George E. Brown, Jr.
Network for Earthquake Engineering Simulation

Infrastructure for Preservation and Publication of Earthquake Engineering Research Data

Stanislav Pejša

IDCC 2014
San Francisco, CA
2014-02-26

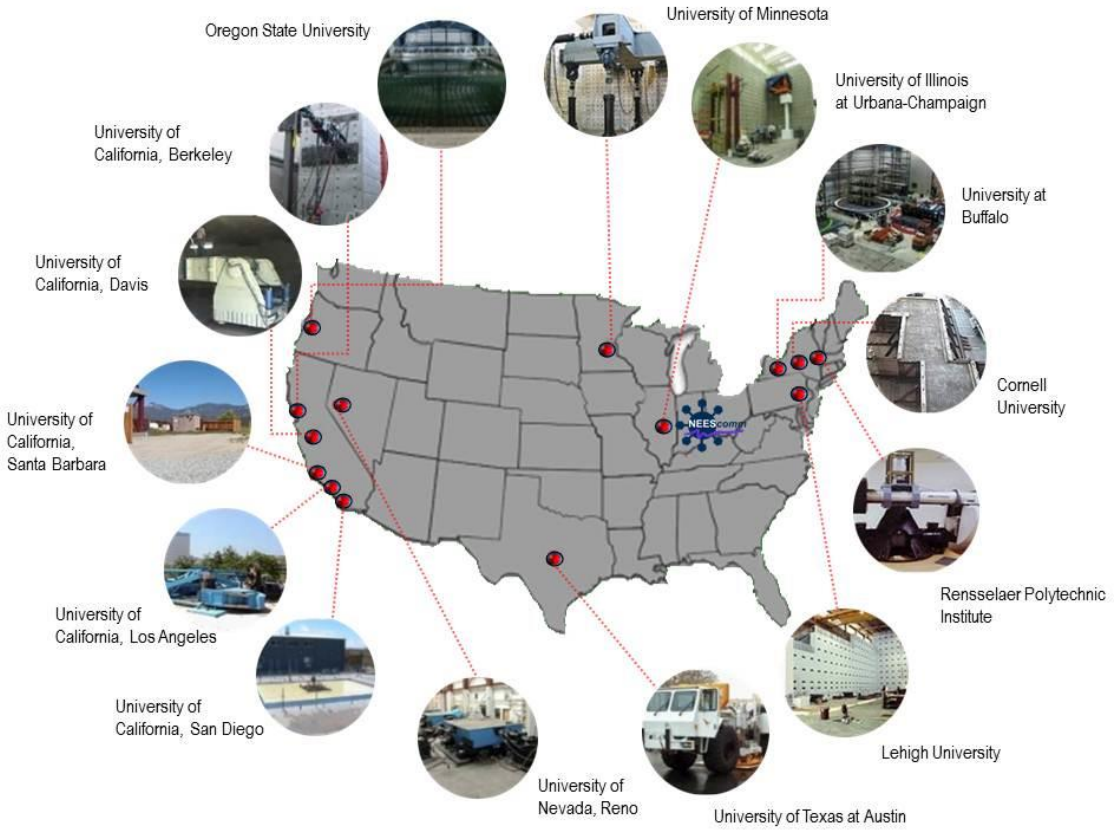
NEES

PURDUE UNIVERSITY
Discovery Park

What Is NEES?

14 engineering laboratories

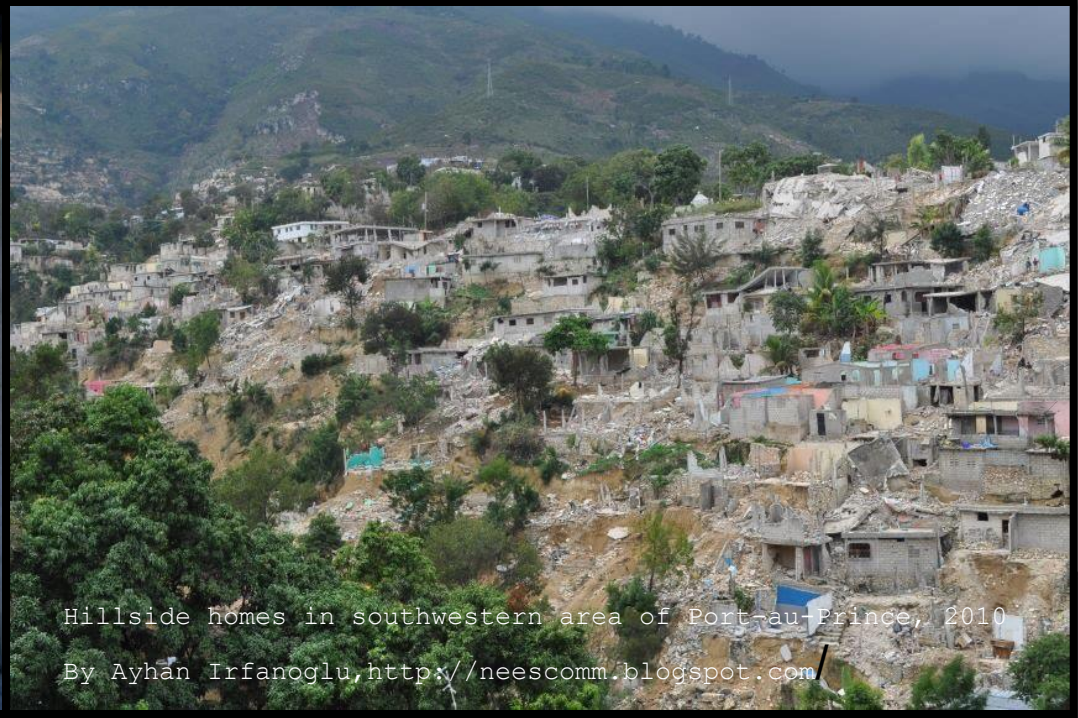
- Shake Tables
  - University at Buffalo
  - UC San Diego
  - UN, Reno
- Tsunami Wave Basin
  - OSU
- Geotechnical Centrifuges
  - RPI
  - UC Davis
- Field Experiments
  - UC Los Angeles
  - UC Santa Barbara
  - UT at Austin
- Large Scale Laboratories
  - Cornell University
  - Lehigh University
  - UC Berkeley
  - UIUC
  - UM, Twin City



Looking Down Sacramento St., 1906. By Arnold Genthe
http://ark.cdlib.rg/ark:/13030/hb200005sz.

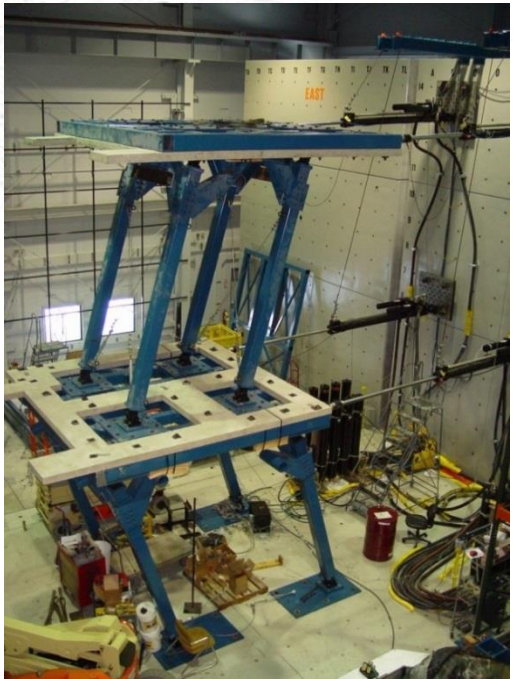
Port at Port-au-Prince by Glenn Rix, 2010
http://eqclearinghouse.org/co/20100112-haiti/wp-content/uploads/2010/01/IMG_0154-150x150.jpg

Northridge Earthquake, CA, January 17, 1994
by Robert A. Eplett
http://en.wikipedia.org/wiki/File:FEMA_-_1807_-_Photograph_by_Robert_A._Eplett_taken_on_01-17-1994_in_California.jpg



