

OpenSEES Tutorial

Silvia Mazzoni
University of California, Berkeley

NEESgrid End-User Workshop



OpenSees

21 January 2005
San Diego, CA

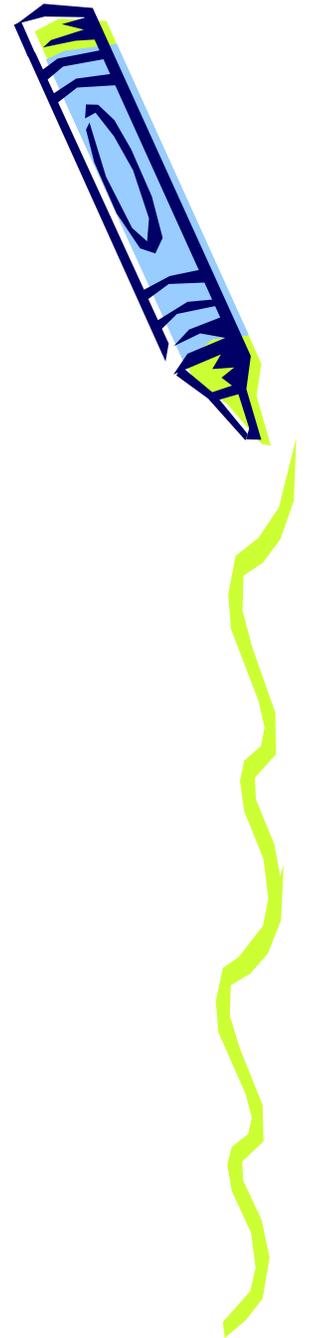
NEESit

NEESit @ berkeley team

- Frank McKenna - OpenSees
- Gregory L. Fenves - OpenSees
- Filip Filippou - FEDEASlab
- Silvia Mazzoni - user services
- TBA - software engineer



Silvia Mazzoni
NEESgrid End-User Workshop 2005



What is OpenSEES??!

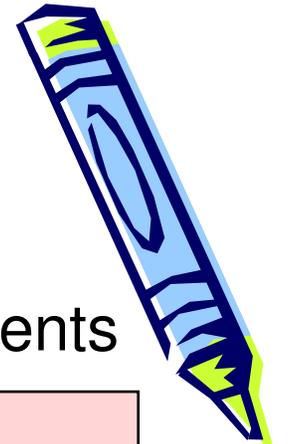
- A software *framework* for simulation applications in earthquake engineering using finite element methods.
- A communication mechanism within PEER and NEES, and beyond, for exchanging and building upon research accomplishments.
- As open-source software, it has the potential for a community code for earthquake engineering.



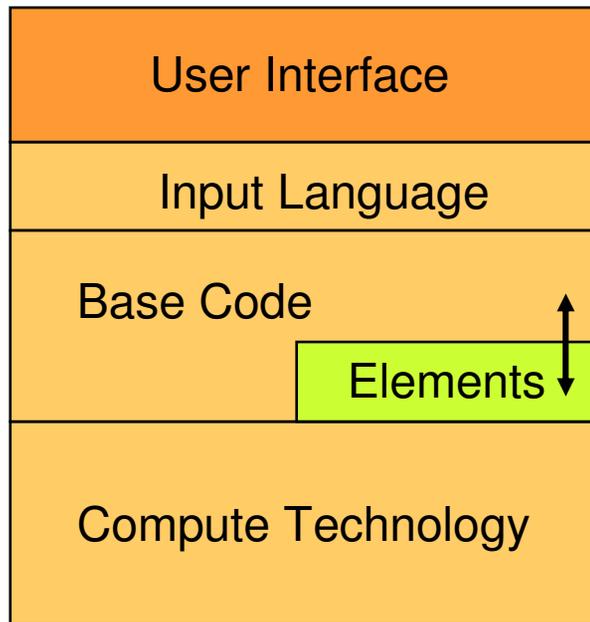
Silvia Mazzoni
NEESgrid End-User Workshop 2005



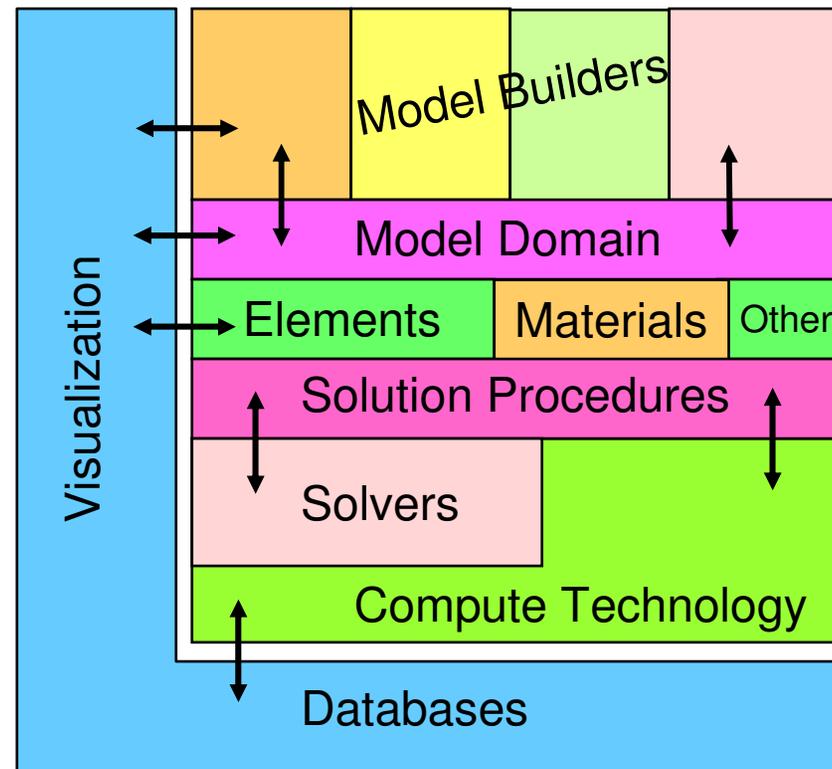
traditional code vs. OpenSEES



Traditional Code



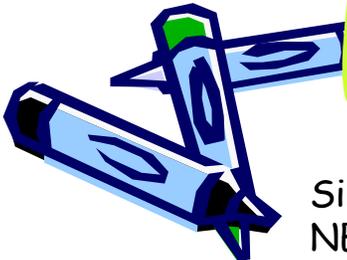
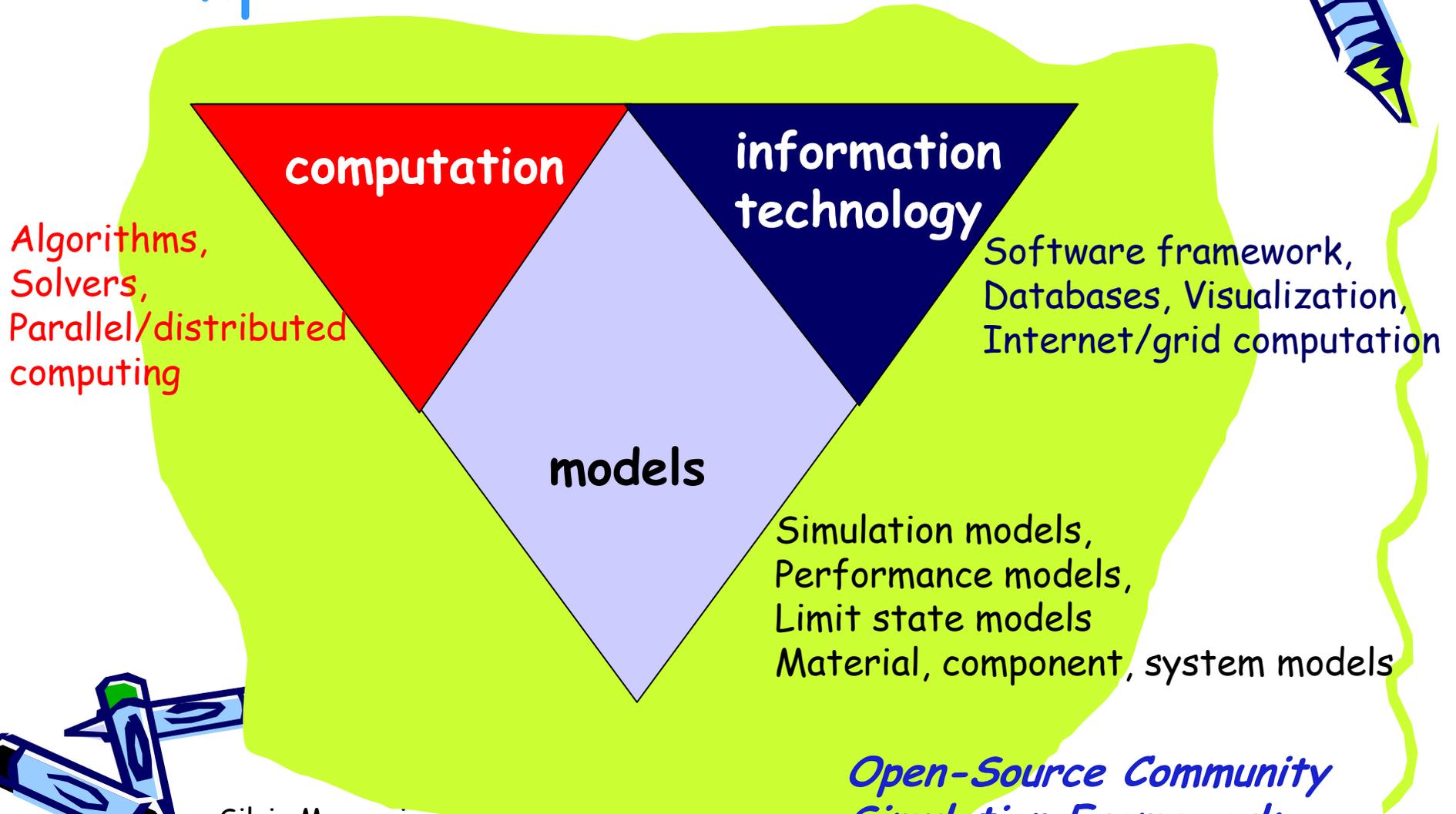
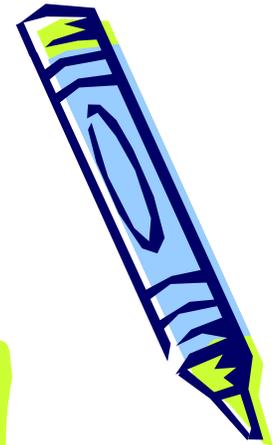
Framework of Components



Application Program Interface (API)

Silvia Mazzoni
NEESgrid End-User Workshop 2005

simulation-framework components



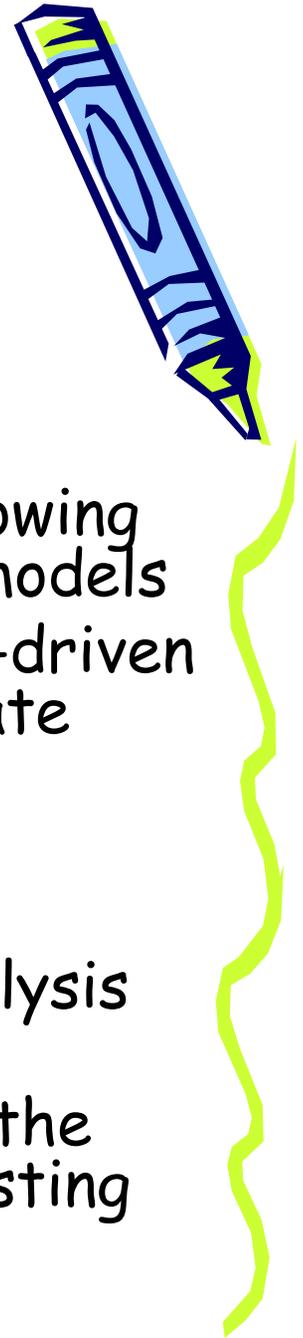
Silvia Mazzoni
NEESgrid End-User Workshop 2005

