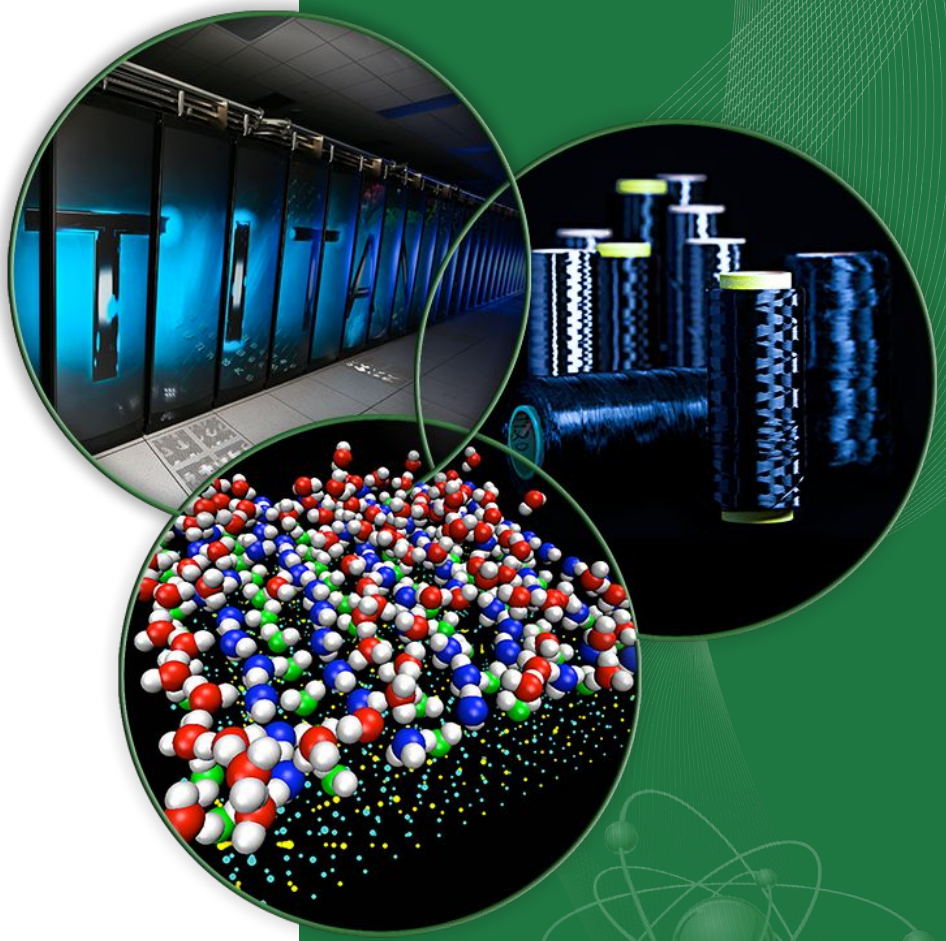
Introduction to the Eclipse Advanced Visualization Project



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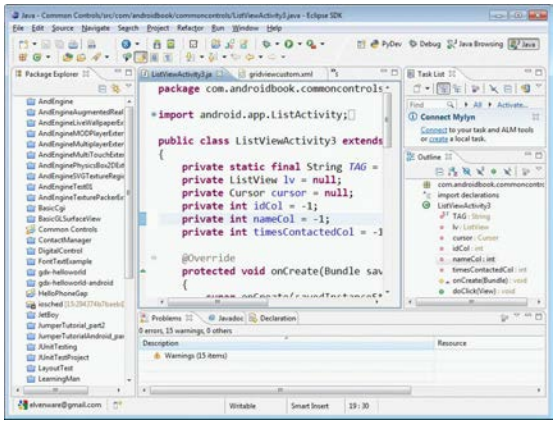
Outline

- Introduction to Eclipse
- Motivations for scientific visualization in Eclipse.
- Example visualization services
  - Graph plotting
  - VisIt and ParaView
  - Geometry and Mesh editing with JavaFX
- Setting up remote connections
- Future Developments

What is Eclipse?

- An Integrated Development Environment(IDE).
- A foundation.



- A community.

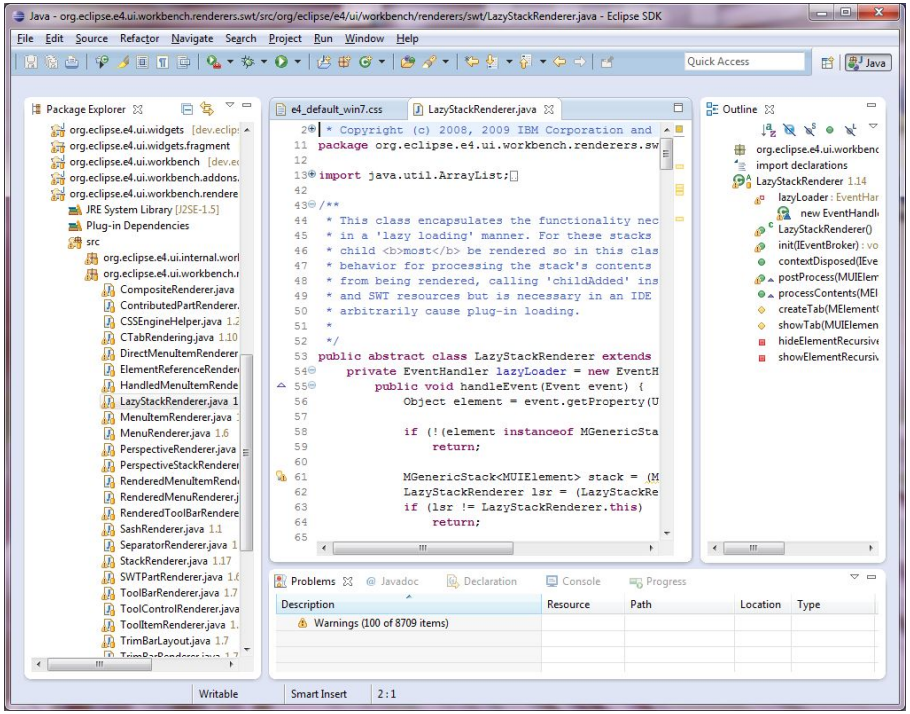
eclipsecon
France 2017

- A place for Research Software Engineers

What is the Eclipse Foundation?