Hillside homes in southwestern area of Port-au-Prince, 2010
By Ayhan Irfanoglu,http://neescomm.blogspot.com/

Earthquake Simulation Equipment



NEEScomm Data Goals

Aligned with NSF Data Management Plan (DMP) requirements*

- **All research data and documentation will be archived**
- **Archived data will be of high quality**
- **Archived data will be accessible and shareable**
- **Archived data will be re-usable**
- **Archived data will be preserved**

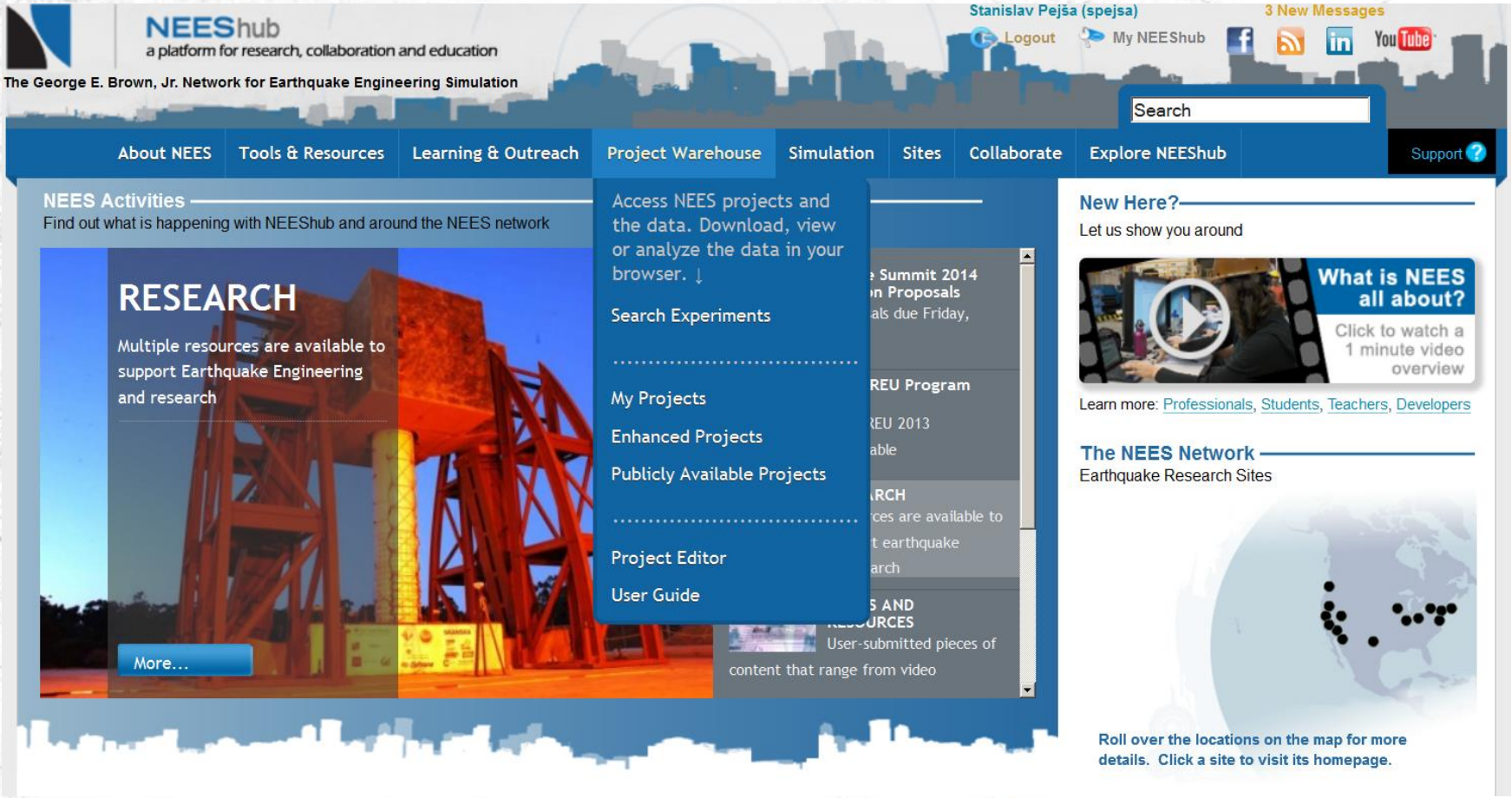
NEEScomm Data Sharing and Archiving Policies, https://nees.org/resources/2811

* http://www.nsf.gov/pubs/policydocs/pappguide/nsf11001/gpg_2.jsp#dmp

What kind of data?

- Diverse
  - shared facilities, not always practices
  - research domain
    - structural engineering
    - geotechnical engineering
    - geophysical research
    - material engineering
    - tsunami research
- type of data
  - experimental
  - observational
  - computational
- increasingly complex
  - number of sensors
  - interdisciplinarity
  - experimenting with computational modeling
  - new types of sensors

NEEShub - www.nees.org/warehouse

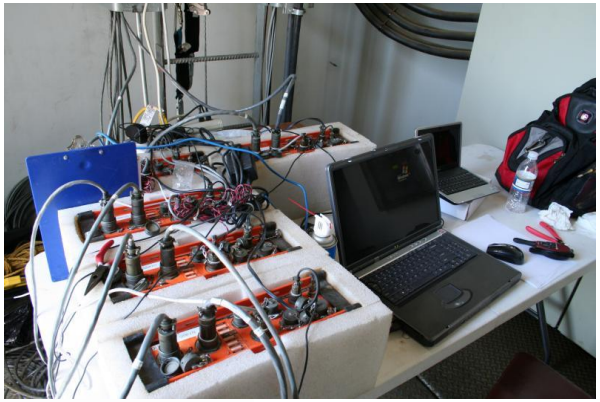


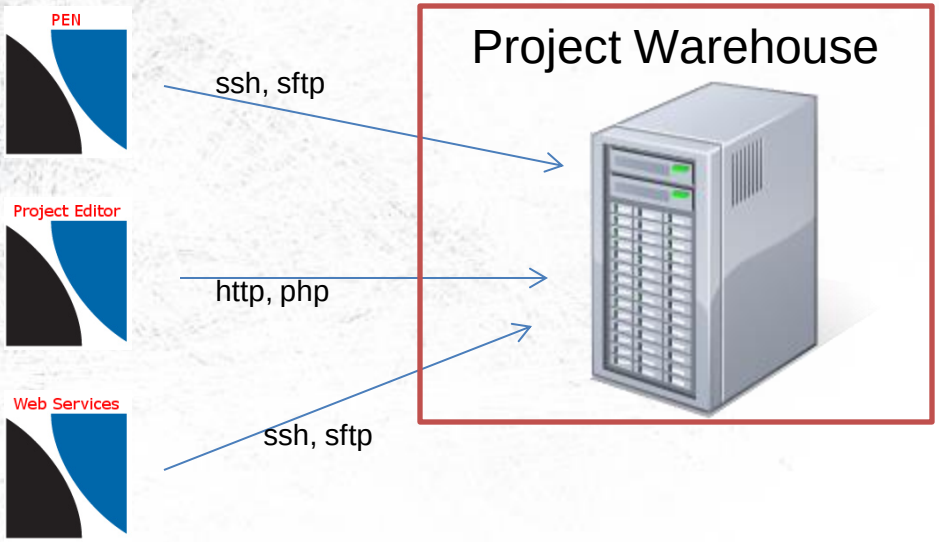
Data Archiving at NEES

- **Who**
  - research team, site personnel, curator, NEEScomm
- **What**
  - sensor measurements (data)
  - sensor calibrations (data)
  - observations (data)
  - analyses
  - numerical simulations
  - reports (including publications and presentations)
- **When**
  - Dates are stated in the Data Sharing and Archiving Policies (1 month, 6 moths, 12 months)
  - For as long as the data are useful ~ indefinitely ~ for 20 years
- **Where**
  - Project Warehouse http://nees.org/warehouse/welcome
- **Why**
  - increases researcher's impact
  - saves work, time, money
  - facilitates knowledge transfer
  - maintained authenticity and integrity of data
  - good practice
  - advances research

