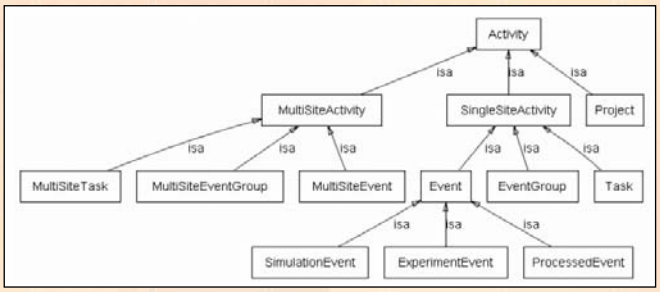
Hierarchy and Relations of a Site



•Above: This is an example of a data model showing an organization and all its possible values. A company, university, laboratory, etc…
•Below: The relationships that a site can have. For example a site can be our laboratory and have relations to equipment like Shake Tables and data acquisition systems.

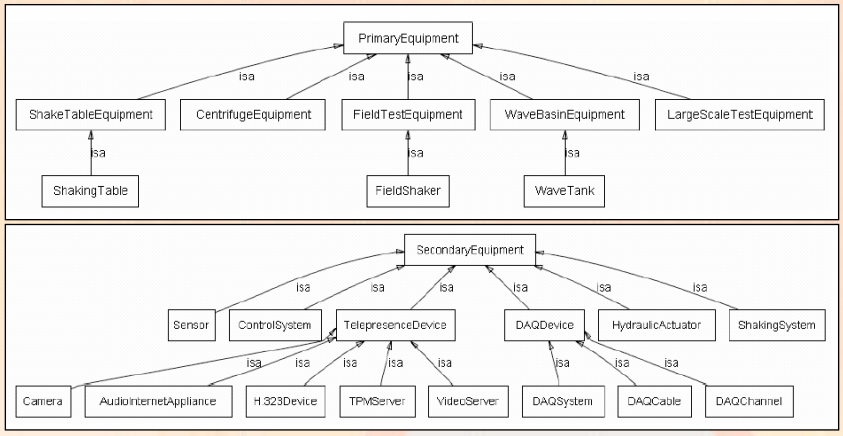


Hierarchy of an Activity



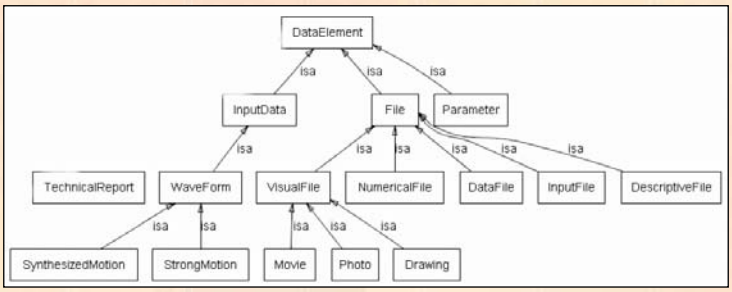
- *An activity is used to describe some physical event that occurs.*
- *Event is the lowest level of this and describes a physical experiment that takes place. An EventGroup is a collection of Events that have a similar setup but a slightly different input motion.*
- *Tasks contain different events that correspond to different goals for testing of the specimen. Project is the top level group that contains these different tasks.*

Hierarchy of Equipment



- *Equipment is used to refer to physical and electronic devices located in a laboratory. These are mostly devices that produce loading or deal with data acquisition and control networks.*

Hierarchy of Data



- *This is used to refer to some type of file which contains data in some way. This can include text files, tabular numeric data, CAD drawings, or photo files.*
- *This data class is used to link to the actual data files from the other metadata objects.*

Why Use Metadata?