- Managed by the Eclipse foundation.
- Not-for-profit corporation that maintains the Eclipse ecosystem
- Members include ORNL and other industry leaders like IBM, Oracle, and Red Hat
- Projects are official initiatives of open source development to benefit the community.
- Working Groups collaborate on focused development.

What is the Eclipse Workbench?



Java source code being edited in the Eclipse workbench.

- Uses the Open Service Gateway Initiative(OSGi) to manage the modular packages that make up the application.
- Provides the Rich Client Platform(RCP) as a way to extend the workbench to create custom apps by writing new OSGi plugins.
- Open source.
- Written in Java.

Motivation

Motivation for Integrating Visualization into a Workbench

- Simulation workflows span from writing code to visualizing results.
- Having a single RCP app which centralizes and simplifies all these actions would provide a useful tool for scientists.
  - Provides a convenient place for performing all parts of the workflow
  - Allows for use case specific knowledge to aid in workflow design (for e.g. error checking).

Motivation for Integrating Visualization into a Workbench

- …But other, non-traditional use cases exist for which the ability to visualize files would be useful.
- The **Eclipse Advanced Visualization Project (EAVP)** was created to provide a framework of visualization resources for diverse RCPs.
- It has been evaluated by:
  - Marintek for creating oceanographic geometry.
  - Bosch evaluated it for use in visualization of automobile parts.
  - As well as Diamond, Itema, and Airbus
-

EAVP Overview

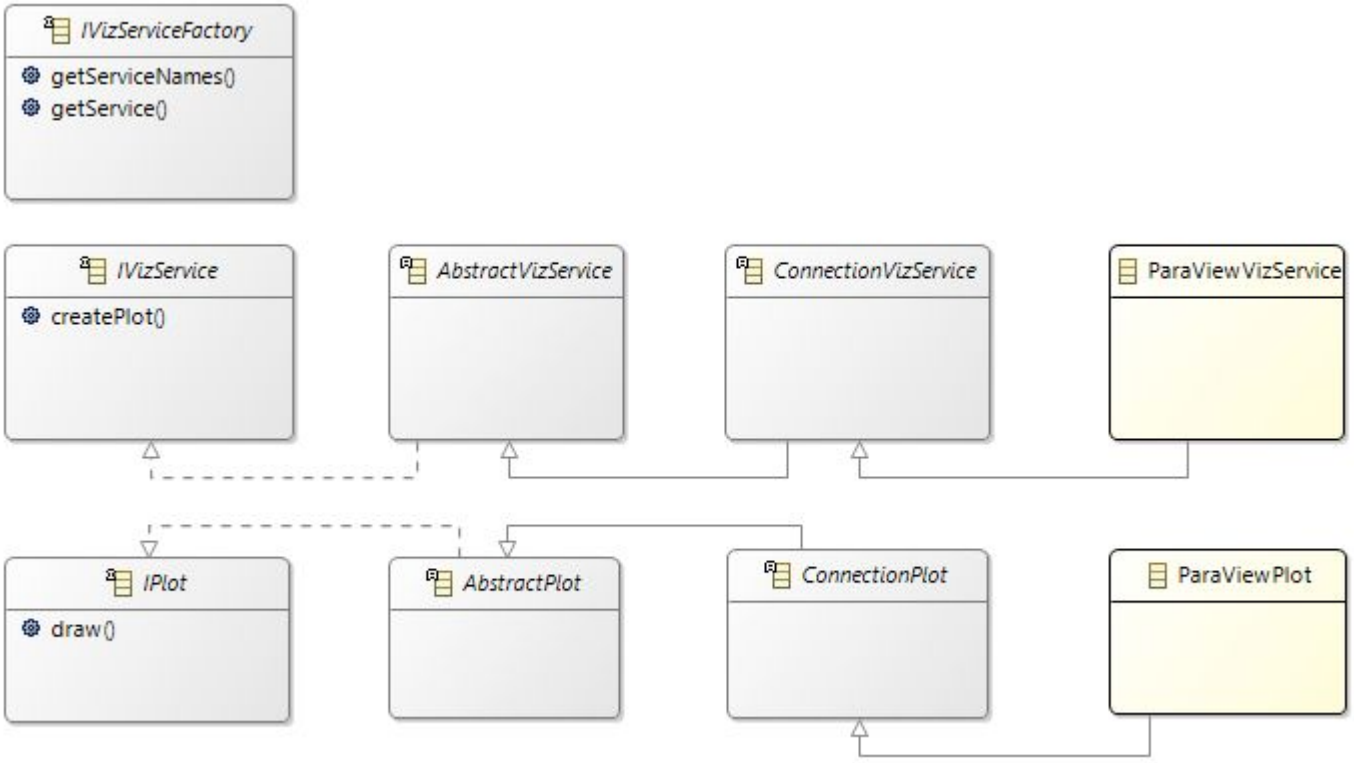
What is EAVP?

- EAVP features a range of services for different kinds of visualization use cases.
- Provides a flexible API for integrating visualizations.
- Native visualizations in Eclipse SWT and embedded JavaFX.
- Third party visualizations.
- Published as a p2 repository to be drawn into RCP applications.

Visualization Service Architecture

- Each type of visualization is implemented as its own OSGi bundle.
- Bundles contain an implementation of IVizService that can draw the visualization to a composite.
- The RCP app can select which visualization capabilities it wants by finding the right IVizService.
- Bundles may also contain extensions to the preferences menu to allow the user to configure the service.