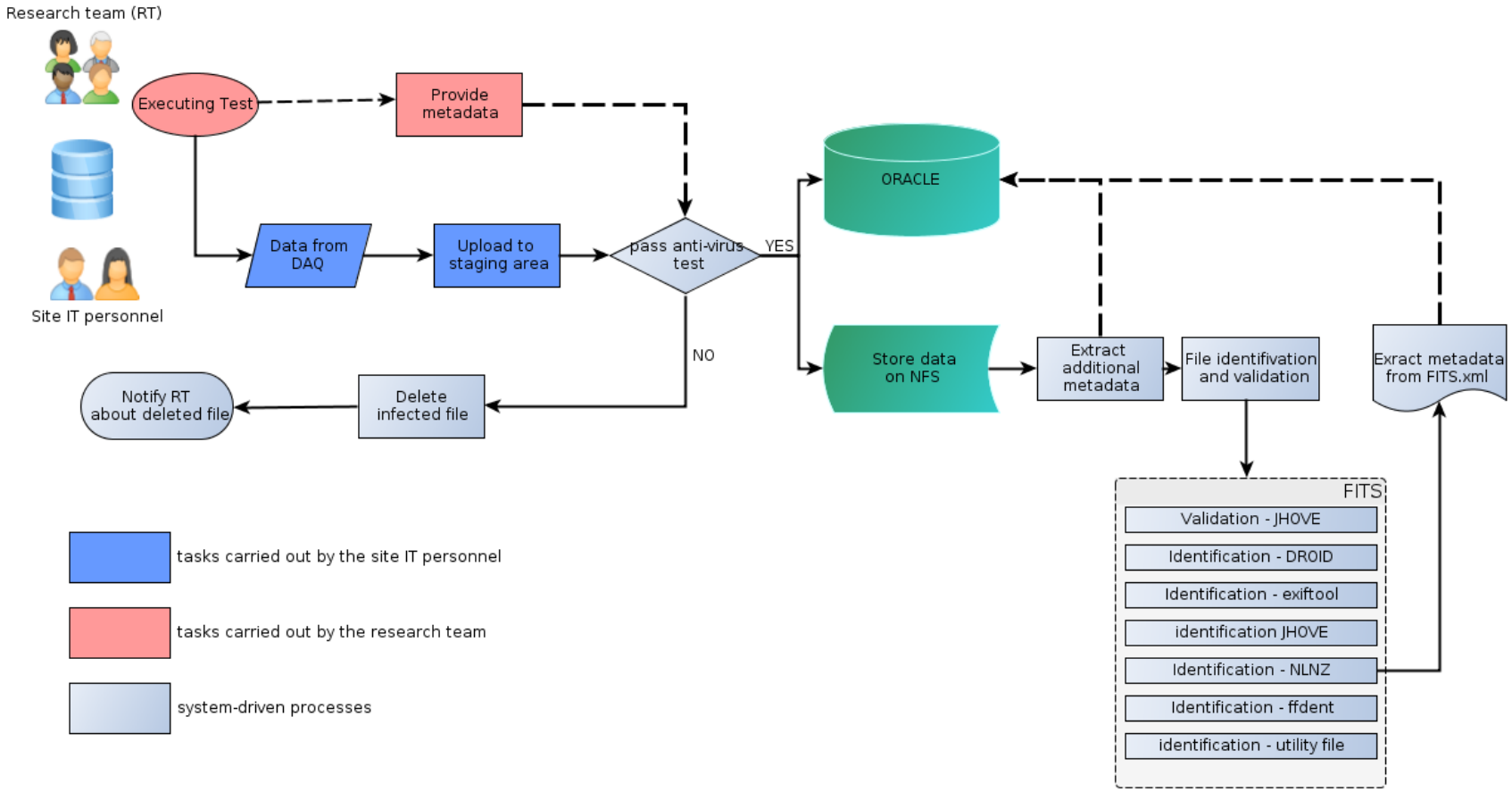
Where Are the Data Coming from?

- DAQ systems on the site
- DAQ systems of research teams
- Researcher's computers
- Thumb-drives