*Open-Source Community
Simulation Framework*



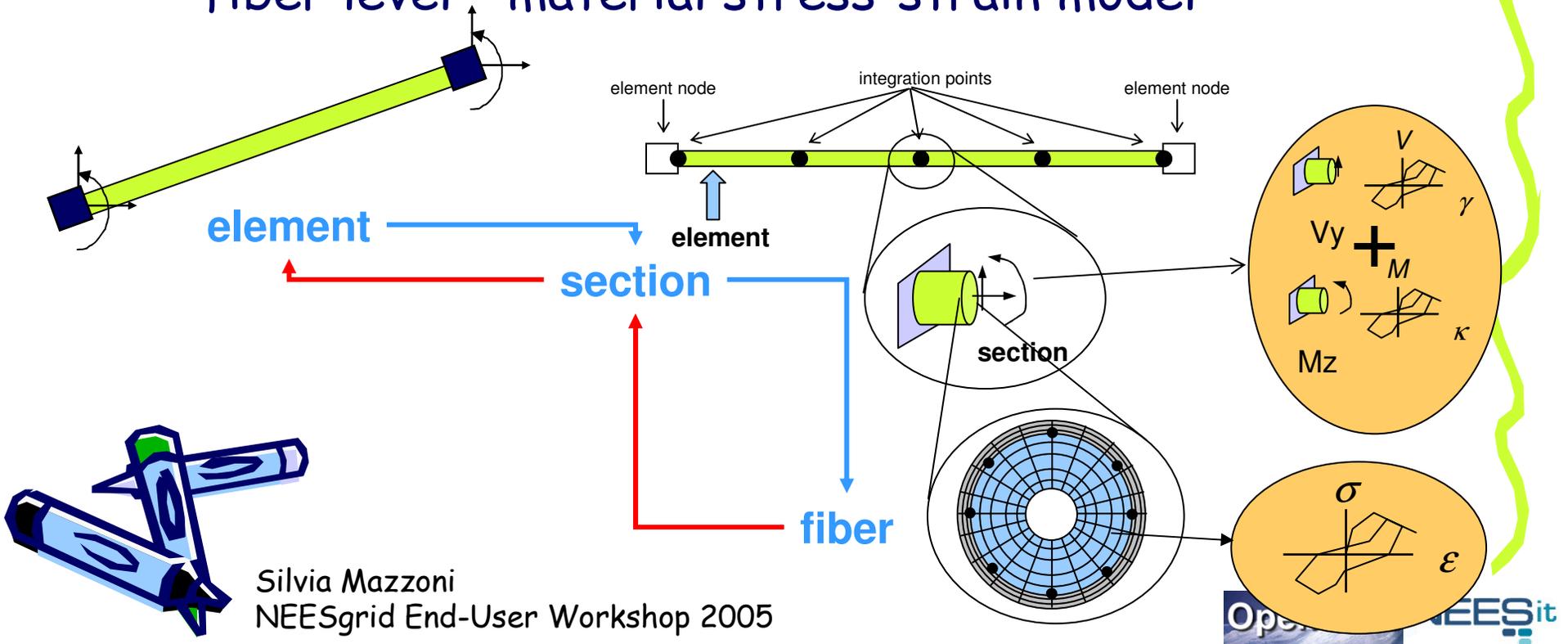
why OpenSEES?

- The library of materials, elements and analysis commands makes OpenSEES a powerful tool for numerical simulation of nonlinear structural and geotechnical systems
- The OpenSEES library of components is ever-growing and at the leading edge of numerical-simulation models
- The OpenSEES interface is based on a command-driven scripting language which enables the user to create more-versatile input files. (*I'll show you how!*)
- OpenSEES is not a black box, making it a useful educational tool for numerical modeling
- You can create your own material, element or analysis tools and incorporate them into OpenSEES
- NEES is supporting integration of OpenSEES as the simulation component of laboratory testing

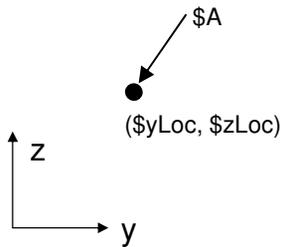
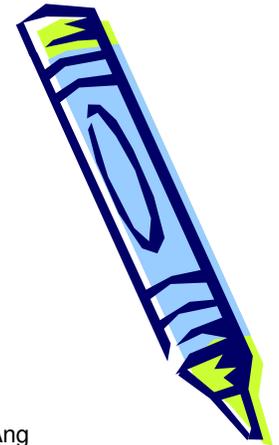


my favorite:

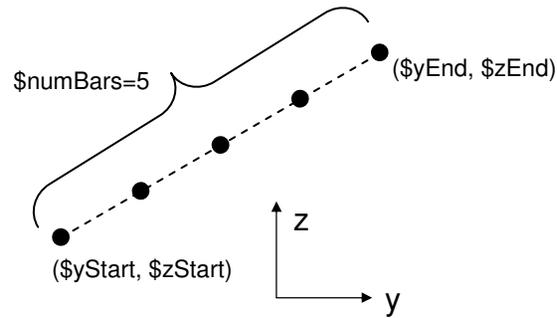
- You can describe a structural/geotech. component at a number of levels:
 - element level - force-deformation model
 - section level - moment-curvature model
 - fiber level - material stress-strain model



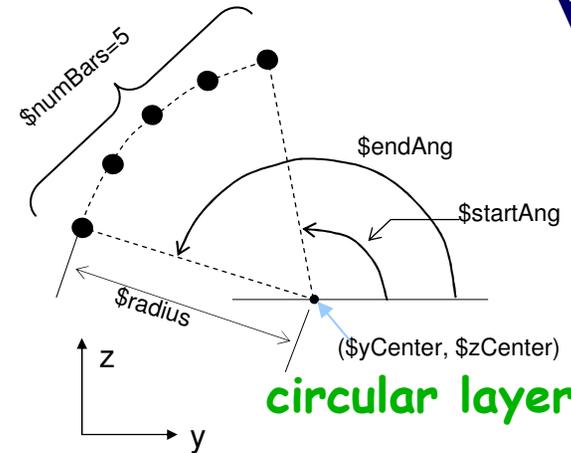
fiber sections:



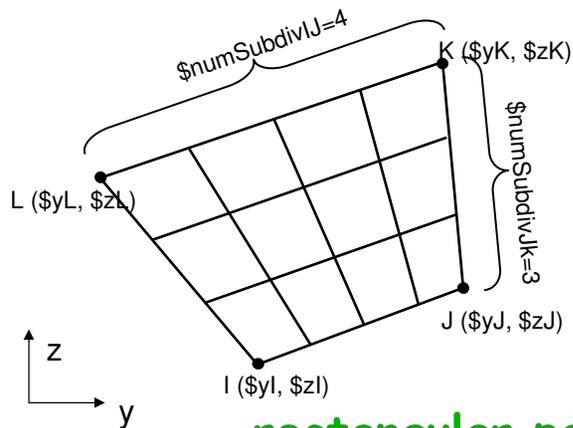
single fiber



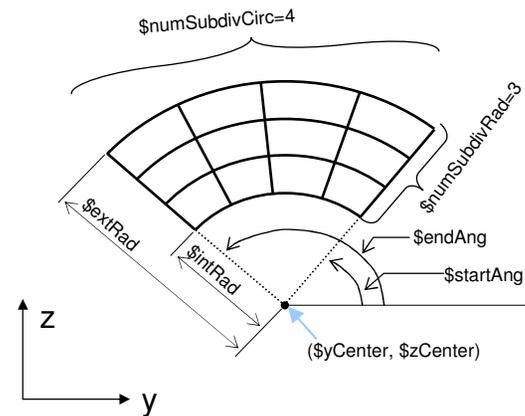
straight layer



circular layer



rectangular patch



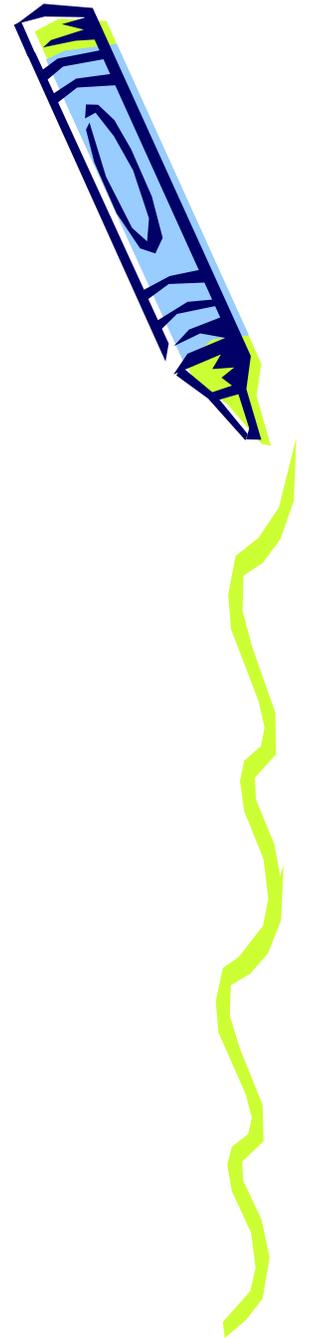
circular patch



Silvia Mazzoni
NEESgrid End-User Workshop 2005

OpenSEES features

- models:
 - linear & nonlinear structural and geotechnical models
- simulations:
 - static push-over analyses
 - static reversed-cyclic analyses
 - dynamic time-series analyses
 - uniform-support excitation
 - multi-support excitation



simulation features

- **Model-Building**

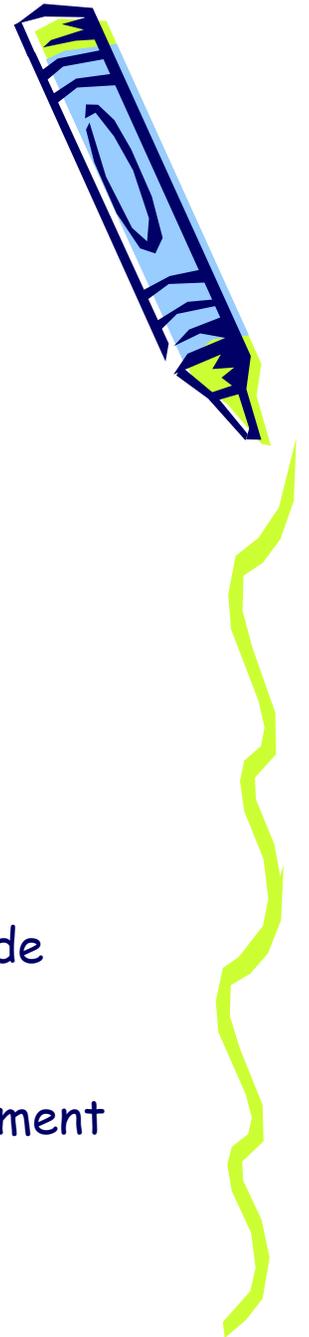
- model
- node
- mass
- Constraints
- uniaxialMaterial
- nDMaterial
- section
- element
- block
- region
- Geometric Transformation
- Time Series
- pattern

- **Analysis**

- constraints
- numberer
- system
- test
- algorithm
- integrator
- analysis
- rayleigh
- eigen
- dataBase

- **Recorders**

- Node
- EnvelopeNode
- Drift
- Element
- EnvelopeElement
- Display
- Plot
- playback



modeling features

- **uniaxial materials:**

- Elastic Material
- Elastic-Perfectly Plastic Material
- Elastic-Perfectly Plastic Gap Material
- Parallel Material
- Series Material
- Hardening Material
- Steel01 Material
- Concrete01 Material
- Elastic-No Tension Material
- Hysteretic Material
- Viscous Material
- PINCHING4 Material
- Fedeas Materials
- PyTzQz Uniaxial Materials

- **nD materials:**

- Elastic Isotropic Material
- J2 Plasticity Material
- Plane Stress Material
- Plate Fiber Material
- Template Elasto-Plastic Material
- FluidSolidPorousMaterial Material
- PressureIndependMultiYield Material
- PressureDependMultiYield Material



modeling features

- **elements:**

- Truss
- Corotational Truss
- Elastic Beam Column
- NonLinear Beam-Column
- Zero-Length
- Quadrilateral
- Brick
- FourNodeQuadUP
- BeamColumnJoint

- **sections:**

- Elastic Section
- Uniaxial Section
- Fiber Section
- Section Aggregator
- Elastic Membrane Plate Section
- Plate Fiber Section
- Bidirectional Section



Silvia Mazzoni
NEESgrid End-User Workshop 2005



analysis features

- **Linear Equation Solvers** -- provide the solution of the linear system of equations $Ku = P$. Each solver is tailored to a specific matrix topology.
 - Profile SPD -- Direct profile solver for symmetric positive definite matrices
 - Band General -- Direct solver for banded unsymmetric matrices
 - Band SPD -- Direct solver for banded symmetric positive definite matrices
 - Sparse General -- Direct solver for unsymmetric sparse matrices
 - Sparse Symmetric -- Direct solver for symmetric sparse matrices
 - UmfPack General -- Direct UmfPack solver for unsymmetric matrices
 - Full General -- Direct solver for unsymmetric dense matrices
 - Conjugate Gradient -- Iterative solver using the preconditioned conjugate gradient method
- **Eigenvalue Solvers** -- provide the solution of the generalized eigenvalue problem $Kv = MvL$
 - Symmetric Arpack -- Arpack solver for symmetric matrices
 - Band Arpack -- Arpack solver for banded matrices



analysis features

- **DOF Numberers** -- number the degrees of freedom in the domain
 - Plain -- Uses the numbering provided by the user
 - RCM -- Renumbers the DOF to minimize the matrix band-width using the Reverse Cuthill-McKee algorithm
- **Static Integrators** -- determine the next time step for an analysis
 - Load Control -- Specifies the incremental load factor to be applied to the loads in the domain
 - Displacement Control -- Specifies the incremental displacement at a specified DOF in the domain
 - Minimum Unbalanced Displacement Norm -- Specifies the incremental load factor such that the residual displacement norm is minimized
 - Arc Length -- Specifies the incremental arc-length of the load-displacement path



analysis features

- **Transient Integrators** -- determine the next time step for an analysis including inertial effects
 - Newmark -- The two parameter time-stepping method developed by Newmark
 - HHT -- The three parameter Hilbert-Hughes-Taylor time-stepping method
 - Central Difference -- Approximates velocity and acceleration by centered finite differences of displacement
- **Solution Algorithms** -- Iterate from the last time step to the current
 - Linear -- Uses the solution at the first iteration and continues
 - Newton -- Uses the tangent at the current iteration to iterate to convergence
 - Modified Newton -- Uses the tangent at the first iteration to iterate to convergence