Visualization Service Architecture



Leveraging EAVP Services to Visualize Files in the Workspace

- Visualizing a file is as simple as handing it to the correct service
- Each IVizService provides a list of compatible file types.
- Invoking createCanvas() or createPlot() returns an IVizCanvas or IPlot.
- Using .draw() will draw it to a composite.

Setting Up Connections to Third Party Software

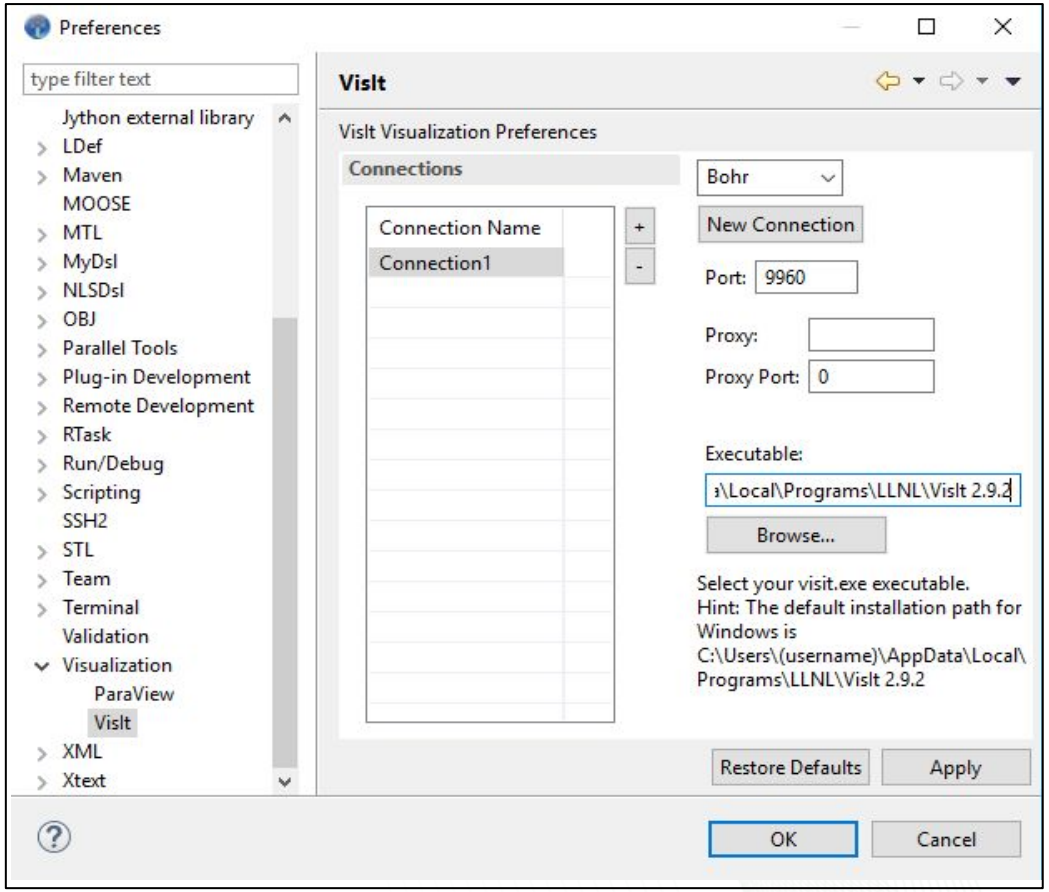
Connections to local or remote machines are supported.

Local visualization

Remote visualization

Setting Up Connections to Third Party Software

- Preference menu contributions configure connection
- Uses the parallel tool platform's connections as a base.
- Can be configured to open connections automatically on startup.