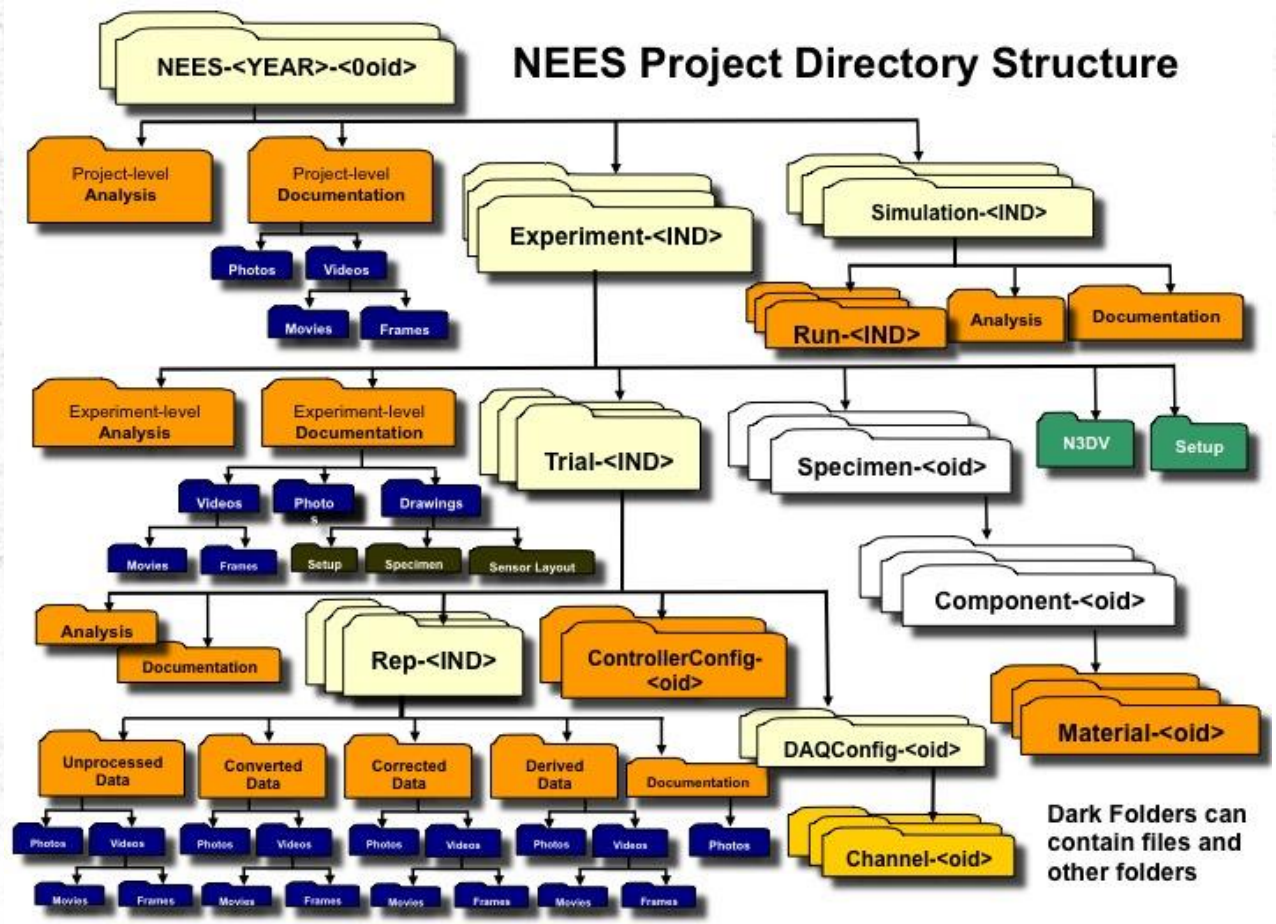




Data Workflow



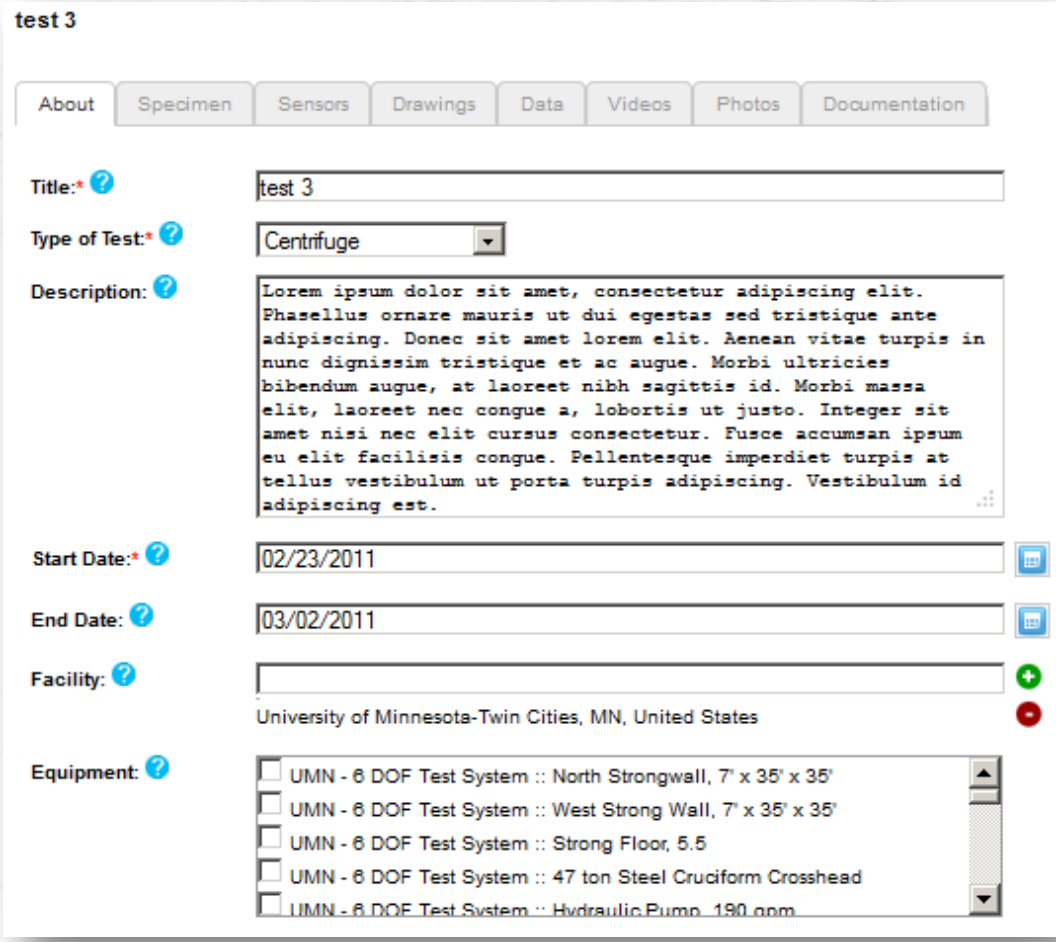
Hierarchy of the NEES data model



https://nees.org/topics/NEESProjectDirectoryStructure

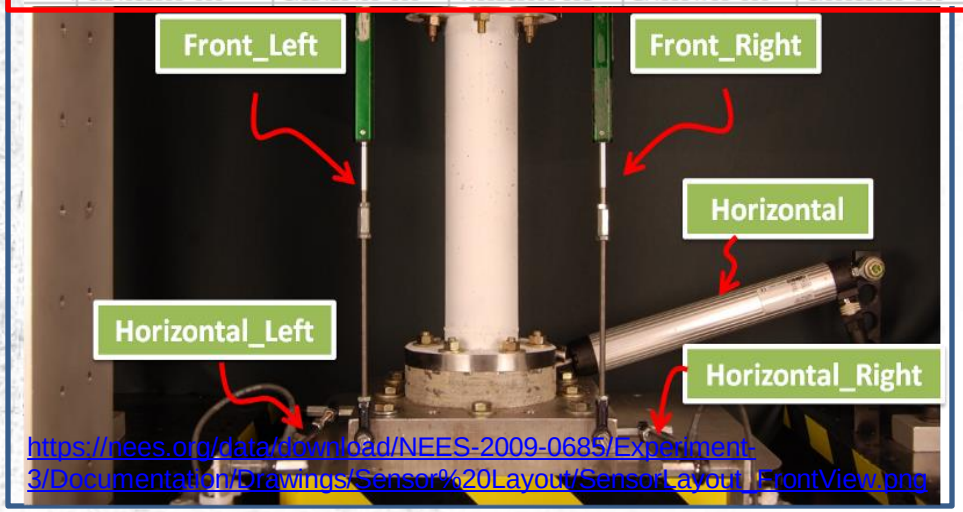
Metadata collection

- Auto complete
  - Names
  - Organization
  - Facility
- Check boxes
  - Equipment
- System-generated folders/Tabs
  - Genre/Format
  - Proxy for metadata
  - Location on file system
  - File format constraints
- Templates
  - Sensors
- Forms
  - Material properties



Understandable data

Step	Horizontal_Right	Horizontal_Left	Back_Vertical	Horizontal	Front_Left	Front_Right
	inch	inch	inch	inch	inch	inch
0	+1.2463610e+000	+1.1243380e+000	+7.3573610e-001	+2.4332460e+000	+1.0029440e+000	+8.6135440e-001
1	+1.2462570e+000	+1.1242340e+000	+7.3583960e-001	+2.4332460e+000	+1.0029100e+000	+8.6128560e-001
2	+1.2461880e+000	+1.1242000e+000	+7.3546010e-001	+2.4333470e+000	+1.0029790e+000	+8.6132000e-001
3	+1.2461880e+000	+1.1243030e+000	+7.3528760e-001	+2.4333470e+000	+1.0030130e+000	+8.6121670e-001
4	+1.2461180e+000	+1.1242340e+000	+7.3521860e-001	+2.4333470e+000	+1.0031160e+000	+8.6128560e-001



https://nees.org/data/download/NEES-2009-0685/Experiment-3/Documentation/Drawings/Sensor%20Layout/Sensor_Layout_FrontView.png

Hybrid Simulation LVDT Set-up

▼ Hybrid Simulation LVDT Set-up

Channel Name	Label	Sensor Type	Comment	Orientation	XYZ Coordinates
Horizontal_Right	Horizontal_Right	LVDT		0, 1, 0	-7.21 in, 12.112 in, 1.65 in
Horizontal_Left	Horizontal_Left	LVDT		0, 1, 0	6.709 in, 12.014 in, 1.717 in
Back_Vertical	Back_Vertical	LVDT		0, 0, 1	1 in, -4.65 in, 19.875 in
Horizontal	Horizontal	LVDT		1, 0, 0	-14.913 in, -8.579 in, 5.084 in
Front_Left	Front_Left	LVDT		0, 0, 1	4 in, 4.15 in, 19.875 in
Front_Right	Front_Right	LVDT		0, 0, 1	-2 in, 4.15 in, 19.875 in

Metadata need to be:

- meaningful
- purposeful
- consistent
- accurate
- predictable
- "*standardized*"

Relationship among:

- Instrumentation plan
- Sensor metadata
- Data

Curation at NEES

- **Long-Term Access**
- **Discovery**
  - Metadata
- **Reuse**
  - Location
  - Formats
  - Rights
- **Preservation**
  - Metadata
  - Permissions
  - Fixity
  - File Integrity
  - File Identification