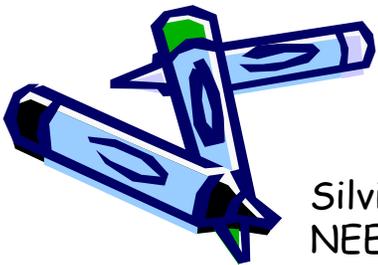
analysis features

- **Convergence Tests** -- Accept the current state of the domain as being on the converged solution path
 - Norm Unbalance -- Specifies a tolerance on the norm of the unbalanced load at the current iteration
 - Norm Displacement Increment -- Specifies a tolerance on the norm of the displacement increments at the current iteration
 - Energy Increment -- Specifies a tolerance on the inner product of the unbalanced load and displacement increments at the current iteration
- **Constraint Handlers** -- Handle the constraints defined on the domain
 - Plain -- Removes constrained degrees of freedom from the system of equations
 - Lagrange -- Uses the method of Lagrange multipliers to enforce constraints
 - Penalty -- Uses penalty numbers to enforce constraints
 - Transformation -- Performs a condensation of constrained degrees of freedom

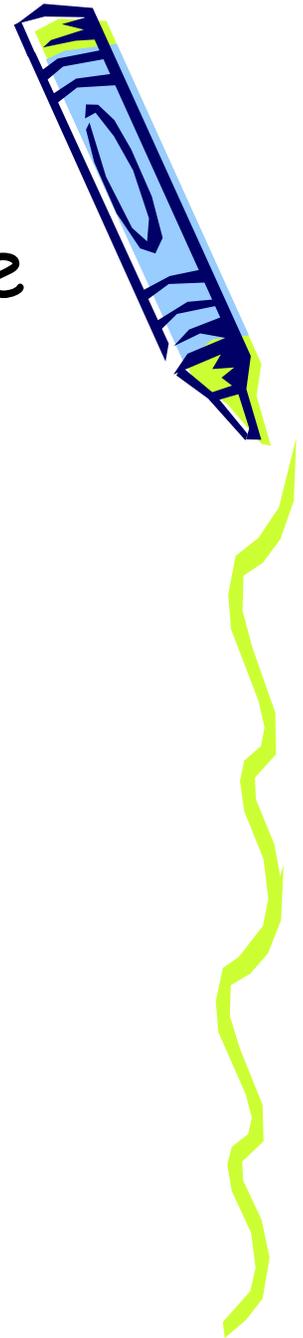


OpenSEES User resources

- Both an executable version and the source code are publicly available
- <http://OpenSEES.berkeley.edu/>
- User Command Manual
- Examples Manual
- e-mail technical support
- Annual User Workshops
- The OpenSEES Community Forum
 - Tcl scripting language for user interface
 - NEES portal

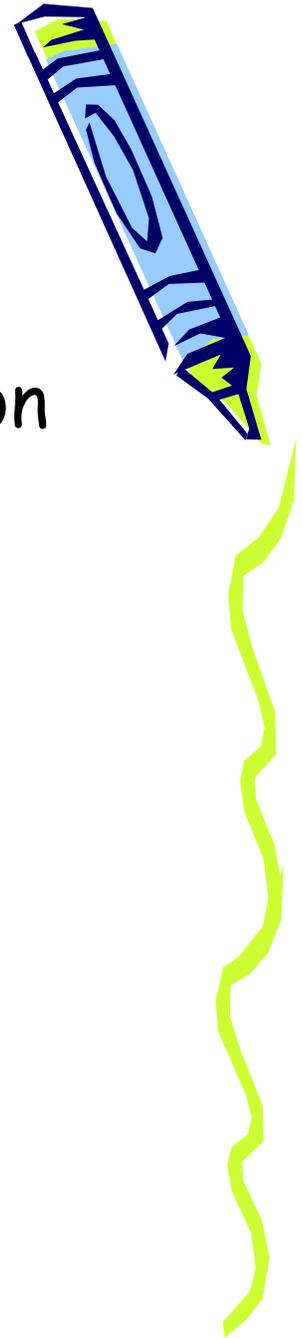


Silvia Mazzoni
NEESgrid End-User Workshop 2005



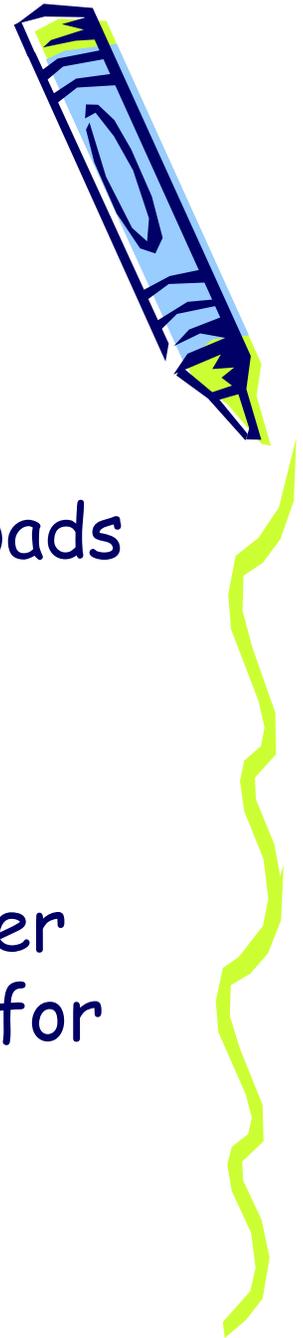
Tcl scripting language

- Tcl is a string based scripting language
- enables variables and variable substitution (use variables to define units!!!)
- Expression evaluation
- Array management
- Basic control structures (if , while, for, foreach)
- Procedures
- File manipulation



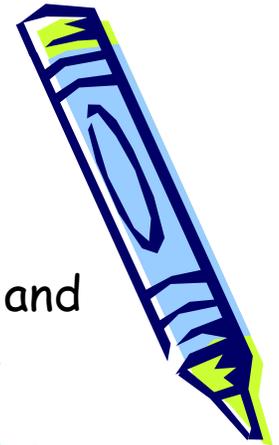
OpenSEES & Tcl

- OpenSEES Commands in Tcl for finite-element analysis:
 1. **Modeling** - create nodes, elements, loads and constraints
 2. **Analysis** - specify the analysis procedure
 3. **Recorders** - specify what it is the user wants to monitor during the analysis for output



main abstractions in OpenSEES

Holds the state of the model at time t_i and $(t_i + dt)$ & is responsible for storing the objects created by the ModelBuilder object and for providing the Analysis and Recorder objects access to these objects



ModelBuilder

Constructs the objects in the model and adds them to the domain.

Domain

Analysis

Moves the model from state at time t_i to state at time and $(t_i + dt)$

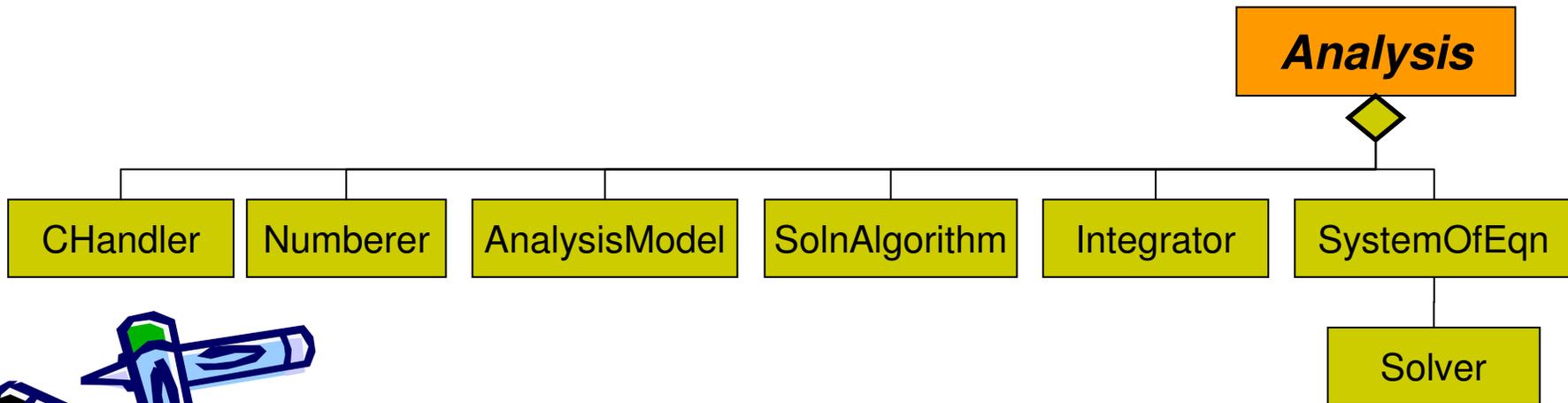
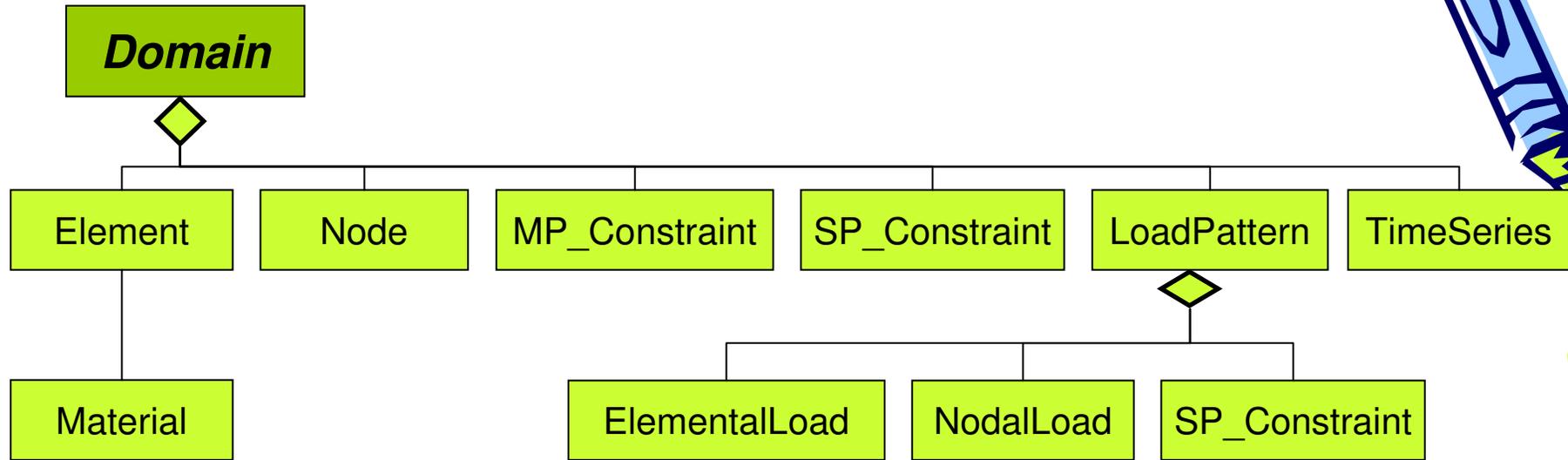
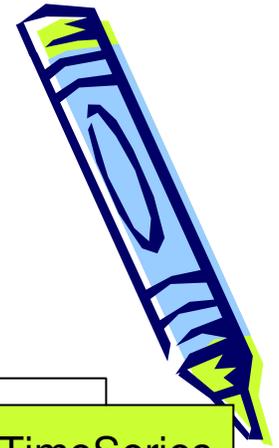
Recorder