- *Producing and packaging metadata is not a trivial matter so why do it if you already have the data you need in an organized way?*
  - *This benefit is to others who want to use your data.*
  - *This allows others to search for your data based on all the information stored in your metadata. For example, search for:*
    - *The particular participant of a project.*
    - *The type of isolation system being tested.*
    - *The testing techniques being used.*
    - *A useful computer model developed that assist in your research.*

How to Create Metadata

- *Pieces of data organized using the given hierarchical structure must be mapped into their respective metadata elements in the data model.*
- *These mappings allow for the metadata to comply with the standard set by the data model and provide an easy way to enter data into the model.*
- *For example, each run of an experiment would map directly to an event in the data model. Attributes of this event such as the data files produced or the parameters of the loading applied.*

Example Mapping to Metadata

Data Organization

- *Test*
  - *WN0101*
    - *Data File 1*
    - *Data File 2*

Data Documentation

- *Event*
  - *Name: WN0101*
  - *Test Type: Shake Table*
  - *Output Data: Data File 1*
    Data File 2
  - *Input Waveform: White Noise*

•A sample mapping of data, using the organization structure, to metadata using the data model.
•This takes the test WN0101 and its data files, and maps it to the metadata object of type **Event**. The object is named the same as the test name and contains the data files along with the input ground motion.

Data Management

- *Data Storage*
- *Data Organization*
- *Data Documentation*
- *Data Viewing and Retrieval*
  - *CHEF*
  - *Searching*
  - *Downloading*
  - *Viewing*
- *Examples*
- *Data in SEESL Projects*

Data Viewing and Retrieval

- *As part of NEES, SEESL uses NEESgrid software to automatically store data in local storage and our local repository.*
- *All data recorded in the laboratory is available after the test from the local storage.*
- *After some time it is available in our local repository for usage. Data in the repository can be accessed anytime through internet using your web browser.*
- *The CHEF web portal is used to access all the data in the local repository. This is a collaborative web site available at:*

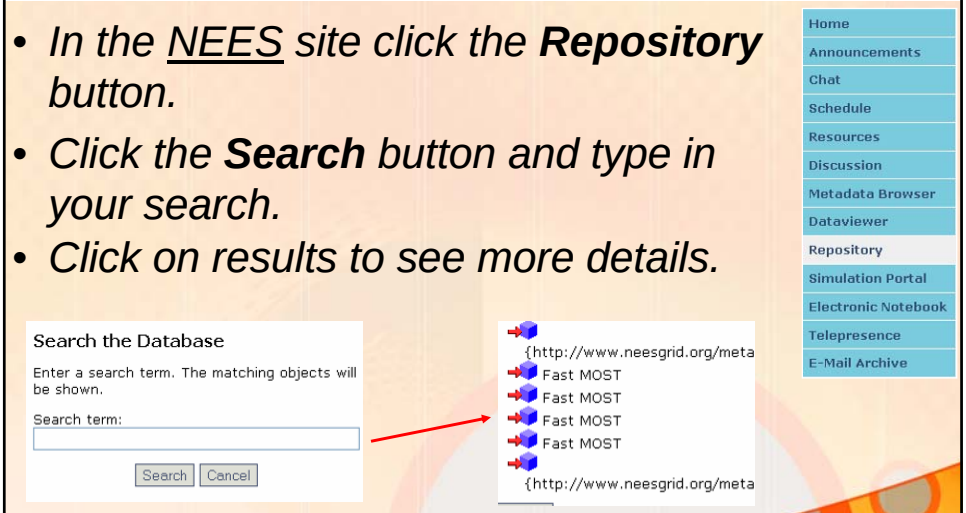
  http://pop.nees.buffalo.edu/
- *CHEF functions*

How to Access CHEF

- *Open http://pop.nees.buffalo.edu/ in your web browser*
- *Click the **Create New Account** button and fill out the form*
- *Click the **Membership** button, select the NEES checkbox, and click **Join**.*
- *Once logged in with your new account, join the NEES site by clicking the tab in the top bar.*