Content

dependent on human input and monitoring

Metadata

Completeness

Based on standards and requirements

- level of research hierarchy
- timeline

Technical

machine-actionable

Formats

Interoperability

Accessibility

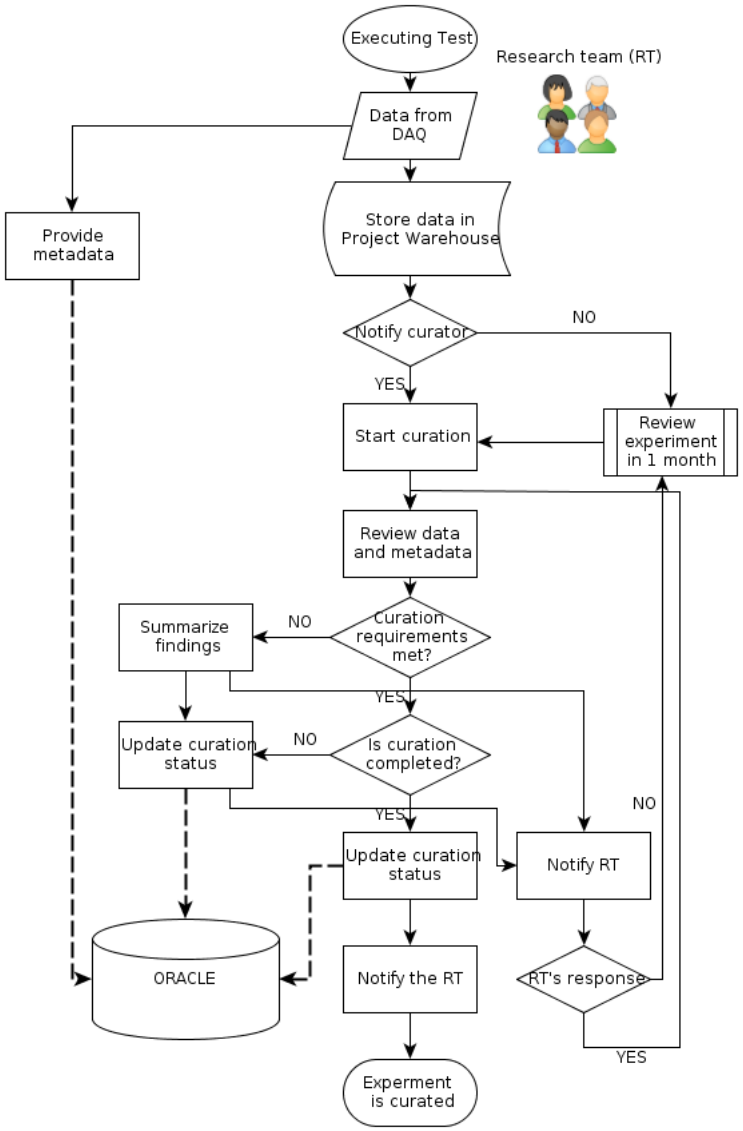
Preservability

File integrity

Duplication

Curation Workflow

- service that helps researchers to archive their data in meaningful way
- assistance with planning and organizing data, metadata, and documentation
- focus on current and future use of data
- iterative and interactive process between researcher teams and curator
- continuum of actions from creation through publication and preservation of data
  - starts early
  - copyright compliance
  - preservation
  - DOI management



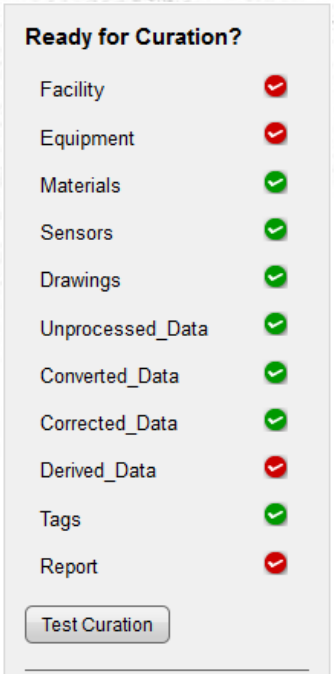
Curation – Check for Completeness

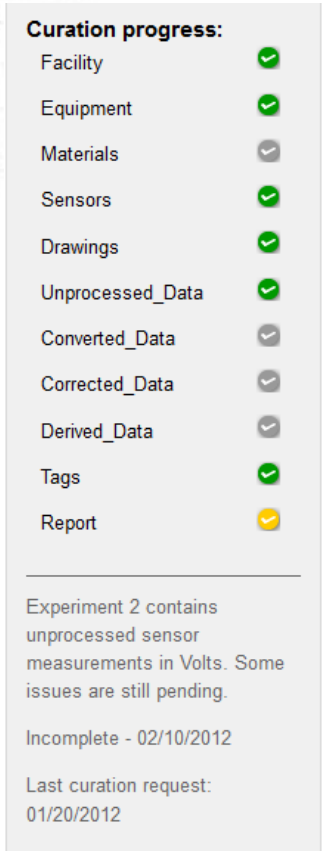
- **Research teams**
  - Professional standards
  - Local Site guidelines
  - Team guidelines for data management
  - NEEScomm documentation and metadata requirements
  - NEEScomm data archiving milestones
    - T0 - completion of an experiment
    - T + 1month: Unprocessed data uploaded
    - T + 6 months: Metadata and Documentation are uploaded
    - T + 12 months: Rest of the data and experimental report are uploaded

OPEN DATA

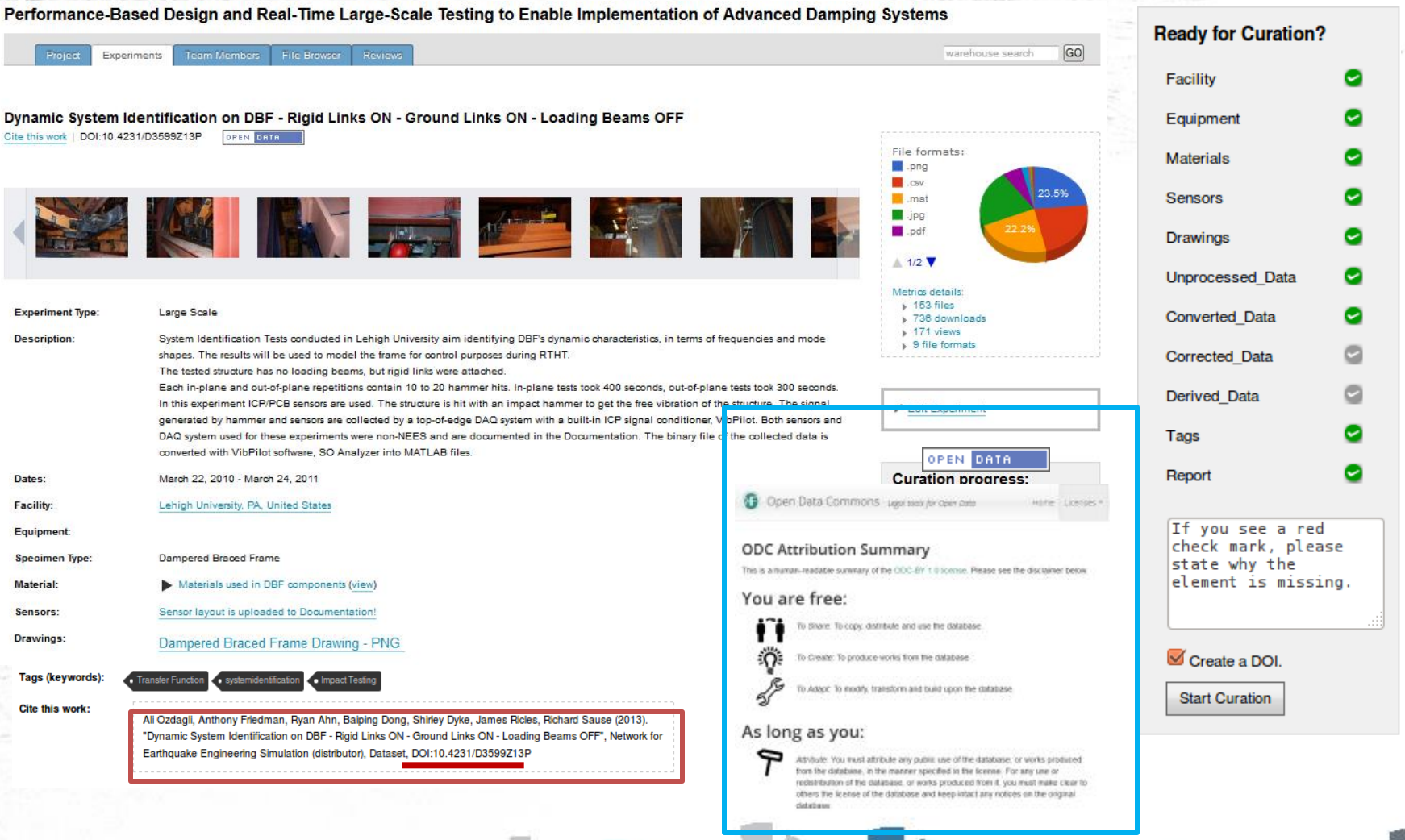
- **NEES Sites**
  - Certifications
  - Professional standards
  - Local guidelines (naming conventions, etc.)