Monitors user-defined parameters in the model during the analysis

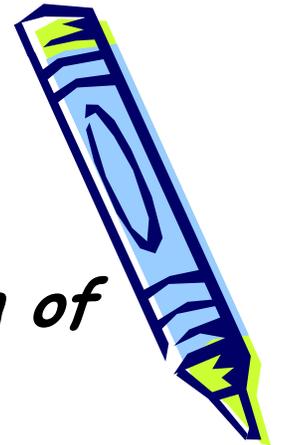
all this is within the
Tcl interpreter & commands



domain & analysis objects



OpenSEES User Manual

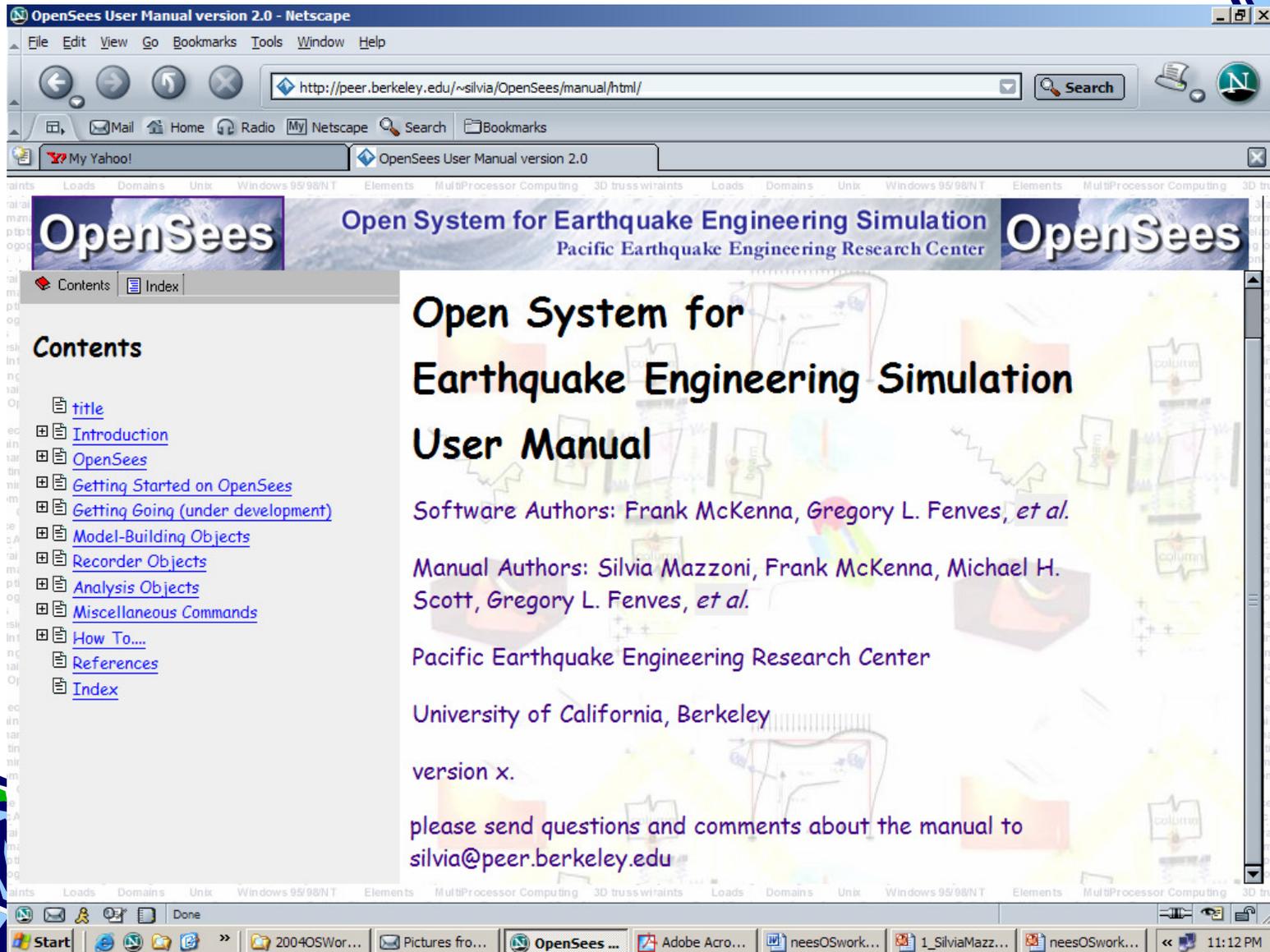


A document providing the syntax and description of OpenSEES commands in 3 formats:

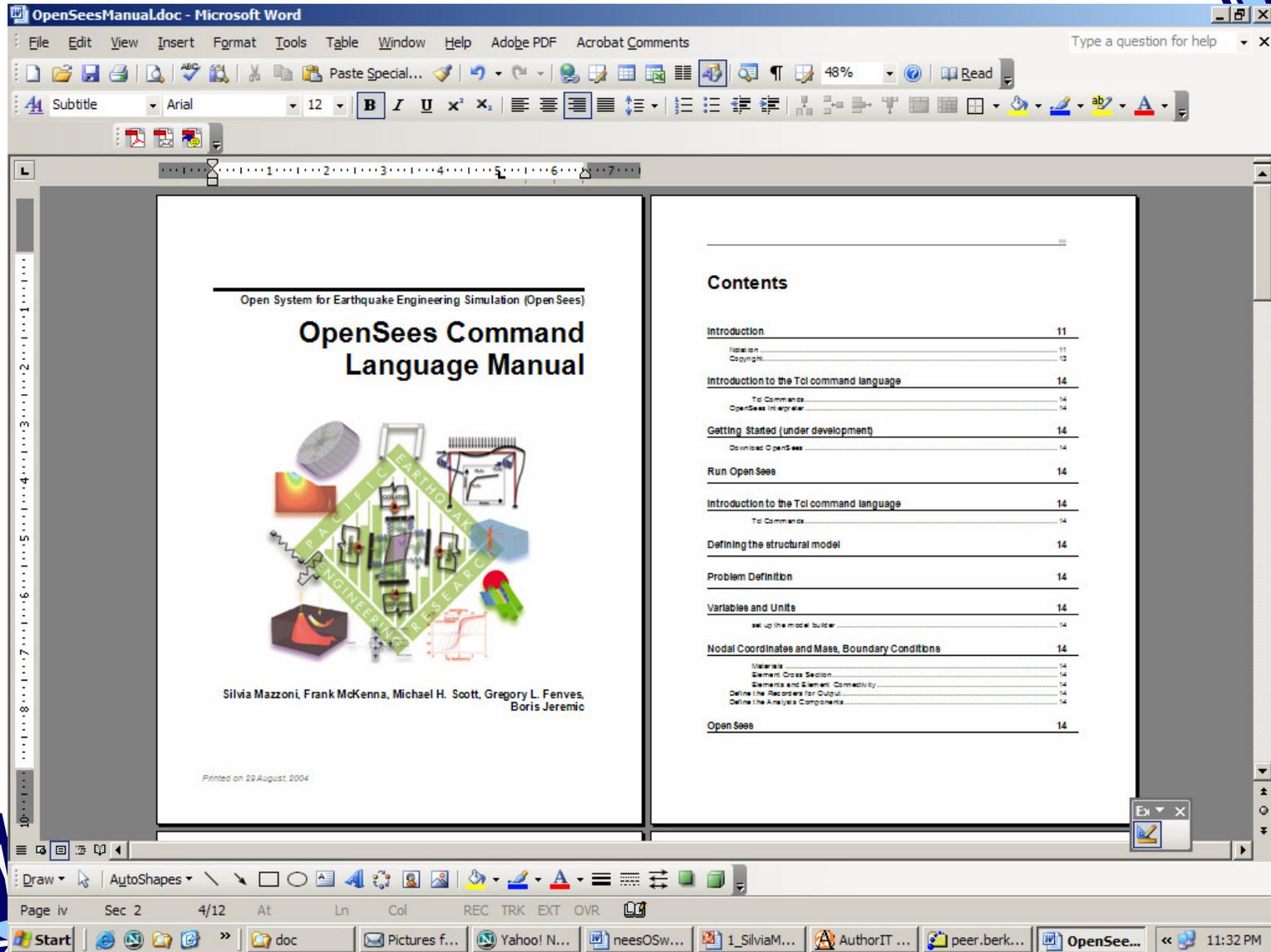
1. **HTML Manual** - on-line HTML document, residing on OpenSEES server. Always going to be the most current.
2. **MS Word** - downloadable and printable Word document
3. **Offline Windows** - downloadable .chm file. it is similar to the HTML format, but the file resides on your computer.



1. HTML on-line format

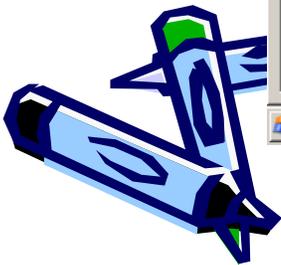
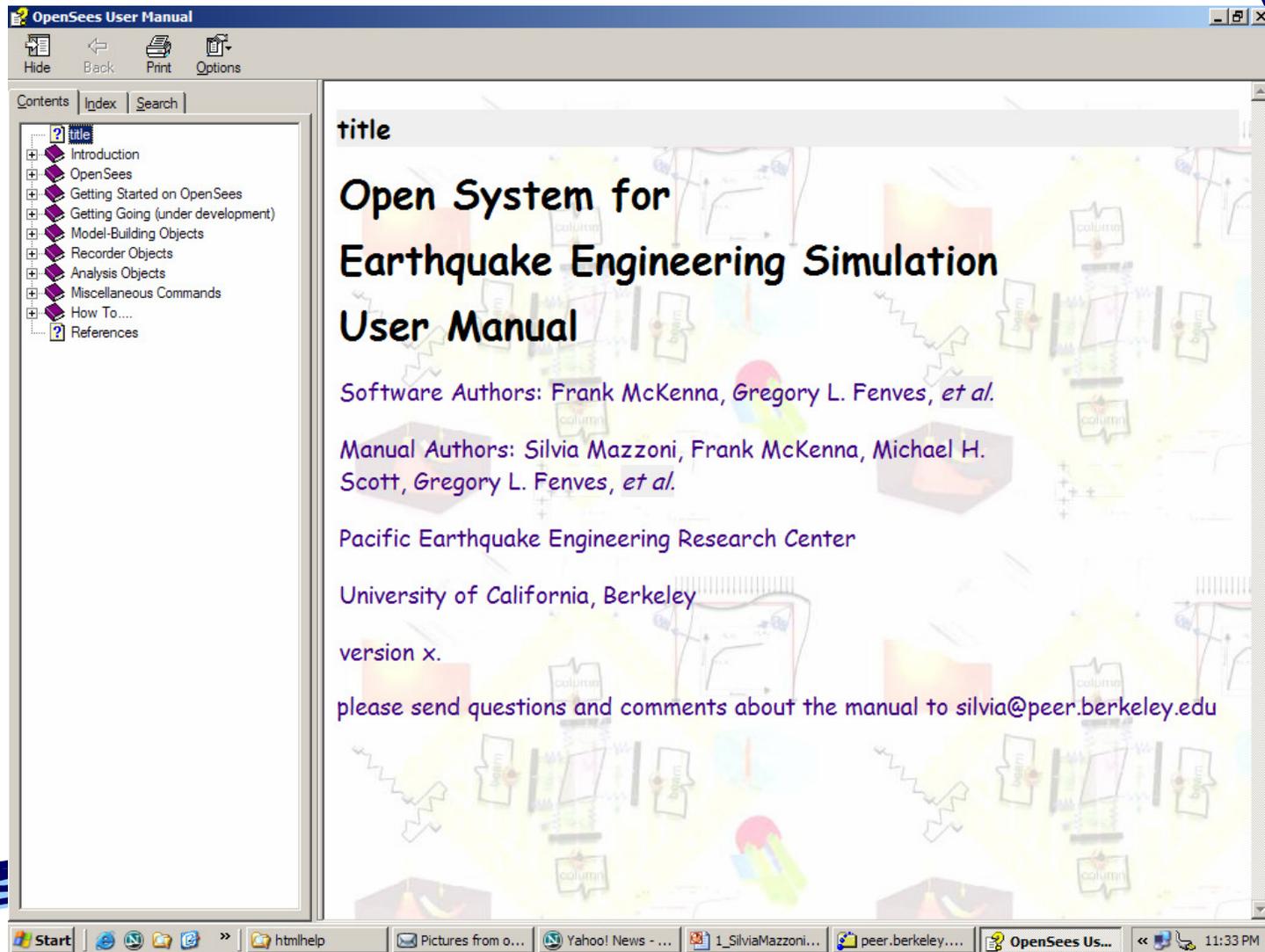


2. MS Word format



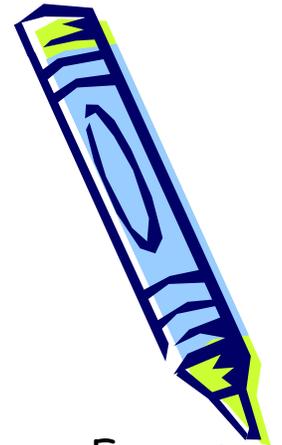
Silvia Mazzoni
NEESgrid End-User Workshop 2005