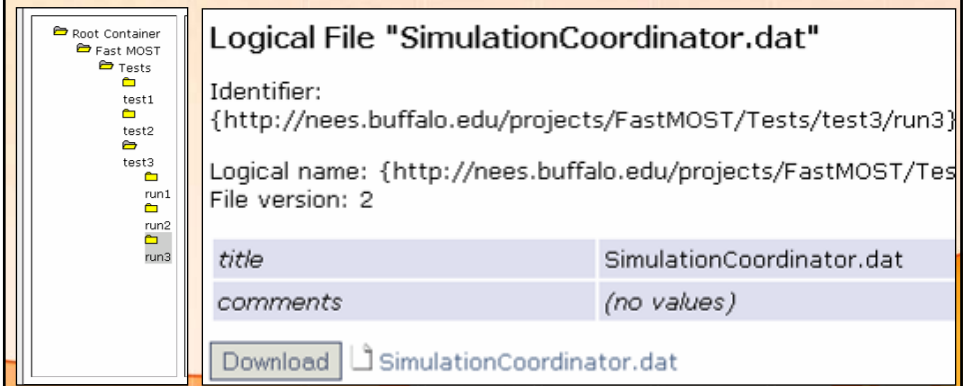
Searching for Data

- *In the NEES site click the **Repository** button.*
- *Click the **Search** button and type in your search.*
- *Click on results to see more details.*



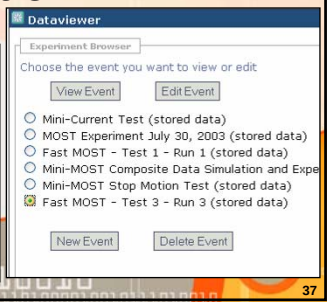
Downloading Data for Analysis

- *Browse like any file system with folders and files by clicking on the file icons or search for a specific file name*
- *Select a file and click the **Download** button to download the file to your computer*



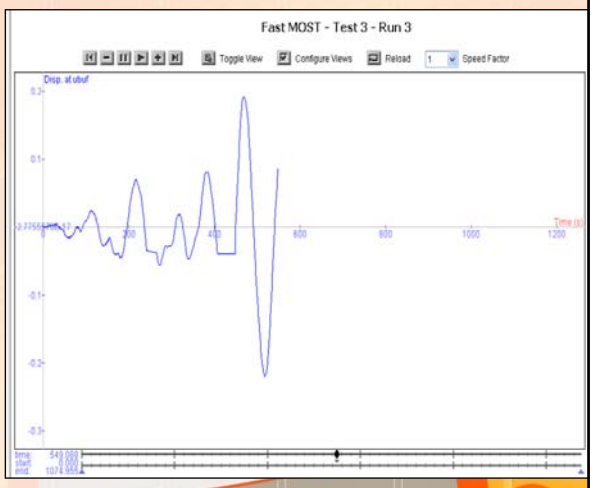
Using the CHEF Data Viewer

- *In the NEES site, click the **Data Viewer** button in the left menu.*
- *Choose the event you would like to view and click **View Event.***
- *Configure the data you would like to view and click **View Configuration.***



Viewing data with Data Viewer

- *Click the play button to start data playback.*
- *Drag the time slider in the bottom to go to a specific time in the data file.*
- *Change the speed factor to increase or decrease playback speed.*



Data Management

- *Data Storage*
- *Data Organization*
- *Data Documentation*
- *Data Viewing and Retrieval*
- *Examples*
  - *Organization*
  - *Data Model*
  - *CHEF Functions*
- *Data in SEESL Projects*

Data Management

- *Data Storage*
- *Data Organization*
- *Data Documentation*
- *Data Viewing and Retrieval*
- *Examples*
- *Data in SEESL Projects*
  - *Electronic Notebook*
  - *Organization and Packaging*
  - *Data Usage*
  - *Role of IT Support*

Data in SEESL Projects

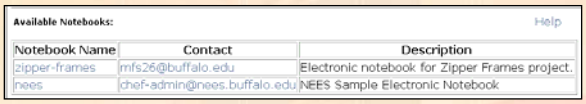
- *The SEESL projects must use the SEESL repository for all its projects - NEES or non-NEES*
- *NEES projects will transfer the data to a permanent repository managed by NEESit*
  - *NEES policies require that:*
    - *NO DATA WILL BE LOST*
    - *DATA CAN BE REPRODUCED BY ANYONE AT ANY TIME DURING THE "LIFE" OF THE REPOSITORY*
- *SEESL will follow the NEES rules and guidelines.*