- **NEES repository**
  - OAIS
  - PREMIS
  - Dublin Core
  - NEEScomm documentation and archiving policies





Curated Experiment



Data Publication in NEEShub

- All recently curated experiments
  - Have assigned DOI
  - Have improved metadata that facilitate discovery
- Datasets are considered published information products and NSF allows listing information products in researchers' bio sketches. "Acceptable products must be citable and accessible including but not limited to publications, data sets, software, patents, and copyright"
  http://www.nsf.gov/pubs/policydocs/pappguide/nsf13001/gpg_2.jsp#IIC2fic
- A special issue of Smart Structures and Systems on Real-time Hybrid Simulation in, Techno Press
- The Earthquake Spectra journal is accepting a new type of manuscript called Data Papers.
  - Peer-reviewed papers that describe datasets of interest to the earthquake community
  - Data must be publically available with a Digit Object Identifier (DOI)
  http://earthquakespectra.org/page/data_papers

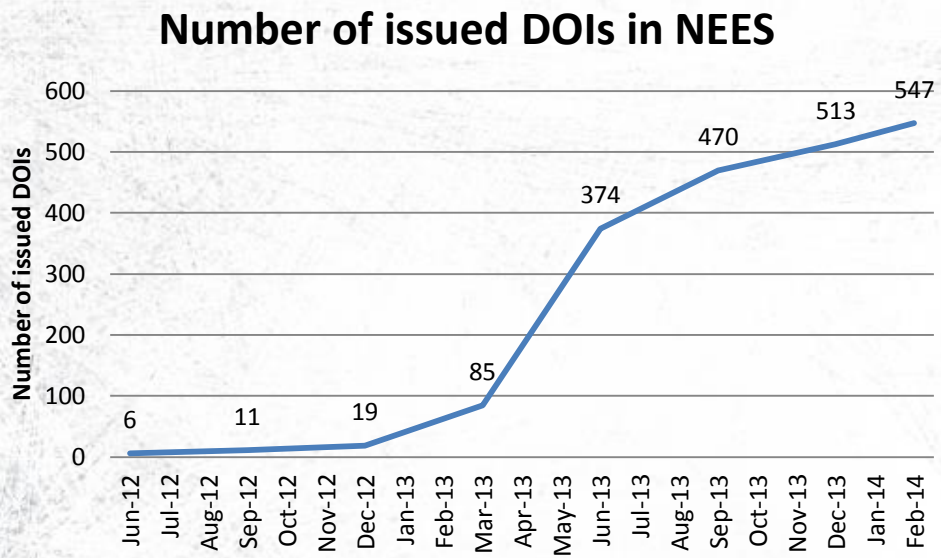
Citation and Attribution

Recommended citation format
Researcher 1, Researcher 2, Researcher 3 (YYYY), "Experiment Title" Network for Earthquake Engineering Simulation (distributor), Dataset, DOI:10.4231/D3SQ8QH1F

Users of the data are expected to cite the data sets they used in the recommended format as shown above and also include an acknowledgement to the NEES Data Repository.

To acknowledge the NEEShub Data Repository:
The facilities of the George E. Brown Network for Earthquake Engineering Simulation (NEES) Data Repository were used for access to data and metadata used in this study (https://nees.org/warehouse/welcome). The NEES Data Repository is funded through the National Science Foundation and specifically the CMMI Directorate through the National Science Foundation under Cooperative Agreement Number CMMI-0927178

DOI – Digital Object Identifier



U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NUREG/CR-XXXX
CCEER 13-09

Large Scale Earthquake Simulation of a Hybrid Lead Rubber Isolation System Designed with Consideration of Nuclear Seismicity

Manuscript Completed: October 3, 2012
Date Published: May, 2013

Prepared by
K. L. Ryan, C. B. Coria, N. D. Dao

Center for Civil Engineering Earthquake Research (CCEER)
University of Nevada, Reno/MS 0258
Reno, Nevada 89557-0258

55. Ryan K, Sato E, Sasaki T, Okazaki T, Guzman T, Dao N, Soroushian S, Coria C (2013a). "Full Scale 5-story Building with Triple Pendulum Bearings at E-Defense", Network for Earthquake Engineering Simulation (database), Dataset, DOI:10.4231/D3X34MR7R

56. Ryan K, Sato E, Sasaki T, Okazaki T, Guzman T, Dao N, Soroushian S, Coria C (2013b). "Full Scale 5-story Building with LRB/CLB Isolation System at E-Defense", Network for Earthquake Engineering Simulation (database), Dataset, DOI:10.4231/D3SB3WZ43

57. Ryan K, Sato E, Sasaki T, Okazaki T, Guzman T, Dao N, Soroushian S, Coria C (2013c). "Full Scale 5-story Building in Fixed-Base Condition at E-Defense", Network for Earthquake Engineering Simulation (database), Dataset, DOI:10.4231/D3NP1WJ3P

DOI in NEEShub

- Datasets – aggregations of data files and documentation

  Machel Morrison, Doug Schweizer, Tasnim Hassan (2012). "Cyclic Testing of Heat treated Beam Section 2 (HBS 2)", Network for Earthquake Engineering Simulation (distributor), Dataset, DOI:10.4231/D3JW86M52
  http://nees.org/warehouse/experiment/3380/project/984
- Models

  Rachelle Howell; Xiaoyue Wang; Ellen M. Rathje (2014), "2D Unit Cell Model", Network for Earthquake Engineering Simulation (distributor), Model, DOI: 10.4231/D3P26Q386

  http://nees.org/resources/7293
- DataStore "databases"

  Reza Jafarzadeh; Jason M. Ingham; Suzanne Wilkinson (2013), "A Database for Seismic Retrofit Construction Cost of Concrete and Steel Framed Schools in Iran," Network for Earthquake Engineering Simulation (distributor), Dataset, DOI: 10.4231/D3959C774

  http://nees.org/resources/7354

DOI and its Payoff

Prof. Ellen M. Rathje, Ph.D., P.E.

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Software

Strata

Developed by Albert Kottke and Ellen Rathje

Strata performs one-dimensional linear-elastic and equivalent-linear (SHAKE-type) site response analyses using time series or random vibration theory ground motions. Strata allows for stochastic variation of the site properties, including the shear-wave velocity, layer thicknesses, depth to bedrock, and shear modulus reduction and material damping curves. The program can be installed as a desktop application or run within the NEES cyberinfrastructure platform, NEEShub. Strata can be downloaded from the NEEShub at Strata.

SigmaSpectra

Developed by Albert Kottke and Ellen Rathje

SigmaSpectra is a computer program that selects suites of of earthquake ground motions from a library of ground motions such that the median of the suite matches a target response spectrum at all defined periods. The program also scales the suite such that the standard deviation fits the target standard deviation. The program can be installed as a desktop application or run within the NEES cyberinfrastructure platform, NEEShub. SigmaSpectra can be downloaded from the NEEShub at SigmaSpectra.

-and-data

SLAMMER

Data

Curated Data Sets available on the NEEShub

Kamai, R., Kano, S., Conlee, C., Marinucci, A., Boulanger, R., Rathje, E., and Rix, G. (2013). "Centrifuge test SSK01 on prefabricated vertical drains for liquefaction remediation", Network for Earthquake Engineering Simulation (database), Dataset, DOI:10.4231/D32J6839J.