.chm file for MS Windows



Silvia Mazzoni
NEESgrid End-User Workshop 2005

annual 2-day User Workshop



AGENDA

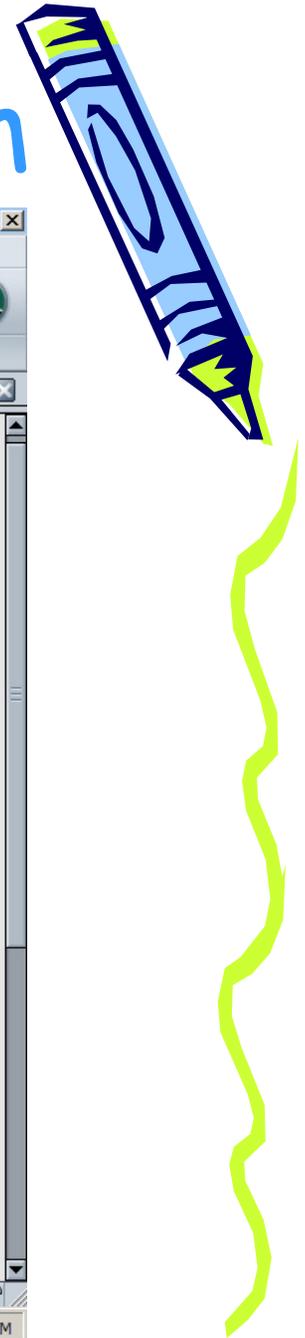
Day 1, Thursday, 2 September 2004

- Welcome and Introduction to OpenSEES & NEESgrid Simulation - Gregory Fenves
- Getting Started with OpenSEES:
 - Downloading and Installing the Software
 - Introduction to Tcl/Tk and OpenSEES Commands -- *Frank McKenna*
- Introduction to the OpenSEES User Manual and Files -- *Silvia Mazzoni*
- Structural Models I (Parameter Definition, Nodes, Constraints, Materials, Sections & Elements, Block & Region, Geometric Transformation)
- Structural Models II (Recorders, Loads) -- *Silvia Mazzoni*
- Introduction to Analysis Commands (System, Integrator, Algorithm, Numberer Analyze)
- When Things Go Wrong: Modifying the Script in the Event of Non-Convergence
- Structural Example - Reinforced-Concrete Frame: Building the Model
- Structural Example - Reinforced-Concrete Frame: Static, Cyclic and Dynamic Analyses, Multiple-Support Excitation -- *Frank McKenna*



Silvia Mazzoni
NEESgrid End-User Workshop 2005

OpenSEES Community Forum



The OpenSees Community Forum :: Index - Netscape

File Edit View Go Bookmarks Tools Window Help

http://opensees.berkeley.edu/phpBB2/index.php Search

The OpenSees Community Forum :: Index

OpenSees

Open System for Earthquake Engineering Simulation
Pacific Earthquake Engineering Research Center

Quick Links

The OpenSees Community Forum

FAQ Search Memberlist Usergroups Register
Profile Log in to check your private messages Log in

The time now is Sat Nov 27, 2004 10:06 am
The OpenSees Community Forum Forum Index [View unanswered posts](#)

Forum	Topics	Posts	Last Post
Test category 1			
Test Forum 1 This is just a test forum.	4	14	Thu Aug 26, 2004 12:56 pm jzhong →
OpenSees			
Interpreter Forum for OpenSees users to post questions, comments, etc. on the use of the OpenSees interpreter.	64	170	Fri Nov 26, 2004 5:13 pm berktaftali →
Documentation For posts concerning the documentation, errors, omissions, general comments, etc.	11	20	Sat Nov 27, 2004 1:45 am lish hit →
Framework For developers writing C++, Fortran, Java, code who have questions or comments to make.	23	65	Fri Nov 26, 2004 7:52 am senseiwa →
Future Directions A forum dedicated to the future direction of OpenSees, i.e. what would you like, what do you need.	7	8	Fri Sep 03, 2004 10:37 am guest →

Start My Computer Re: NEESgrid s... The OpenSee... Untitled - Note... Microsoft Powe... Adobe Photosh... 10:08 AM



NEESgrid End-User Workshop 2005

four forum categories



The time now is Sat Nov 27, 2004 10:09 am
The OpenSees Community Forum Forum Index View unanswered posts

Forum	Topics	Posts	Last Post
Test category 1			
 Test Forum 1 This is just a test forum.	4	14	Thu Aug 26, 2004 12:56 pm jzhong →
OpenSees			
 Interpreter Forum for OpenSees users to post questions, comments, etc. on the use of the OpenSees interpreter.	64	170	Fri Nov 26, 2004 5:13 pm berktaftali →
 Documentation For posts concerning the documentation, errors, omissions, general comments, etc.	11	20	Sat Nov 27, 2004 1:45 am lish hit →
 Framework For developers writing C++, Fortran, Java, code who have questions or comments to make.	23	65	Fri Nov 26, 2004 7:52 am senseiwa →
 Future Directions A forum dedicated to the future direction of OpenSees, i.e. what would you like, what do you need.	7	8	Fri Sep 03, 2004 10:37 am guest →

Mark all forums read All times are GMT - 8 Hours

Who is Online

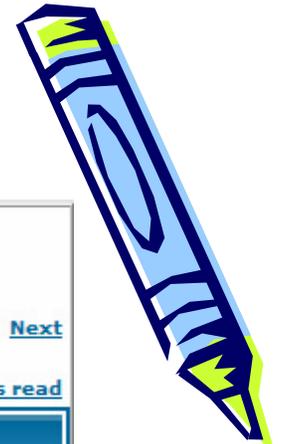
Our users have posted a total of **277** articles
We have **88** registered users
The newest registered user is [caz](#)

In total there is **1** user online :: 0 Registered, 0 Hidden and 1 Guest [[Administrator](#)] [[Moderator](#)]
Most users ever online was **4** on Mon Aug 09, 2004 10:42 am
Registered Users: None



Silvia Mazzoni
NEESgrid End-User Workshop 2005

very busy message board



Interpreter

Moderators: None

Users browsing this forum: None

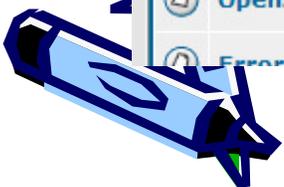
Goto page [1](#), [2](#) [Next](#)



The OpenSees Community Forum Forum Index -> Interpreter

[Mark all topics read](#)

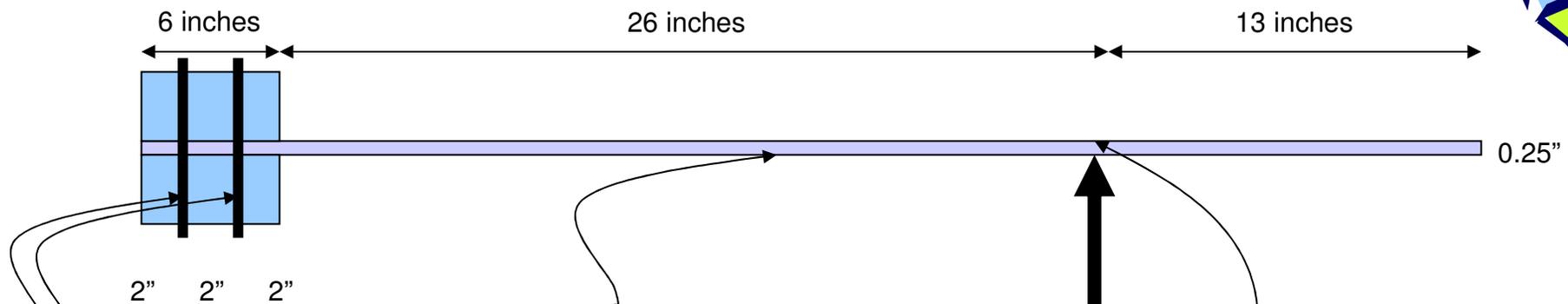
Topics	Replies	Author	Views	Last Post
3D building, diaphragm constraint	1	maf	10	Fri Nov 26, 2004 5:13 pm berktaftali →
mass	12	lish hit	209	Tue Nov 23, 2004 6:16 am lish hit →
nonlinearBeamColumn: sections at integration points	3	Maf	103	Mon Nov 22, 2004 9:39 am Paolo Franchin →
uniaxialMaterial Hysteretic	0	Ciak	19	Fri Nov 19, 2004 4:13 pm Ciak →
Print residuals	1	alupoj	28	Thu Nov 18, 2004 10:14 am berktaftali →
How to determine points of uniaxialMaterial Pinching4	1	Araj	26	Thu Nov 18, 2004 7:18 am berktaftali →
hinge state: display colour	3	maf	49	Wed Nov 17, 2004 11:38 am fmk →
How can I impose displacement time history to a node	0	Dennis	20	Tue Nov 16, 2004 9:36 am Dennis →
A problem in OS 2D model	2	lish hit	46	Sat Nov 13, 2004 7:05 am lish hit →
Must i put gravity	2	OS	60	Tue Nov 09, 2004 4:05 am OS →
BeamColumnJoint element	0	Araj	37	Mon Nov 08, 2004 2:26 am Araj →
OpenSees script for beam-column joint element	2	Araj	58	Sun Nov 07, 2004 6:51 pm Araj →
Error messages	4	Guest	51	Sun Nov 07, 2004 7:11 am



Silvia Mazzoni
NEESgrid End-User Workshop 2005

OpenSEES application

- MiniMOST model:



2 Bolts: each 2 inches apart.
Essentially a fixed boundary condition.

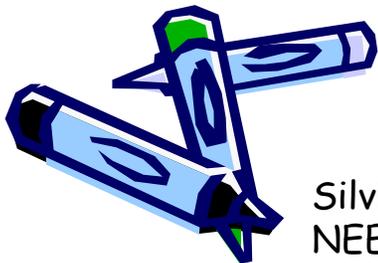
Steel beam: thickness is 0.25", depth is 2" (dimension not shown), total length of beam including 6" at anchor is 45")

Material Property:
Young's modulus: 29000 Kip/inch
Mass per unit volume: 7.345×10^{-7} Kip/inch³
Poisson's ration: 0.3

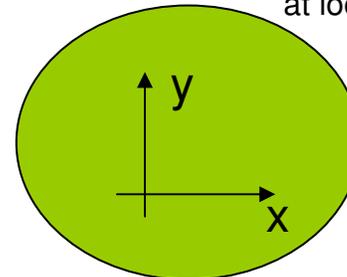
Sectional Property
Height: 2.0 inch
Width: 0.25 inch
Area: 0.5 inch²
Moment of Inertia: 0.0026 inch⁴

Point load applied here
under displacement control:
 ± 0.394 inches (10mm)

Concerned about displacement measured at location of load



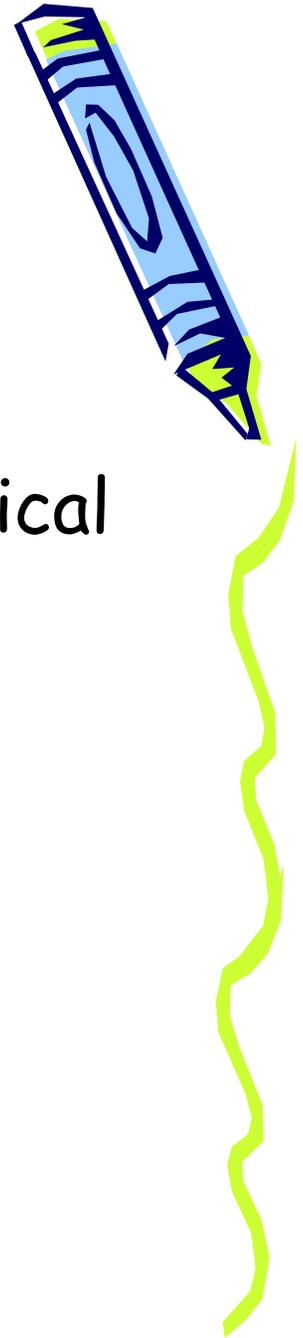
Silvia Mazzoni
NEESgrid End-User Workshop 2005



STEP 1

numerical simulation

1. Set up preliminary Tcl variables to define units and constants
2. Build the numerical model of the physical object (nodes, material, elements, connectivity, etc.)
3. Define the loading configurations
4. Define the output
5. Prescribe the analysis procedure



Tcl & OpenSEES commands

- **Command syntax:**

```
command arg1 arg2 ...; # comment
```

example Tcl command:

```
set a 1; # assign value of 1 to a  
set b [expr 2*$a];
```

example OpenSEES command:

```
node 1 10. 10. -mass $Mnode 0 0
```



example command

node Command

This command is used to construct a Node object. It assigns coordinates and masses to the Node object.

```
node $nodeTag (ndm $coords) <-mass (ndf $MassValues)>
```

\$nodeTag	integer tag identifying node
\$coords	nodal coordinates (<u>ndm</u> arguments)
\$MassValues	nodal mass corresponding to each DOF (<u>ndf</u> arguments) (optional)

The optional **-mass** string allows analyst the option of associating nodal mass with the node

EXAMPLE:

```
node 1 0.0 0.0 0.0; # x,y,z coordinates (0,0,0) of node 1
```

```
node 2 0.0 120. 0.0; # x,y,z coordinates (0,120,0) of node 2
```