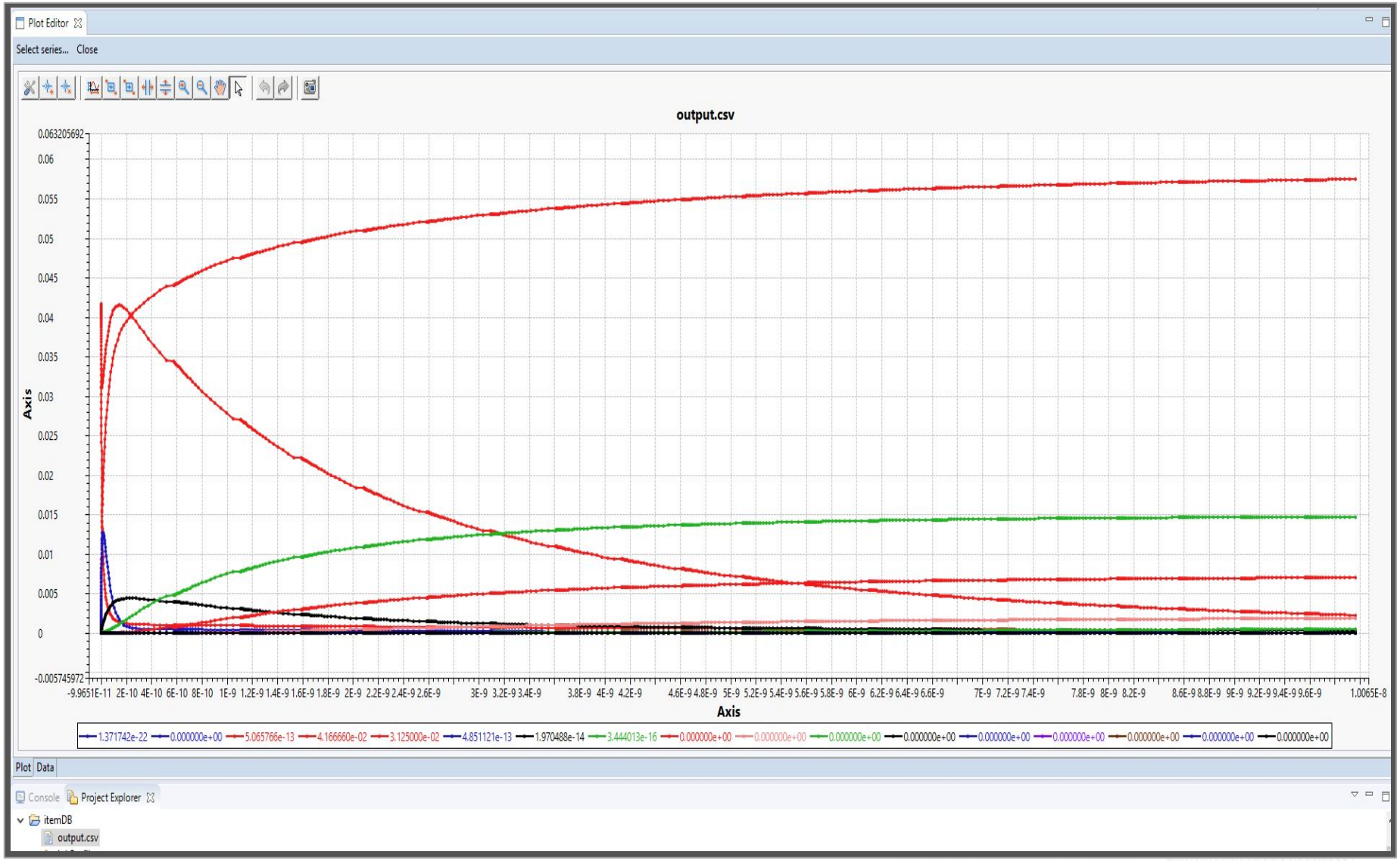
Preferences Menu in Workbench

Examples - 2D Plotting

2D Plotting

- The simplest example of a visualization service is the CSV graph implemented with SWT-XY-Graph.
- The service takes a .csv or .dat file as input.
- Parses the file to try to guess the delimiter.
- Draws a plot containing the file's data to the given composite.
- Has controls for editing how the graph is displayed.
- Also includes the data from the file in a text editor.

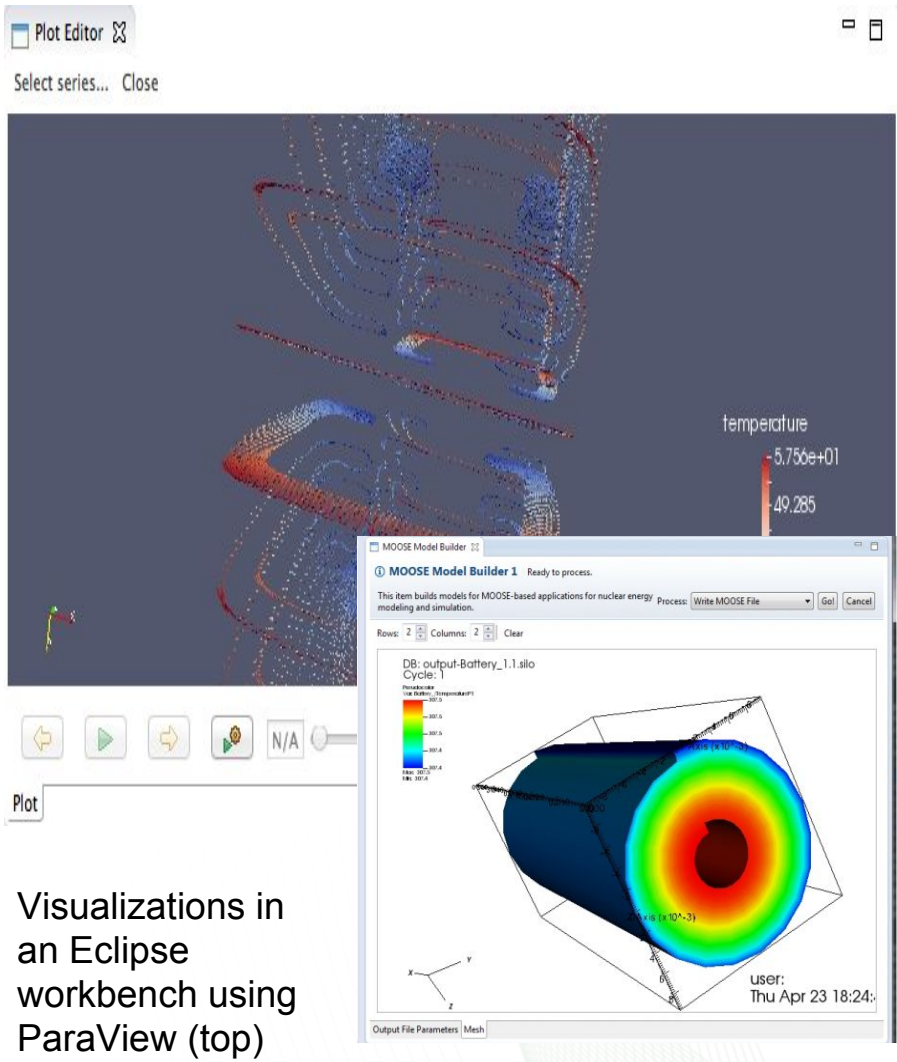
2D Plotting



Examples - VisIt and Paraview

VisIt and ParaView Integration

- VisIt and Paraview are two of the most popular visualization programs for scientific data.
- Open source.
- Scale to visualizing even HPC data.
- Handle a large variety of file types, including .exo, .gen, .nemesis, .silo, .nek5000, and .xyz