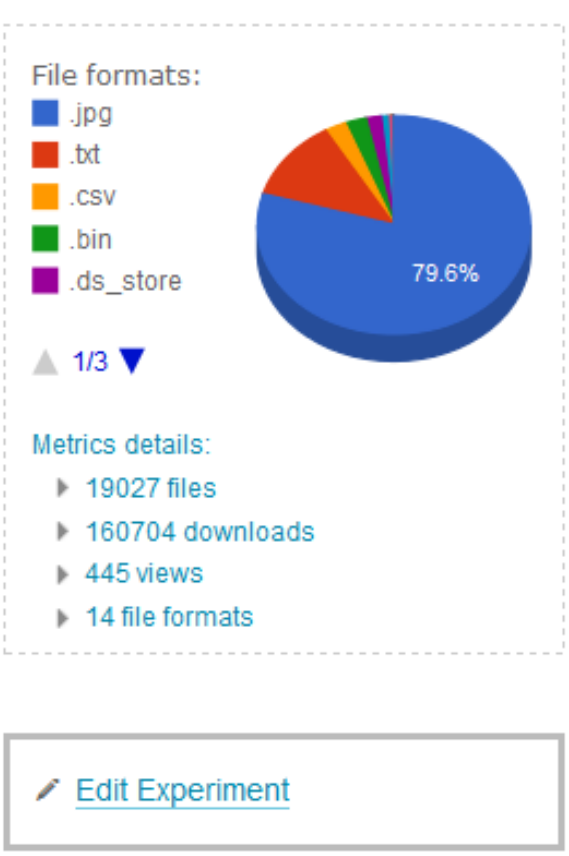
Kamai, R., Howell, R.L., Conlee, C., Boulanger, R., Rathje, E., Marinucci, A., and Rix, G. (2013). "Centrifuge test RNK01 on prefabricated vertical drains for liquefaction remediation", Network for Earthquake Engineering Simulation (database), Dataset, DOI:10.4231/D3VX0628F.

Howell, R.L., Kamai, R., Conlee, C., Rathje, E., Boulanger, R., Marinucci, A., and Rix, G. (2013). "Centrifuge test RLH01 on prefabricated vertical drains for liquefaction remediation", Network for Earthquake Engineering Simulation (database), Dataset, DOI:10.4231/D3XS5JG5N.

Marinucci, A., Menq, F.-Y., and Rathje, E. (2013). "Prefabricated Vertical Drains Field Experiment - Untreated Test Area", Network for Earthquake Engineering Simulation (database), Dataset, DOI:10.4231/D3930NV20.

Marinucci, A., Menq, F.-Y., and Rathje, E. (2013). "Prefabricated Vertical Field Experiment - Drain-treated Test Area", Network for Earthquake

Metrics on Experiment Level



Number of Downloads by Country *

160,704

Nov 2011 - Feb 2014

COUNTRY	NUMBER OF FILES
PUERTO RICO	149794 (93.2%)
UNITED STATES	6826 (4.2%)
CHINA	4032 (2.5%)
Unknown	46 (0.0%)
INDIA	3 (0.0%)
GERMANY	1 (0.0%)
KOREA, REPUBLIC OF	1 (0.0%)
ITALY	1 (0.0%)

* This metrics started to be collected in November 2011.

Number of Views by Country *

52

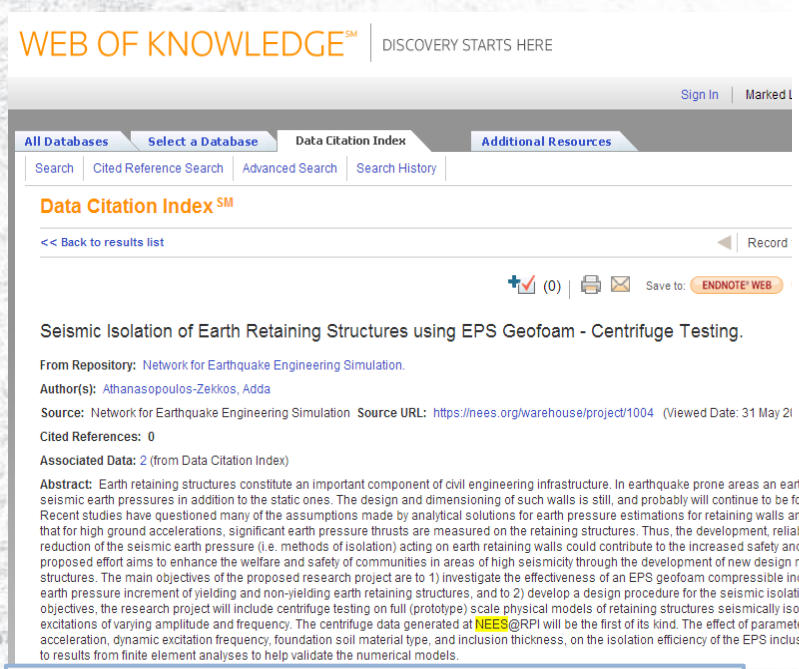
Nov 2013 - Feb 2014

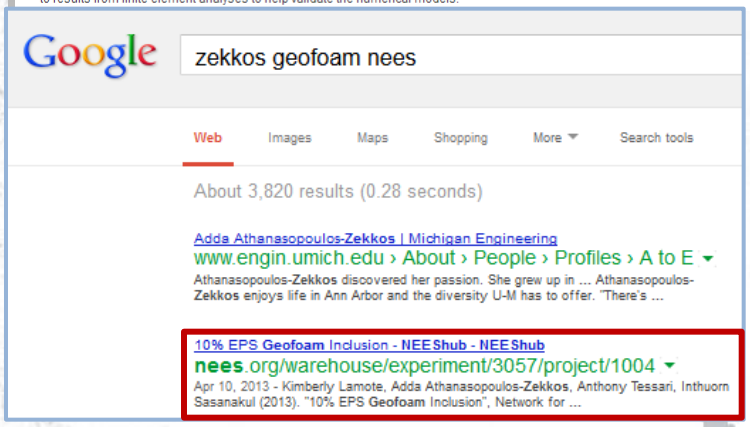
COUNTRY	NUMBER OF FILES
United States	33 (63.5%)
Unknown	8 (15.4%)
China	5 (9.6%)
Canada	4 (7.7%)
Ukraine	1 (1.9%)

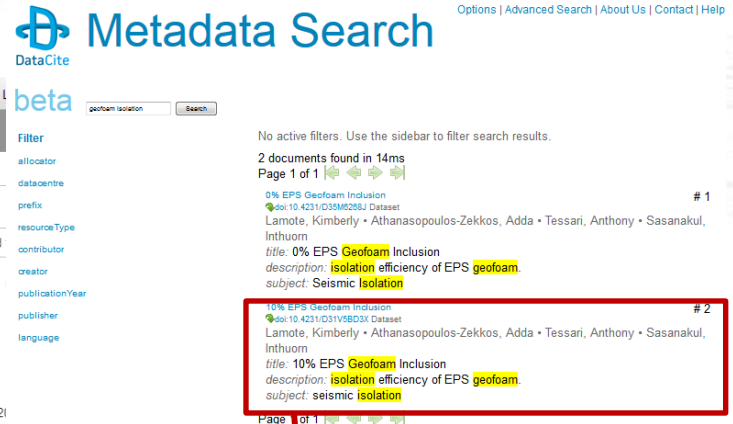
experiment: http://nees.org/warehouse/experiment/2838/project/987