Electronic Notebook

- *The electronic notebook is the equivalent to the pen and paper notebook used during the course of a project.*
- *Use it to record any data you would record during test setup or an experiment, such as:*
  - *A written record of work done*
  - *Pictures of the test setup*
  - *Calibration data*
- *The electronic notebook can record all kinds of data such as text, images, and any type of file.*
- *All you need to access it is a web browser and an internet connection.*

Starting the Electronic Notebook

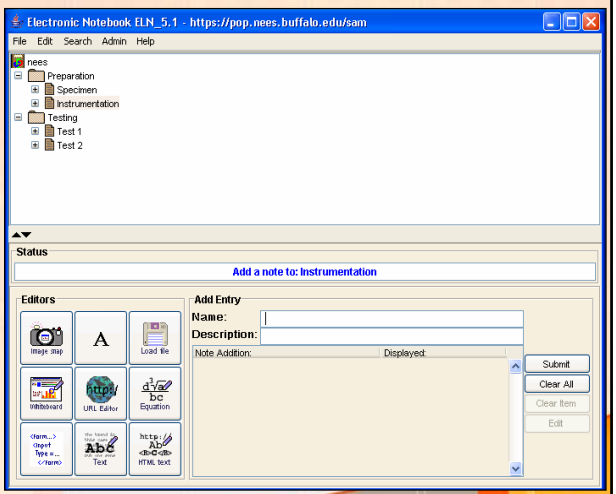
- *Go to http://pop.nees.buffalo.edu/ and login with your account.*
- *Go to the NEES site and click the **Electronic Notebook** icon.*



- *Select the name of the notebook you would like to view and click it.*

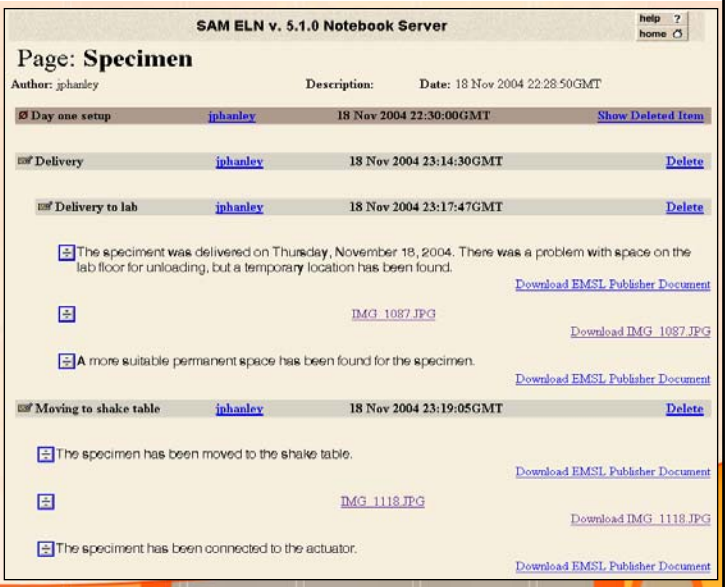
Electronic Notebook Client

- *This is the main screen of the electronic notebook.*
- *It is arranged using chapters containing pages which information can be added.*
- *The sample contains a chapter named **Preparation** with a pages called **Specimen** and **Instrumentation.***



Electronic Notebook Page

- *This is the **Specimen** page with text describing its delivery to the lab and moving to the shake table.*



Organization and Packaging

- *Data will be stored in the initial repository:*
  - *From notebook*
  - *From all components in the data organization*
- *Metadata will be prepared according to the "(meta)data models"*
- *When whole package is complete, a curator will catalog all basic information*
- *The package will then be placed in the repository*

Data Usage (through CHEF)

- *See the Data Viewing and Retrieval section in this presentation.*

Role of IT Support

- *IT support is provided to aid in creating and managing data and metadata.*
  - *Support will be provided for using the CHEF website.*
  - *Support will be provided for uploading and retrieving data to/from the local repository*
  - *Support will be provided for creation of metadata and upload to the repository. Guidance is only provided for this, you must create your own metadata.*

Examples

Examples

- *Example of Project Data:*
  - *"Versatile model for collapse evaluation"*
- *Example of Metadata Model*
  - *" "*
- *Example of Users Interface – CHEF*
  - *" Platform for use in NEES system"*