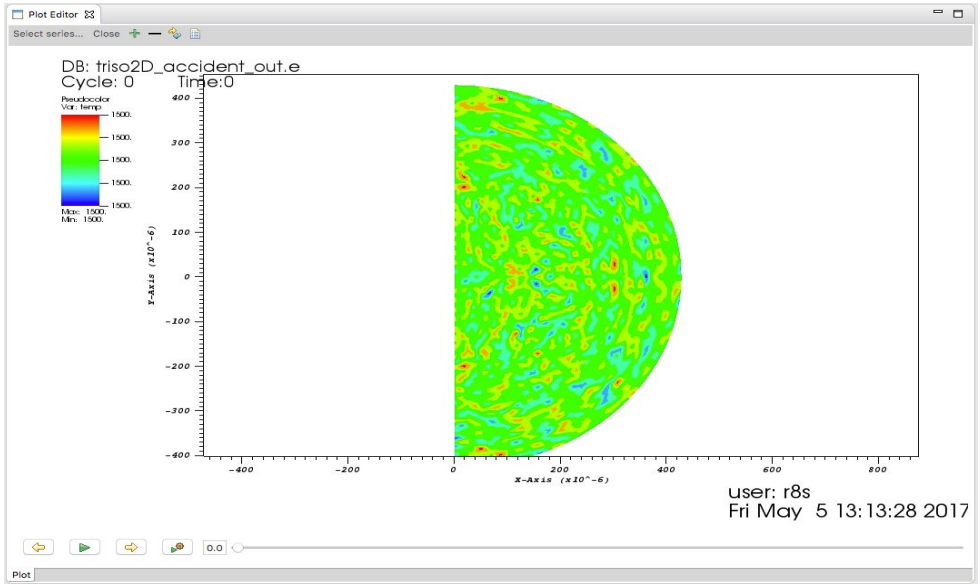


Visualizations in an Eclipse workbench using ParaView (top) and VisIt (right).

VisIt and ParaView Integration

- VisIt/ParaView must be downloaded and installed separately from Eclipse, not necessarily on the same machine.
- The EAVP service allows the user to configure a connection to the third party program.
- When the connection is opened, EAVP will launch VisIt/ParaView in the background.

VisIt and ParaView Integration

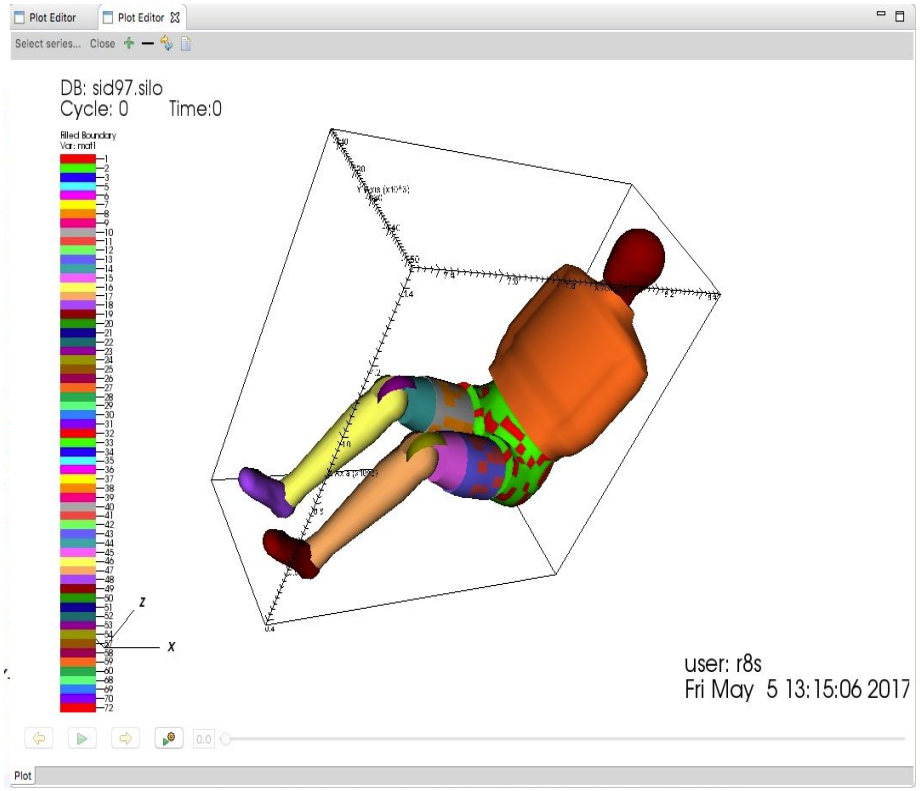


Temperature map for a tristructural-Isotropic fuel pellet, visualized in VisIt.

- When EAVP is set to visualize a file, it will pass the file to VisIt/ParaView.
- The visualization program will open the file and create a model as normal. Images are sent back to Eclipse to paint to the screen.

VisIt and ParaView Integration

- Interacting with the canvas (eg by clicking and dragging) sends commands to program.
- Other functionality (such as setting the model type or exposing Python scripting) done through UI.



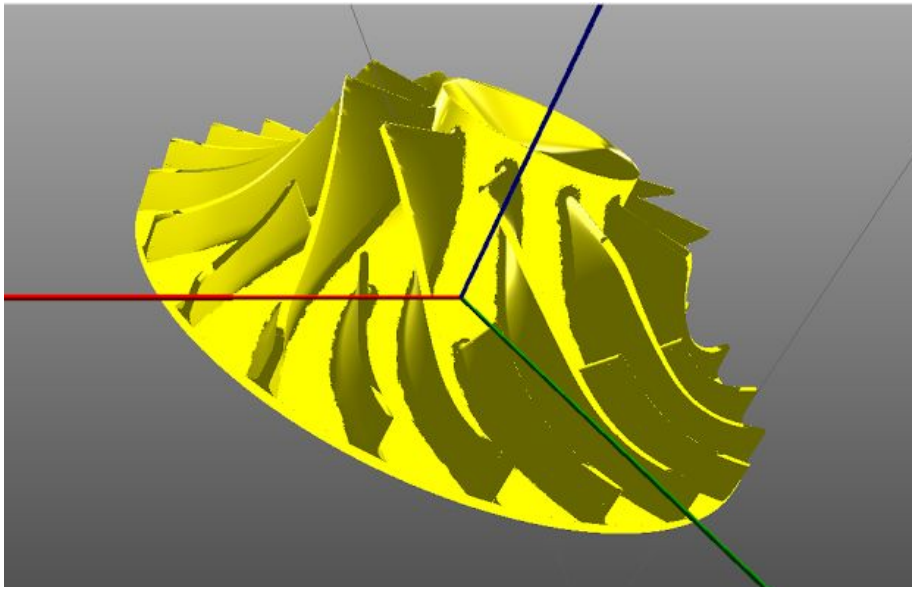
A crash test dummy model in VisIt.