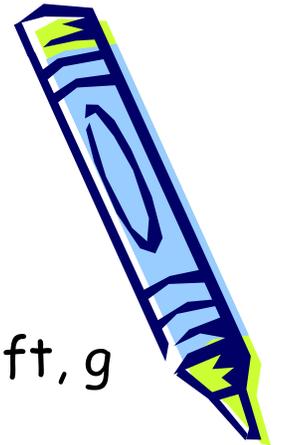
For an example of this command, refer to the [Model Building Example](#)

Note: this is taken from the user manual



set up initial variables

```
# define UNITS and constants available:      in, kip, ksi, psi, ft, g
set in  1.;                                # define basic units
set sec 1.;
set lb  1.;
set kip  [expr $lb*1000];                   # define engineering units
set ksi  [expr $kip/pow($in,2)];
set psi  [expr $ksi/1000.];
set ft  [expr 12.*$in];
set PI  [expr 2*asin(1.0)];                 # define constants
set U   1.e10;                              # a really large number
set u   [expr 1/$U];                        # a really small number
set g   [expr 32.2*$ft/pow($sec,2)];        # gravitational acceleration
```

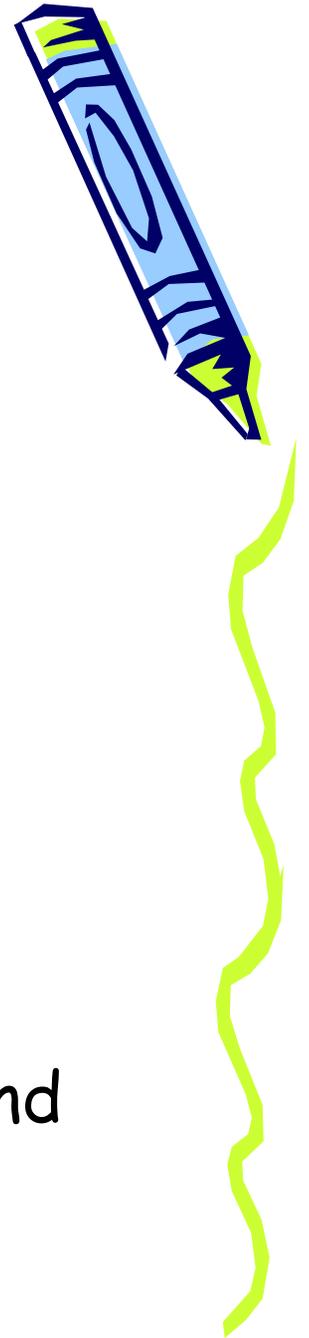


model-builder objects

- model Command
- node Command
- mass Command
- Constraints objects
- uniaxialMaterial Command
- nDMaterial Command
- section Command
- element Command
- block Command
- region Command
- Geometric Transformation Command
- Time Series
- pattern Command



Silvia Mazzoni
NEESgrid End-User Workshop 2005



model parameters

define GEOMETRY parameters

```
set Hbeam      [expr 2.*$in];  
set Bbeam      [expr 0.25*$in];  
set IzBeam     [expr $Hbeam*pow($Bbeam,3)/12];  
set Abeam      [expr $Hbeam*$Bbeam];  
set Lbeam      [expr (26.+13.)*$in];
```

define MATERIAL parameters

```
set Es         [expr 29000.*$ksi]; # modulus of steel
```

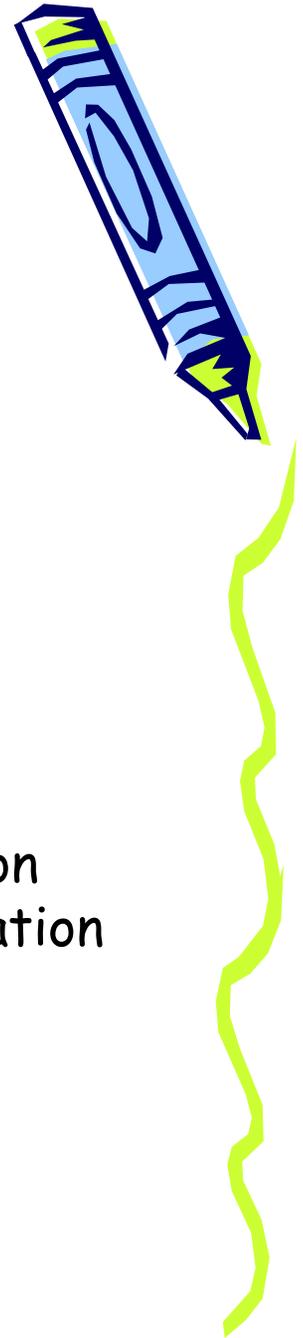
set up parameters for column section and element definition

```
set IDbeamTrans 1; # ID tag for beam transformation
```

define displacement-cycle amplitude

```
set iDmaxCycl "[expr 0.394*$in]"
```

```
wipe; # clear analysis memory
```



model-building commands



Create modelbuilder

model basic -ndm 2 -ndf 3; # ndm= number of dimensions, ndf= #dof/node

Define nodes ----- frame is in X-Y plane (X-horizontal, Y-vertical)

node 1 0. 0.

node 2 [expr 2*\$Lbeam/3] 0.

node 3 [expr \$Lbeam] 0.

identify some node tags

set IDctrlNode 2; # control node: where displ./forces are applied

set IDendNode 3; # identify node ID for free end of beam

Boundary conditions

fix 1 1 1 1 1 1 1

fix 2 0 0 0 0 0 0

fix 3 0 0 0 0 0 0

Define BEAM elements

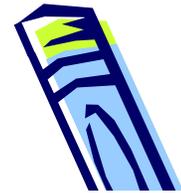
geomTransf Linear \$IDbeamTrans

element elasticBeamColumn 1 1 2 \$Abeam \$Es \$IzBeam \$IDbeamTrans

element elasticBeamColumn 2 2 3 \$Abeam \$Es \$IzBeam \$IDbeamTrans

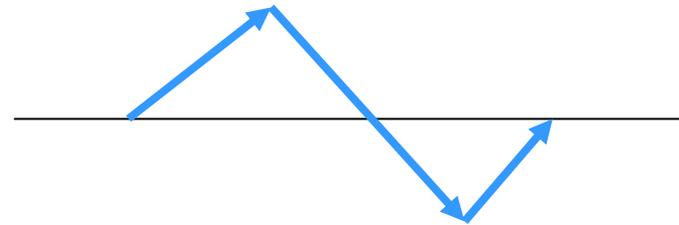


loading (cyclic displacements)



```
# define LATERAL LOADS --
# define procedure which creates a displacement-history vector
proc genPeaks {Dmax outFileID} {
  puts $outFileID "set iDstep { "
  set Disp 0.
  set Nsteps 50
  set dx [expr $Dmax/$Nsteps]
  puts $outFileID $Disp
  for {set iCycle 1} {$iCycle <= 3} {incr iCycle 1} {; # cycle 3 times
    for {set i 1} {$i <= $Nsteps} {incr i 1} {; # zero to one
      set Disp [expr $Disp + $dx];
      puts $outFileID $Disp
    }
    for {set i 1} {$i <= [expr 2*$Nsteps]} {incr i 1} {; # one to minus one
      set Disp [expr $Disp - $dx];
      puts $outFileID $Disp
    }
    for {set i 1} {$i <= $Nsteps} {incr i 1} {; # minus one to zero
      set Disp [expr $Disp + $dx];
      puts $outFileID $Disp
    }
  }; # end iCycle
  puts $outFileID " }"; close $outFileID
}; # end of proc

pattern Plain 2 Linear {; # Set lateral load pattern
  load $IDctrlNode 0. 100. 0. .; # Fx Fy Mz
}
```



cycle 3 times
zero to one

one to minus one

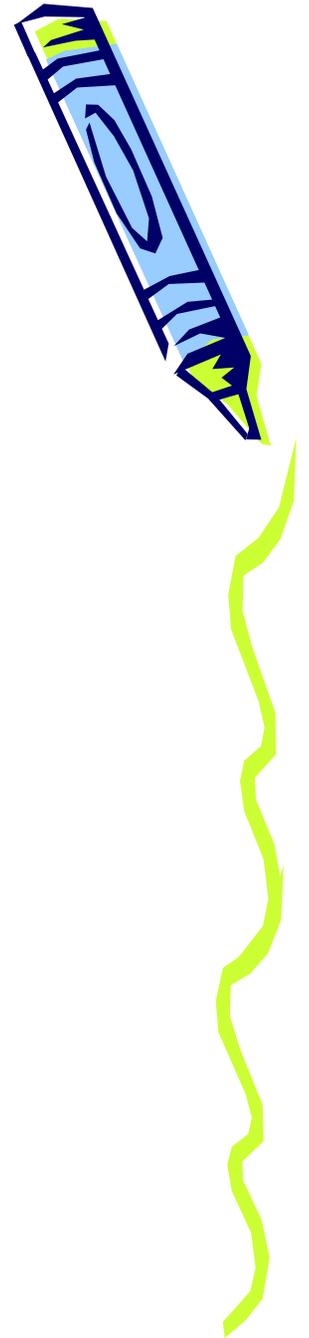
minus one to zero

recorder objects

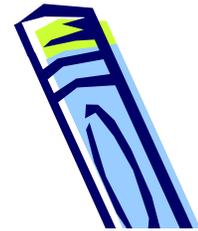
- Node Recorder
- EnvelopeNode Recorder
- MaxNodeDisp Recorder
- Drift Recorder
- Element Recorder
- EnvelopeElement Recorder
- Display Recorder
- Plot Recorder
- playback Command



Silvia Mazzoni
NEESgrid End-User Workshop 2005



output commands



```
# Record nodal displacements -NODAL DISPLACEMENTS
# ALL displs where load is applied and at free end of the beam
set iNode "$IDctrlNode $IDendNode";
foreach xNode $iNode {
    set Dfile DNode$xNode
    recorder Node -file $Dfile.out -time -node $xNode -dof 1 2 3
    disp;
}; # end of xNode
# Record vertical-y displacement of ALL nodes
set DfileALL DNodeALL
recorder Node -file $DfileALL.out -time -node all -dof 2 disp;

# Record REACTION FORCES - (=forces in element 1)
set iEL "1"
foreach xEL $iEL {
    set Ffile FEI[expr $xEL]
    recorder Element -file $Ffile.out -time -ele $xEL localForce
}; # end of xEL
```

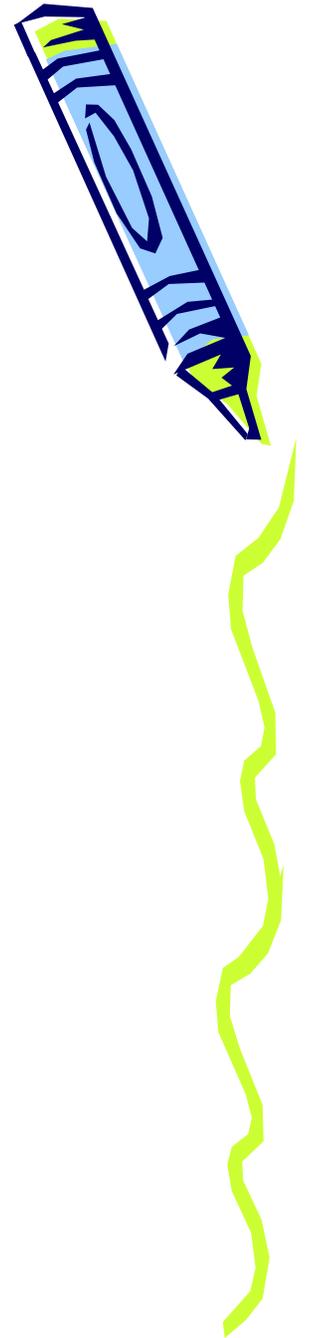


analysis objects

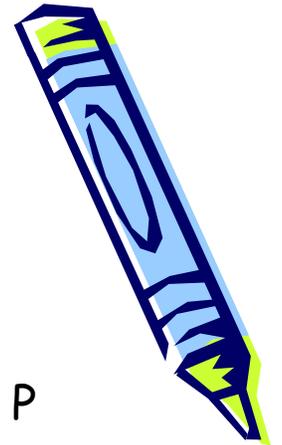
- constraints Command
- numberer Command
- analysis Command
- algorithm Command
- integrator Command
- system Command
- test Command
- analyze Command
- rayleigh command
- eigen Command
- dataBase Commands