Report Organization (Level 1)

- 1. Summary
- 2. Scope and general presentation
- 3. Test set-up overview
- 4. Test procedures
- 5. Test Results
- 6. Data processing
- 7. Analytical predictions
- 8. Discussion and recommendations

Report Organization (Level 2)

- 1. Summary
- 2. Scope and general presentation
- 3. Test set-up overview
  - 3.1 Specimen description
  - 3.2 Loading system
  - 3.3 Instrumentation
- 4. Test procedures
  - 4.1 Test schedule
  - 4.3 Test implementation
- 5. Test Results
- 6. Data processing
- 7. Analytical predictions
- 8. Discussion and recommendations

Report Organization (Level3)

- 1. Summary
- 2. Scope and general presentation
- 3. Test set-up overview
  - 3.1 Specimen description
  - 3.2 Loading system
  - 3.3 Instrumentation
- 4. Test procedures
  - 4.1 Test schedule
  - 4.3 Test implementation
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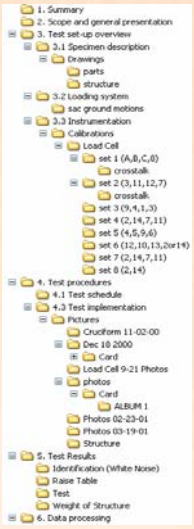
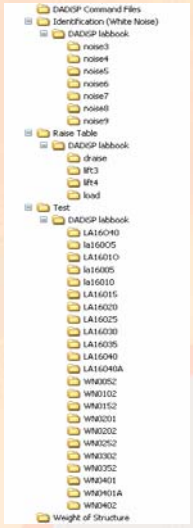
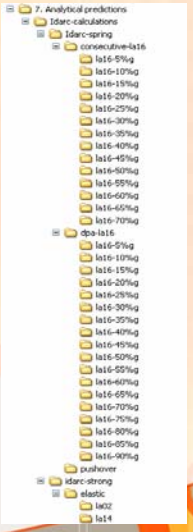
  - Idarc-calculations
    - Idarc-spring
    - idarc-strong
    - idarc-weak
  - Idarc-Program (Spring)
- 8. Discussion and recommendations

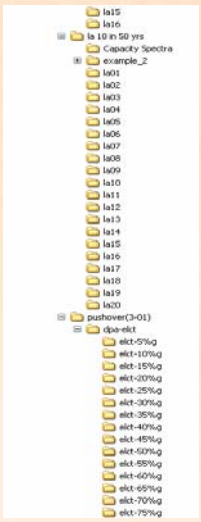
Report Organization (Full)

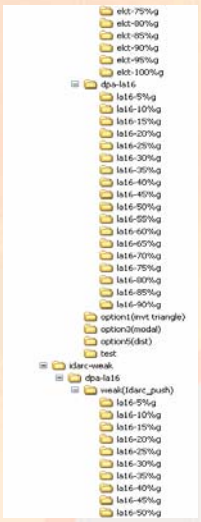


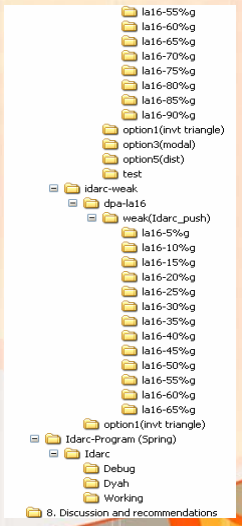




Report Organization (Full) cont.







Data Model

- *!!!!!!! To be completed !!!!!!!*

CHEF Functions

- *CHEF is the collaborative web portal that is the interface to all of the electronic data collection and viewing tools. Its capabilities include:*
  - *Electronic Notebook (ELN)*
  - *Repository Browser*
  - *Data Viewer*
  - *Announcements, Chat, Discussion*
  - *Scheduling*
  - *Shared Resources (file sharing)*
  - *Email Archiving*
- *View the NEESgrid End-User Quick Start Guide*
- *Download at http://it.nees.org/documentation/pdf/TR_2004_15.pdf*