Examples - 3D Modeling in Java FX

3D Modeling with JavaFX

- JavaFX allows for displaying a 3D graphics scene.
  - Shipped as part of the JDK.
  - Lacks potential copyright problems from e.g. LWJGL.
- Intended for casual development without advanced graphics features (eg direct shader support, access to matrix transforms, custom vertex stream configuration, etc.)
- Better suited to real time editing than heavy duty visualizers.

3D Modeling with JavaFX: Technical Concerns



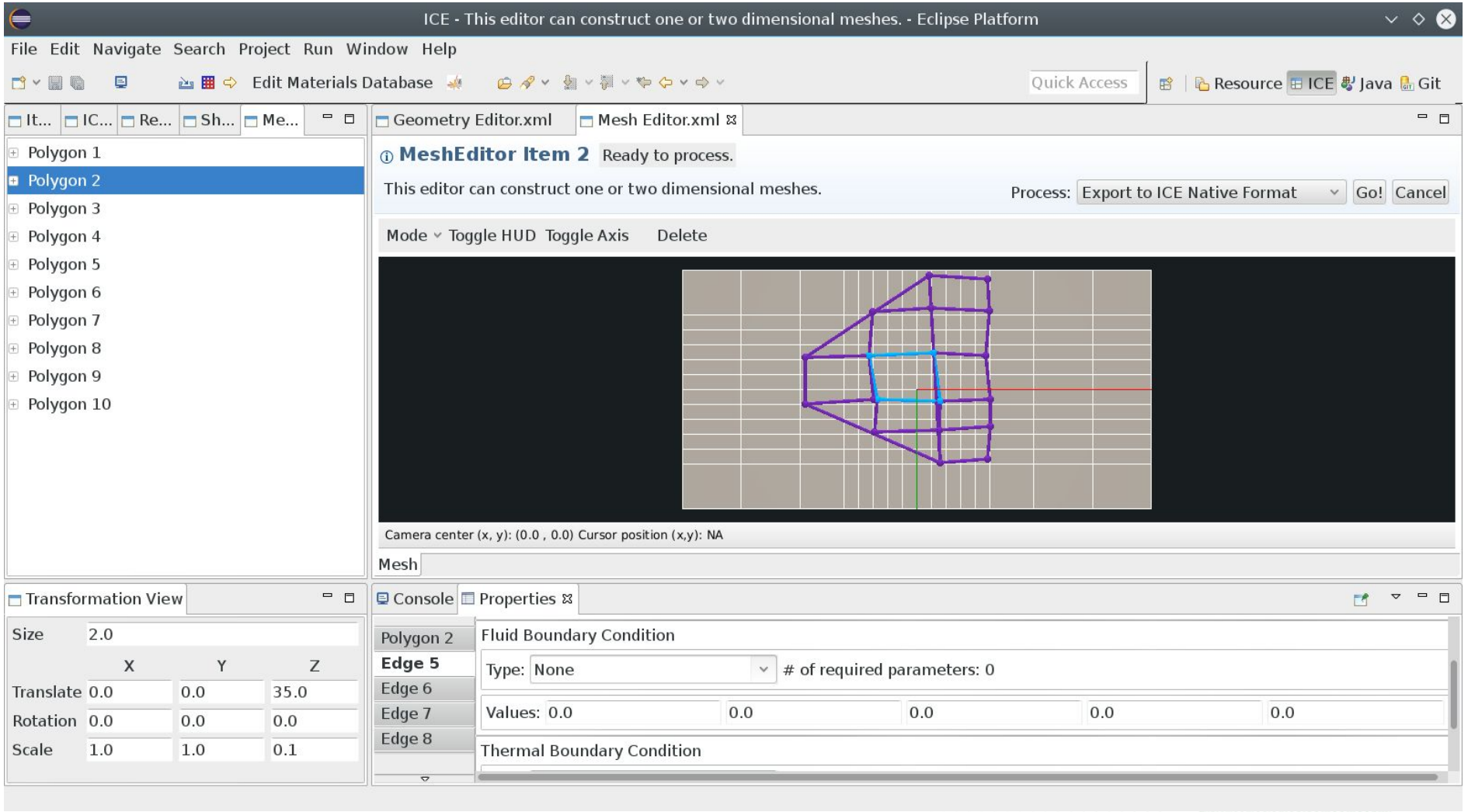
A fluid impeller modeled in the Geometry Editor.

- e(fx)clipse project integrates it with Eclipse.
- A JavaFX scene is embedded directly into a Eclipse SWT composite.
- User events are transparently forwarded to scene.