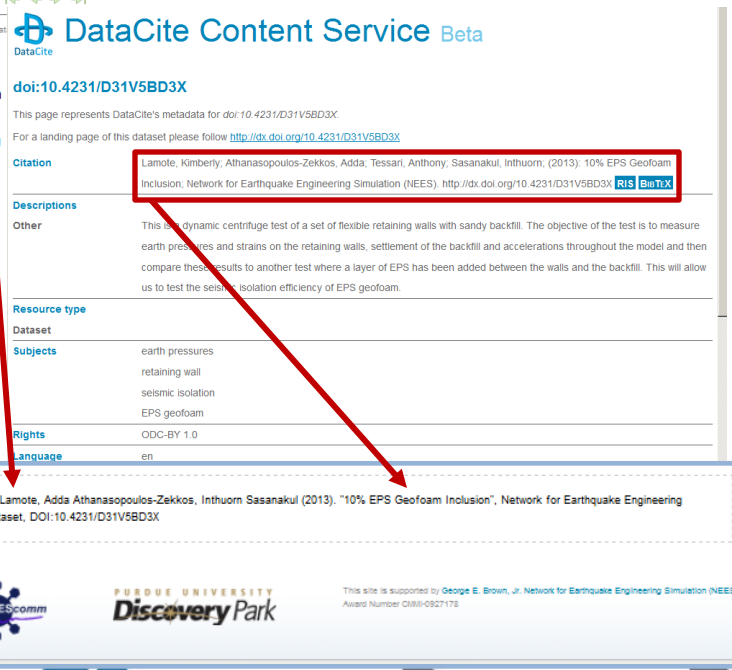
Matthew Schoettler; Jose Restrepo; Gabriele Guerrini; David Elias Duck; francesco carrea (2012), "A Full-Scale, Single-Column Bridge Bent Tested by Shake-Table Excitation," http://nees.org/resources/6868

Exposure of EE Research Data









Repository for EE Data

re3data.org
REGISTRY OF RESEARCH DATA REPOSITORIES

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Repository details

NEEShub

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General information

Name of repository	**NEEShub**
Additional name	Network for Earthquake Engineering Simulations a platform for research, collaboration and education The George E. Brown, Jr. Network for Earthquake Engineering Simulation
Repository URL	http://nees.org/
Subjects	Geosciences (including Geography)
Description	NEES network features 14 geographically-distributed, shared-use laboratories that support several types of experimental work: geotechnical centrifuge research, shake table tests, large-scale structural testing, tsunami wave basin experiments, and field site research
Content type(s)	Databases Structured graphics Scientific and statistical data formats Structured text
Keyword(s)	geotechnical centrifuges, field experimentation and monitoring, large-scale laboratory experimentation, shake tables, tsunami wave basin, earthquake, seismology

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Title: Network for Earthquake Engineering Simulation

URL: http://nees.org/

Authority: National Science Foundation, Purdue University Discovery Park

Subjects: Geosciences

Earthquake damage | Earthquake hazard analysis | Earthquakes | Seismites | Seismology | Tsunami damage | Tsunamis

Description:
The George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) aims to assist in the development of innovations related to construction and design that minimizes or prevents damage during natural disasters such as earthquakes or tsunamis. The NEES provides access to 14 shared-use laboratories that support experimental work in such areas as geotechnical centrifuge research, shake table tests, large-scale structural testing, tsunami wave basin experiments, and field site research.

Access: Open

Start Date: 2004

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Network for Earthquake Engineering Simulation.

Group Author(s): Network for Earthquake Engineering Simulation

Source: Network for Earthquake Engineering Simulation

Source URL: http://nees.org/ (Viewed Date: 22 Nov 2012) **Published Year:** 2004

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Abstract: The Network for Eearthquake Engineering Simulation focuses on accelerating innovations in infrastructure design and construction practices to minimize damage during earthquakes or tsunamis. Their Project Warehouse is the centralized data repository for sharing and publishing earthquake engineering research data from experimental and numerical studies. The data in the Project Warehouse are associated with research projects funded by a variety of agencies, including the National Science Foundation (NSF), and include experiments performed at NEES and non-NEES equipment sites. 2009 NEEShub

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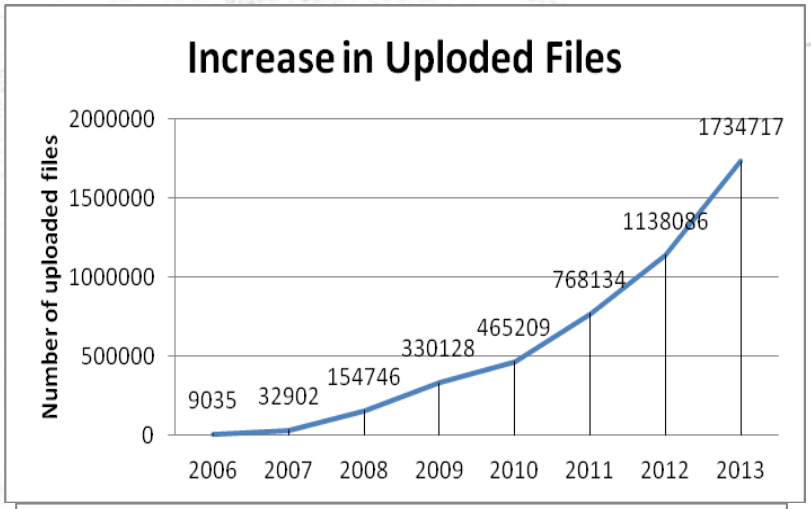

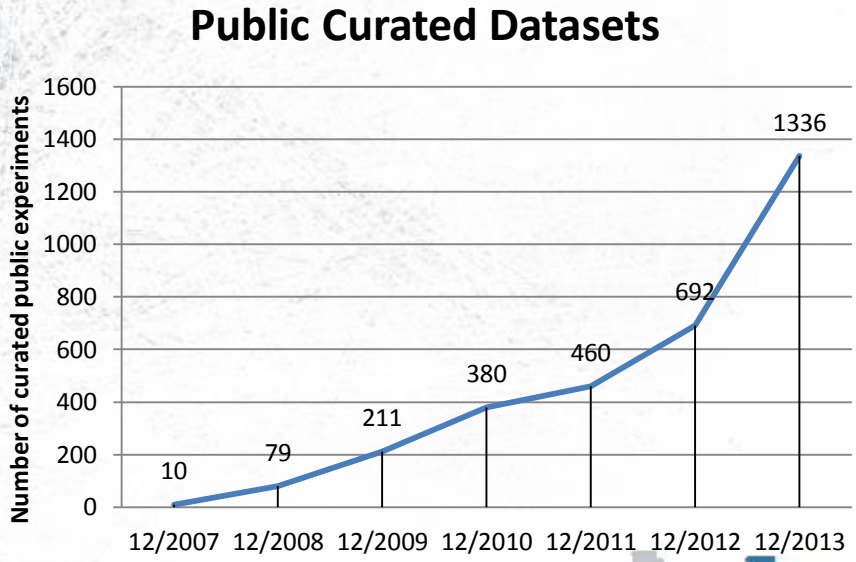

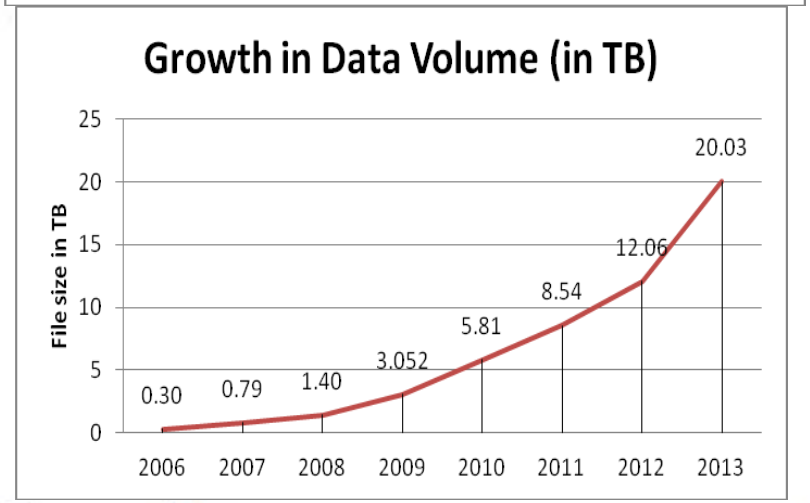

Thank you.

Questions?

Comments?

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Network for Earthquake Engineering Simulation