Silvia Mazzoni
NEESgrid End-User Workshop 2005



analysis and solution

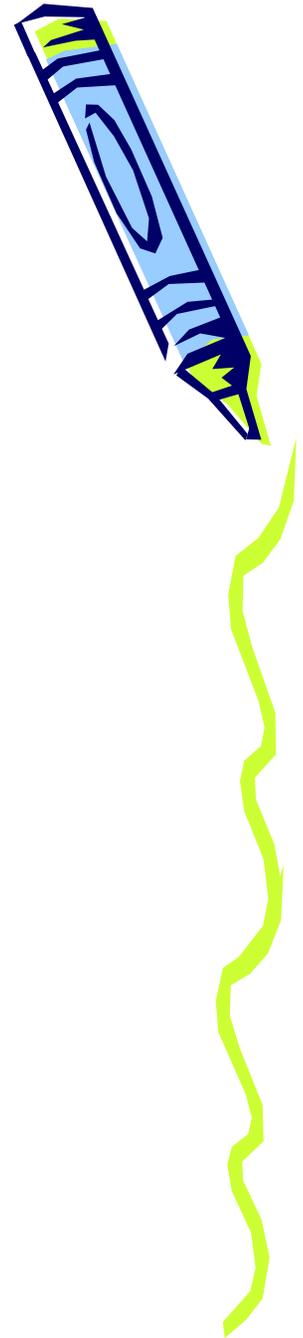


- system ProfileSPD;** # solve the linear system of equations $Ku = P$
- constraints Plain;** # Handle the constraints defined on the domain
- algorithm Linear;** # Iterate from the last time step to the current
- numberer Plain;** # number the degrees of freedom in the domain
- integrator LoadControl 0.1;** # determine the next time step for an analysis
- analysis Static;** # analysis type

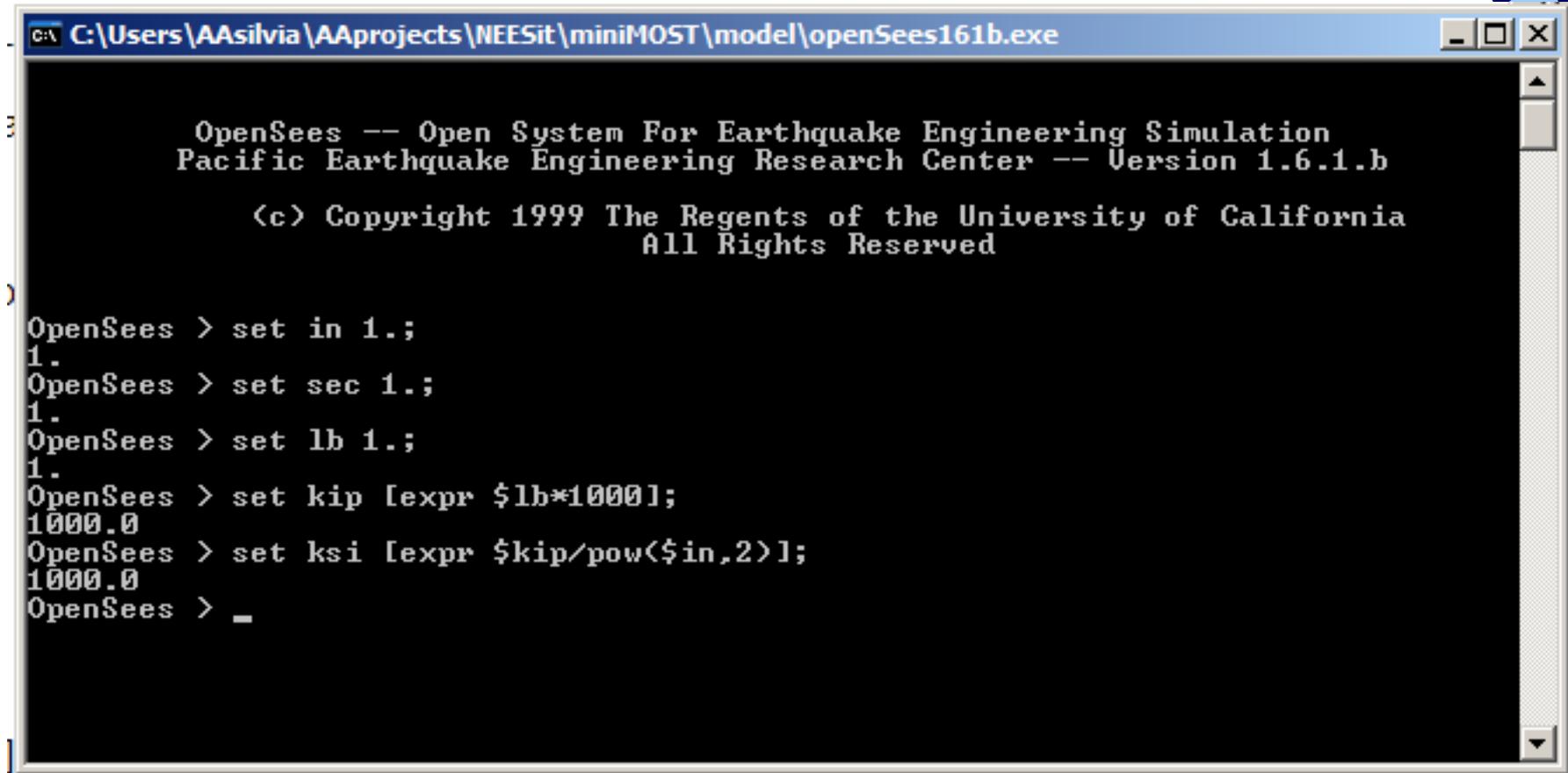


cyclical displacement solⁿ

```
set DOF 2
foreach Dmax $iDmaxCycl {
  set outFileID [open Dsteps.tcl w]
  genPeaks $Dmax $outFileID
  source Dsteps.tcl
  set D0 0.0
  foreach Dstep $iDstep {
    set D1 $Dstep
    set Dincr [expr $D1 - $D0]
    integrator DisplacementControl $IDctrlNode
    $DOF $Dincr 1 $Dincr $Dincr
    set ok [analyze 1]
    set D0 $D1
  }
}; # end of iDmaxCycl
```



interactive execution

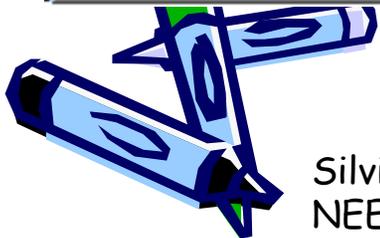


```
C:\Users\AAsilvia\AAsilvia\AAprojects\NEESit\miniMOST\model\openSees161b.exe

OpenSees -- Open System For Earthquake Engineering Simulation
Pacific Earthquake Engineering Research Center -- Version 1.6.1.b

(c) Copyright 1999 The Regents of the University of California
All Rights Reserved

OpenSees > set in 1.;
1.
OpenSees > set sec 1.;
1.
OpenSees > set lb 1.;
1.
OpenSees > set kip [expr $lb*1000];
1000.0
OpenSees > set ksi [expr $kip/pow($in,2)];
1000.0
OpenSees > _
```



Silvia Mazzoni
NEESgrid End-User Workshop 2005

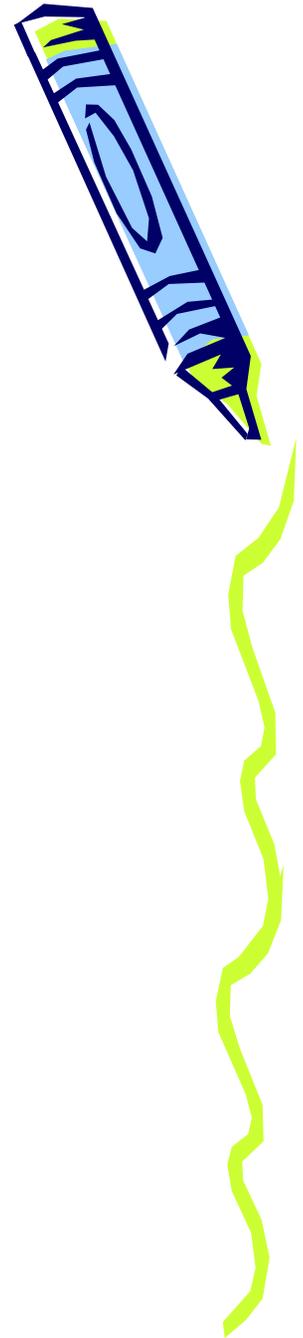
matlab post-processing

```
cd ..... \model\data
% UNITS: pound, inch, sec
load DNode2.out
load DNode3.out
load DNodeAll.out
load FE1.out

figure
subplot(2,1,1)
plot(DNode2(:,3));
title('Y-displacement at node 2')
xlabel('step')
ylabel('inch')
grid
subplot(2,1,2)
plot(DNode2(:,4));
title('Rotation at node 2')
grid
xlabel('step')
ylabel('radian') .....
```

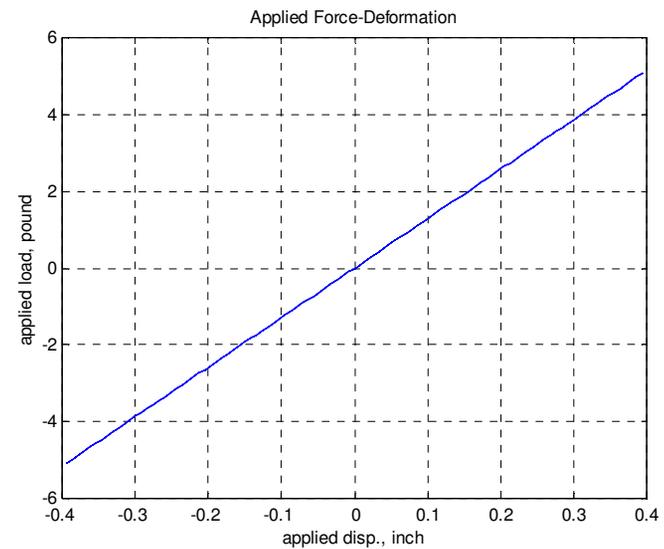
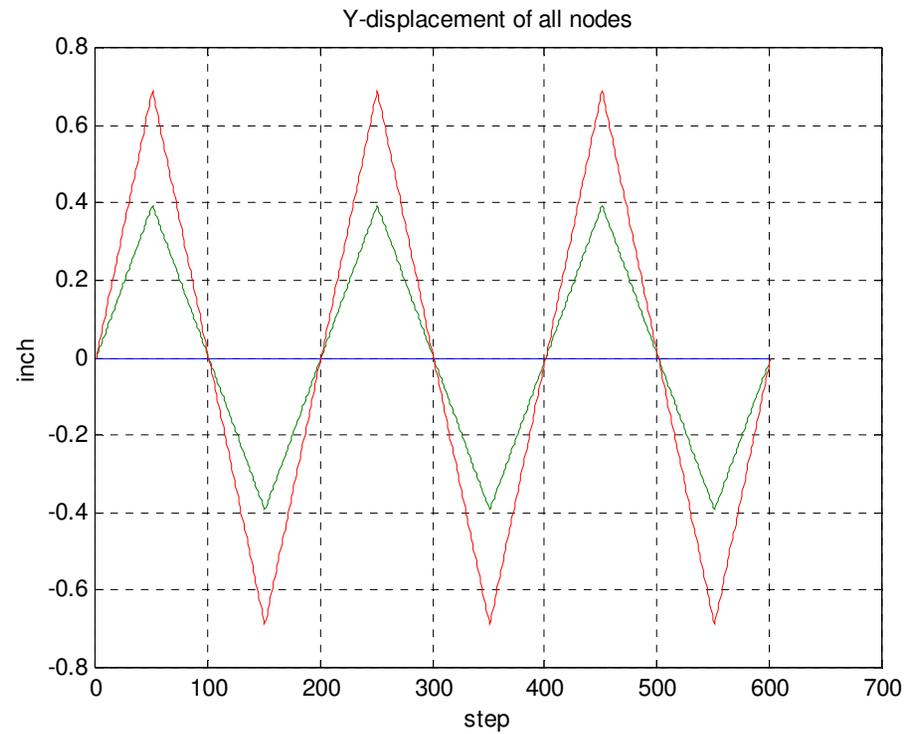
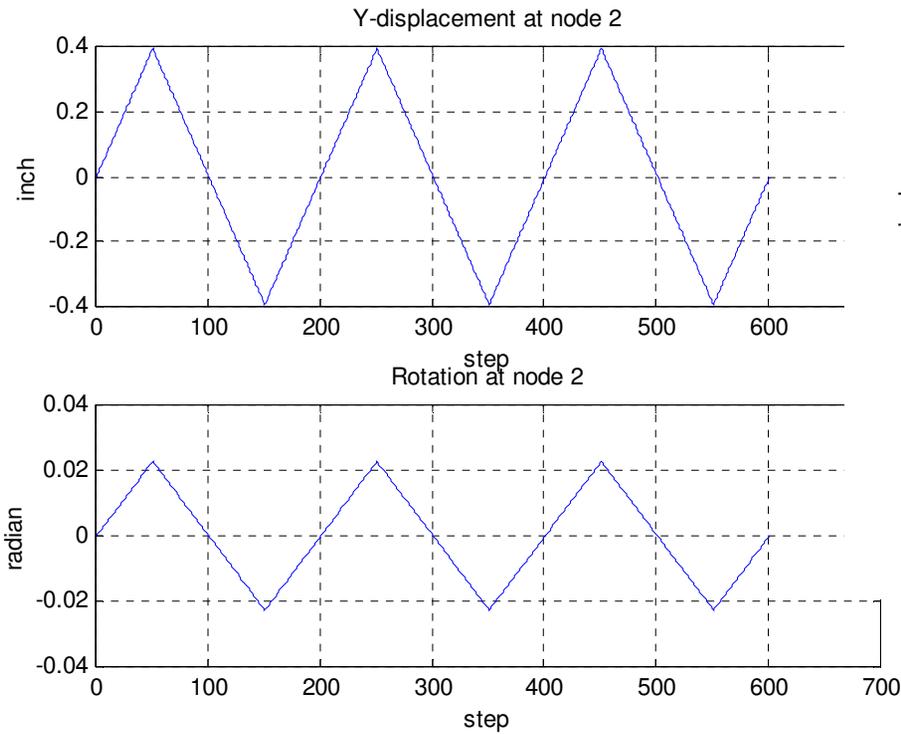