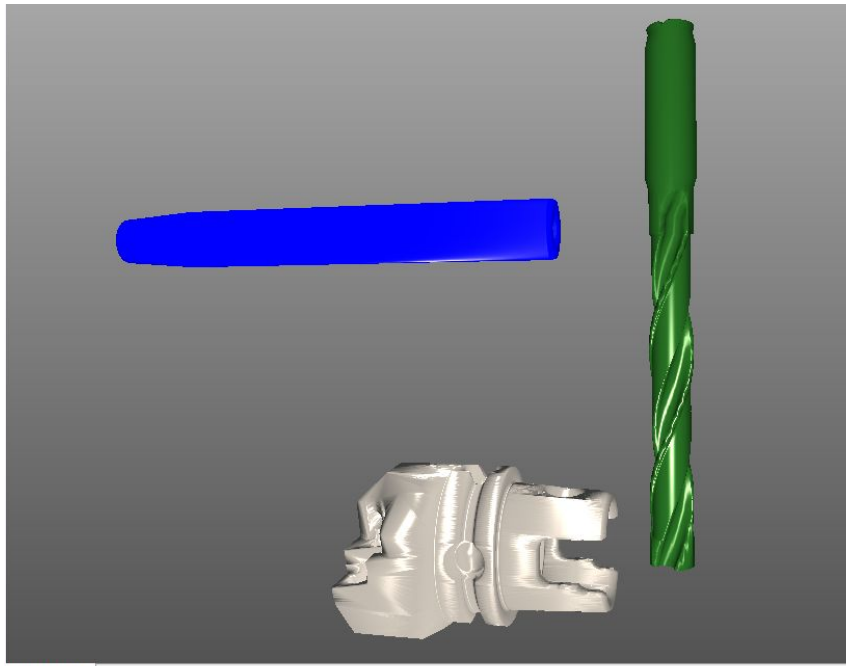
3D Modeling with JavaFX: Mesh Editor

- Mesh Editor allows for editing of 2D meshes.
- User may create new polygons by clicking.
- Existing meshes can be edited either by mouse or through the properties view.
- Properties may be assigned/edited for polygons/lines/points.
- Currently limited to fluid dynamics boundary conditions

3D Modeling with JavaFX: Mesh Editor



3D Modeling with JavaFX: Geometry Editor



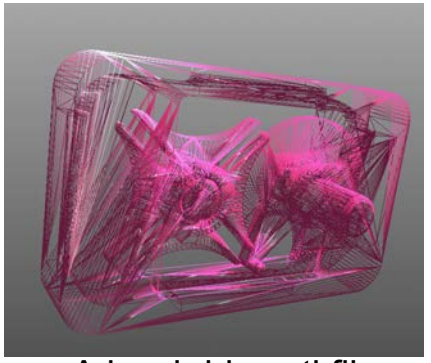
Shrinker, drill bit, and fastener in the geometry editor

- Geometry Editor is an editor for 3D structures.
- Uses constructive solid geometry.
- Provides basic sample shapes, but main use is importing geometry files.

3D Modeling with JavaFX: Geometry Editor

- Supports a variety of file types (.stl, .obj, .vtk, .mtl, .iges)
- Files are read through Xtext DSLs provided through Eclipse extension points.
- Related data structures for file reading have been moved to the January Eclipse project.

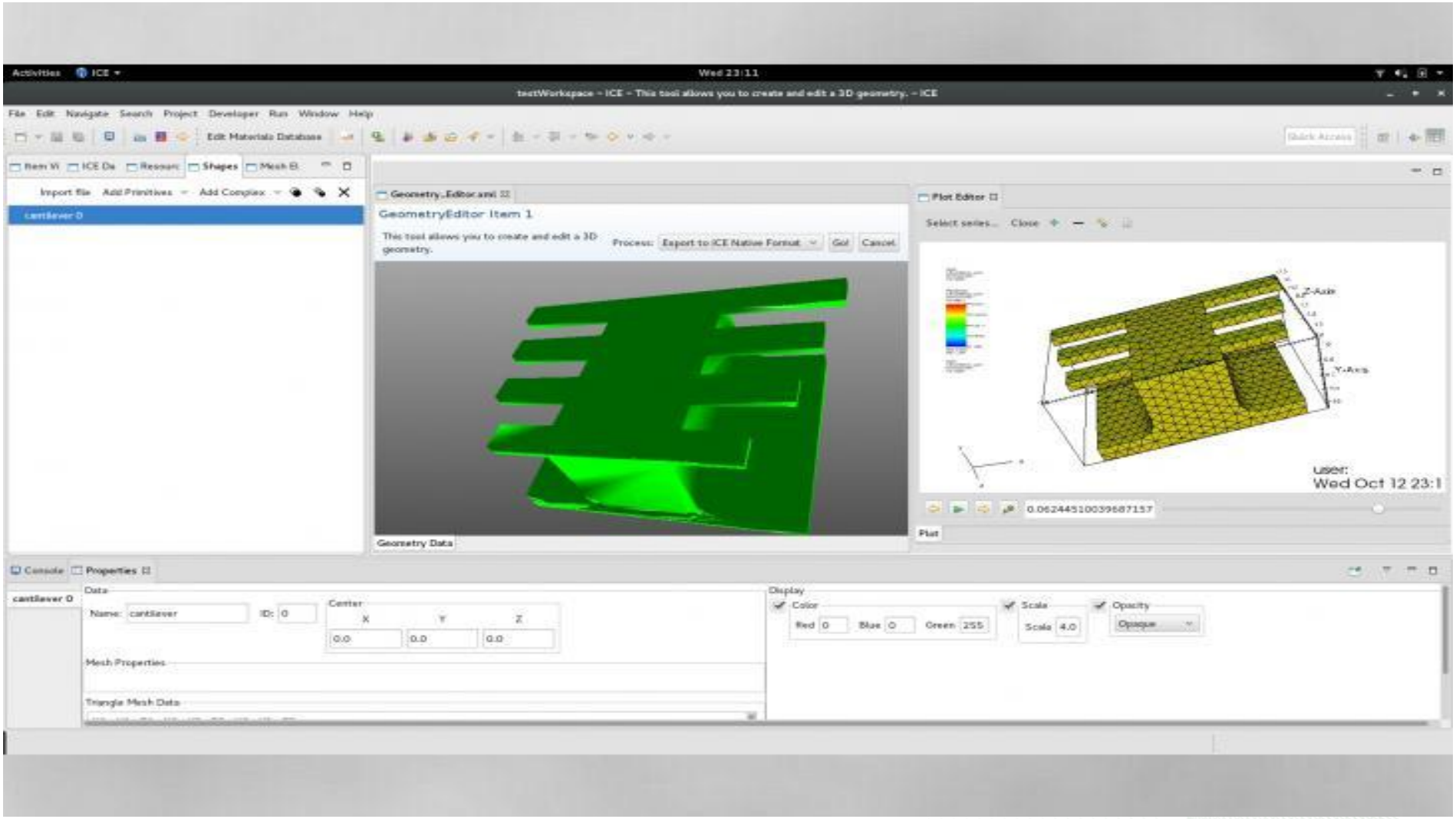
A teapot obj file



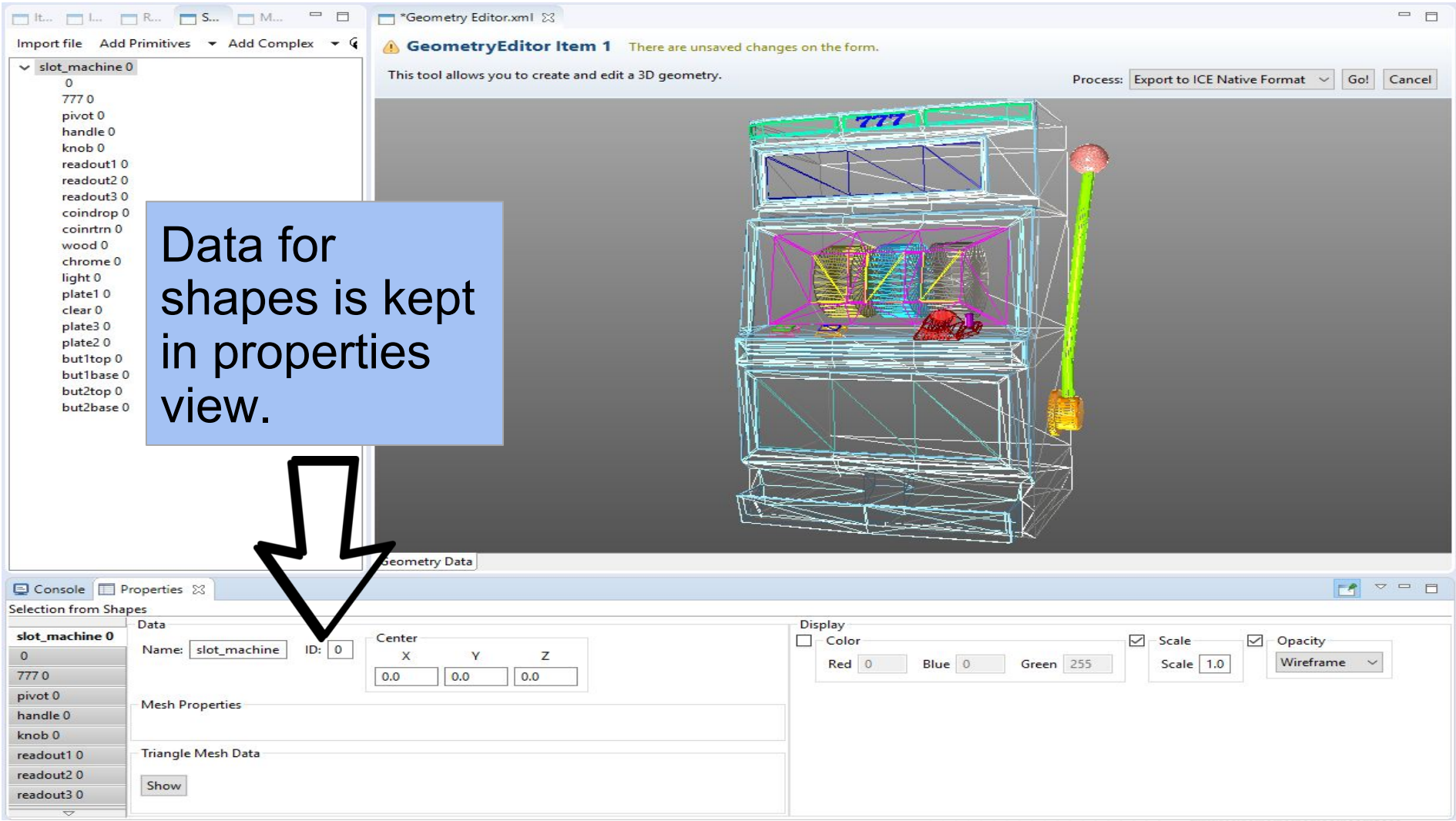
A hard drive stl file

“VTK” spelled out by a vtk file

3D Modeling with JavaFX: Geometry Editor



3D Modeling with JavaFX: Geometry Editor



Future Developments

- Integration with the Eclipse Advanced Scripting Environment(EASE) to allow interoperability between the visualizations and Python scripting.
- Expand to cover use cases outside of Eclipse RCP, with a focus on working on the web.
  - Vaadin framework
  - Swing
  - JavaFX

More Future Work…

- Offering alternate graphical engine implementations for services.
- In Situ visualization support.
- Full 3D mesh editing and better finite element support.
- Paper under development

Questions?

- Thanks to…
  - Our research sponsors.
  - My colleagues at ORNL who have contributed to EAVP, including Jay Jay Billings, Alex McCaskey, Greg Watson, and Anara Kozhokanova
  - Sandia National Laboratory for collaboration with the Sandia Analysis Workbench(SAW).
  - Chemclipse for providing a SWTChart visualization service.
  - L33t Labs for collaboration on JavaFX Geometry Editor.

Links and Getting Started

EAVP Project Page
http://projects.eclipse.org/projects/science.eavp

GitHub Repo
https://github.com/eclipse/eavp

OSGi Beginner's Tutorial for consuming visualization services
https://wiki.eclipse.org/EAVP_Service_Integration