Silvia Mazzoni
NEESgrid End-User Workshop 2005





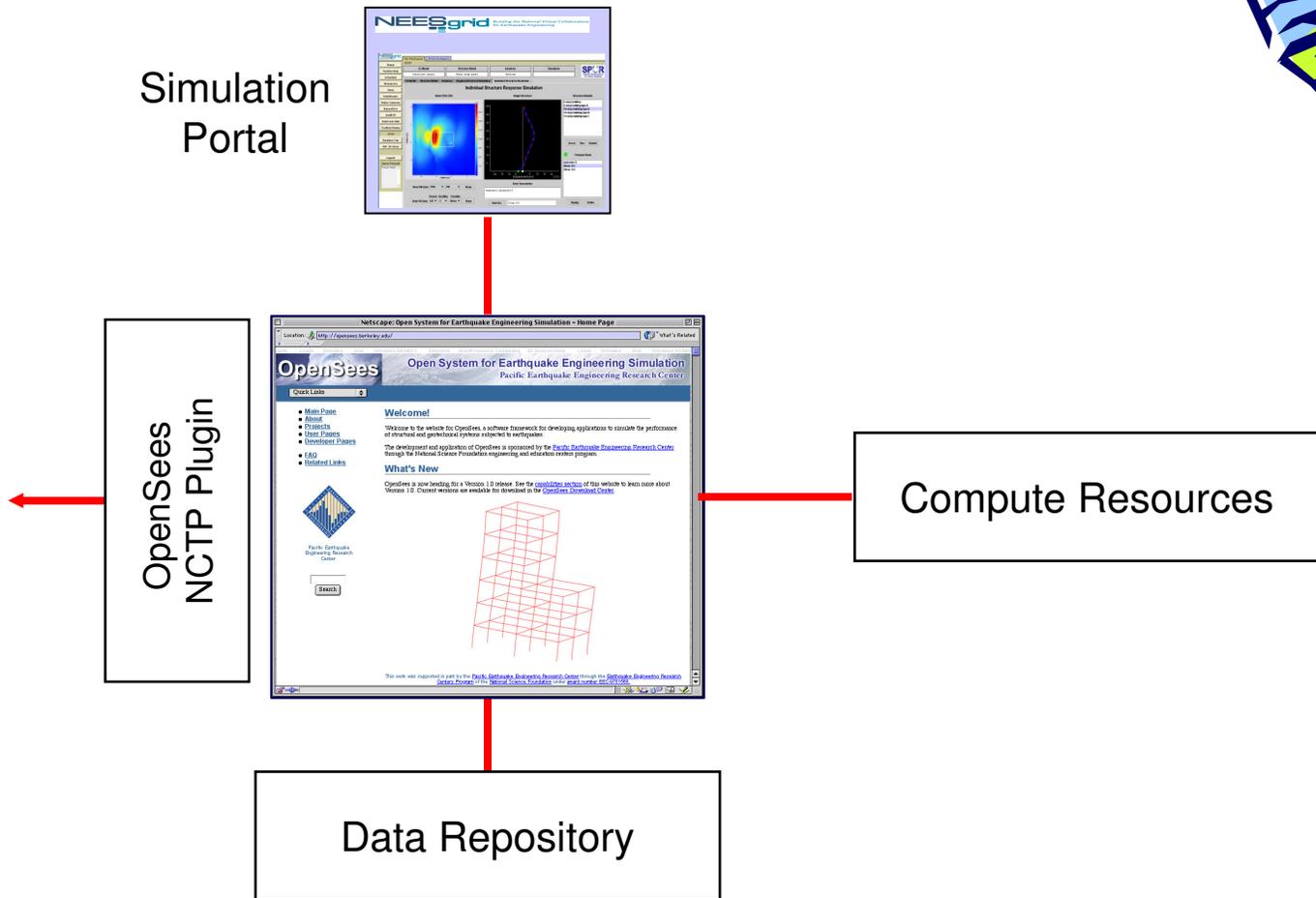
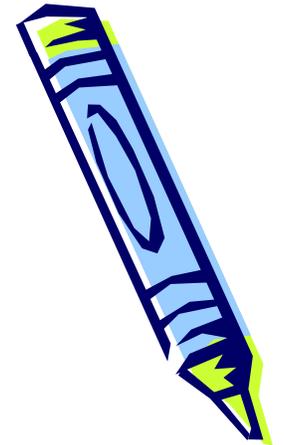
figures



Silvia Mazzoni
NEESgrid End-User Workshop 2005

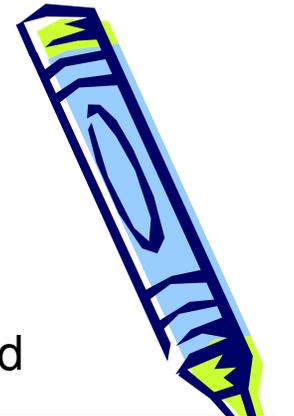


NEESit Simulation Overview

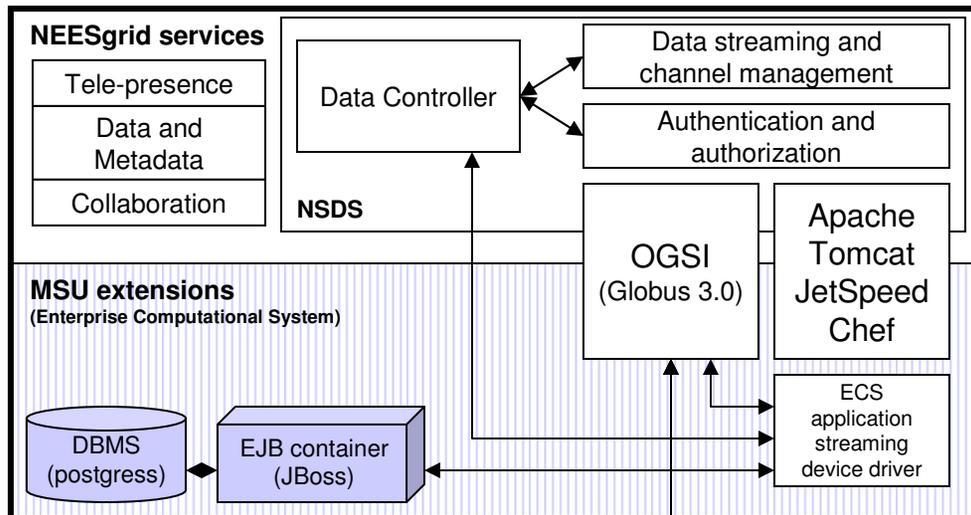


Silvia Mazzoni
NEESgrid End-User Workshop 2005

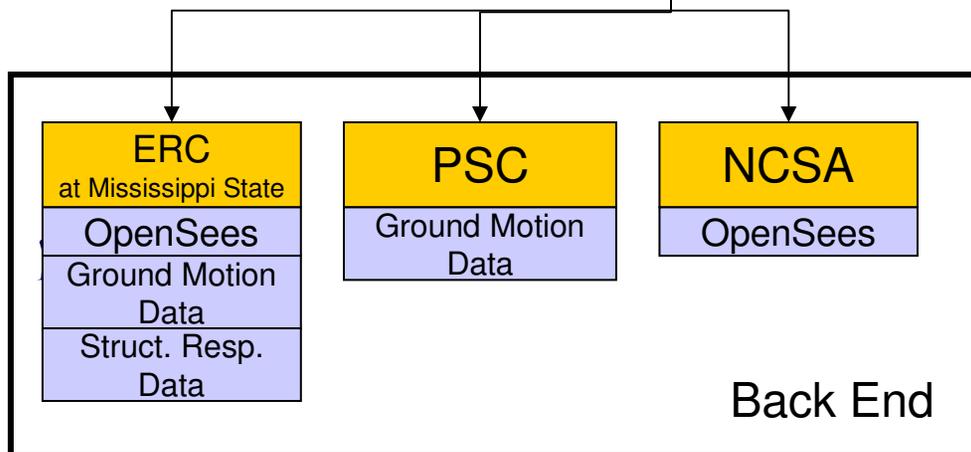
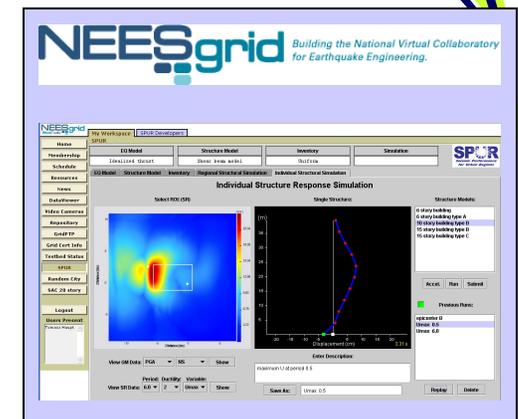
SPURport Architecture



NEESpop (middleware)

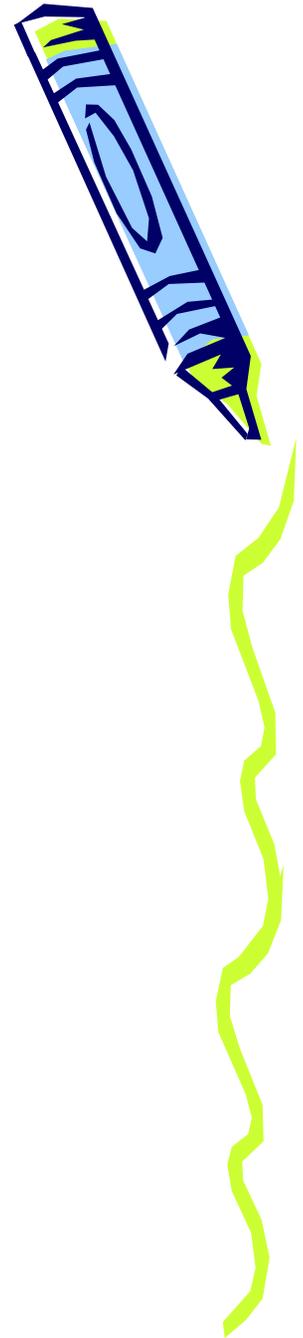


Front End



Fedeas^{Mat}Lab Toolbox for Structural Simulation

- Need for Matlab toolbox in NEES.
 - Research
 - Education
- Relationship between FedeasLab and OpenSees.



Silvia Mazzoni
NEESgrid End-User Workshop 2005

Questions, or statements!

The OpenSees Community Forum:

<http://opensees.berkeley.edu/phpBB2/index.php>

which can be accessed from:

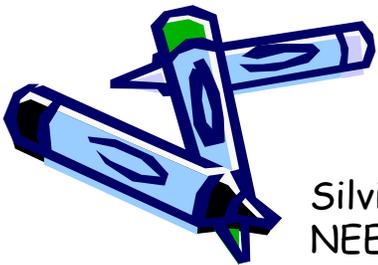
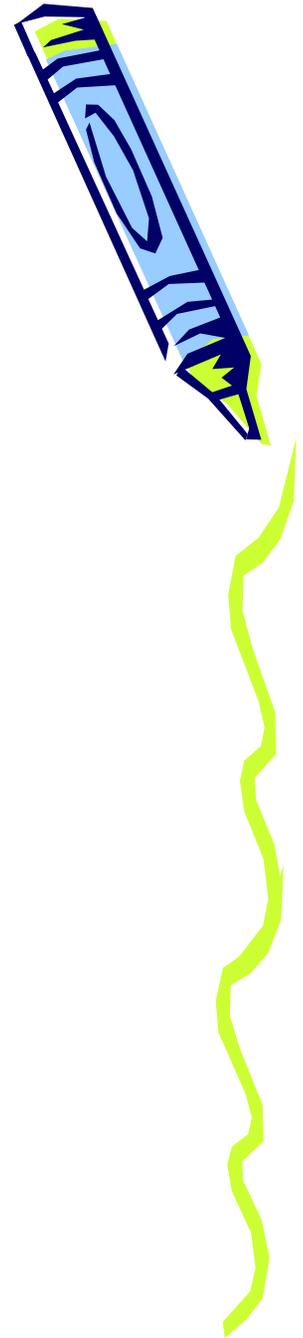
<http://opensees.berkeley.edu>



Silvia Mazzoni
NEESgrid End-User Workshop 2005



thank you!!!



Silvia Mazzoni
NEESgrid End-User Workshop 2005