Center for Active Learning of Microelectronics and Photonics

Java Enabled Opto-Electronic Learning Tools

and A Supporting Framework

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Motivation

- Java Applets for supplementary instructional material
  - Extend the power of Java and the Internet to educational tools
  - Present information in a more visually appealing manner
  - Create a dynamic and stimulating learning environment
  - Address various learning styles in students

- Develop a supporting software framework that
  - Provides guidelines for developing ideal instructional tools
  - Follows good software design and development practices
  - Captures the experience of instructors and software developers
  - Helps instructors to effortlessly develop educational applications(Applets)

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Teaching and Learning Styles

Preferred Learning Style		Corresponding Teaching Style	
Sensory Intuitive	*Perception*	Concrete Abstract	*Content*
Visual Auditory	*Input*	Visual Verbal	*Presentation*
Inductive Deductive	*Organization*	Inductive Deductive	*Organization*
Active Reflective	*Processing*	Active Passive	*Student Participation*
Sequential Global	*Understanding*	Sequential Global	*Perspective*

Dimensions of Learning and Teaching Styles
(Felder and Silverman (1988)).

Educational Applets address the styles appearing in blue.

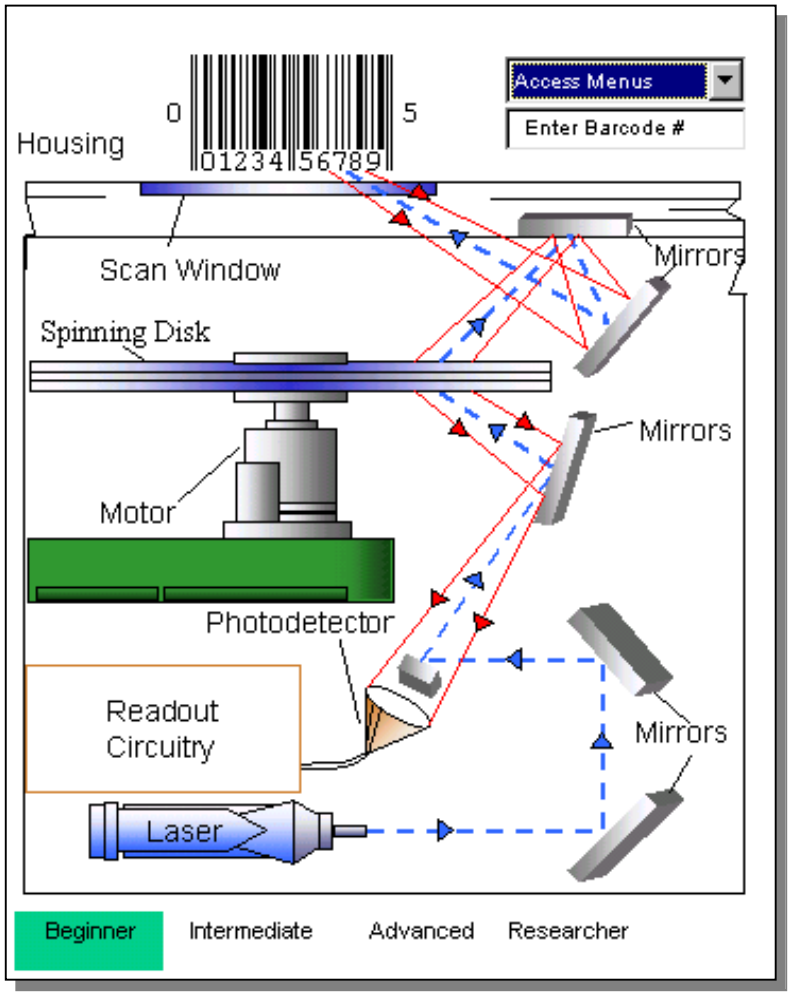
Teaching and Learning Styles

- To address various learning styles, instruction should
  - Introduce new concepts by building on fundamental principles
  - Help visualization of complex systems
  - Facilitate context based learning with demonstrations of real life scenarios
  - Encourage experimentation
  - Call for understanding information in a global context

Educational Java Applets and Learning Styles

- Educational Java Applets
  - Provide user configurable and data probing tools to help inductive style of learning
  - Promote global understanding of large-scale systems using context based case studies
  - Explain complex systems using vivid simulation schematics to favor visual learners

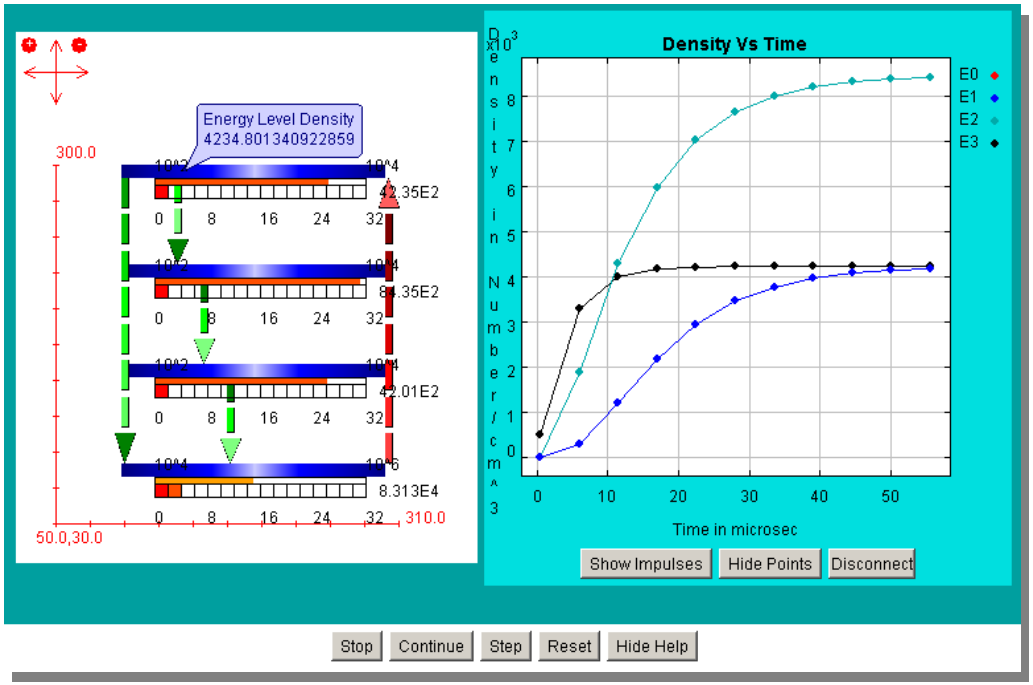
Bar Code Scanner



Educational Java Applets and Learning Styles

Gain Mechanism (Rate Equations)

- Educational Java Applets
  - Provide helpful demonstrations of theoretical concepts
  - Provide virtual experimentation
  - Provide graphical interfaces to allow active learners to dynamically change the behavior of the system

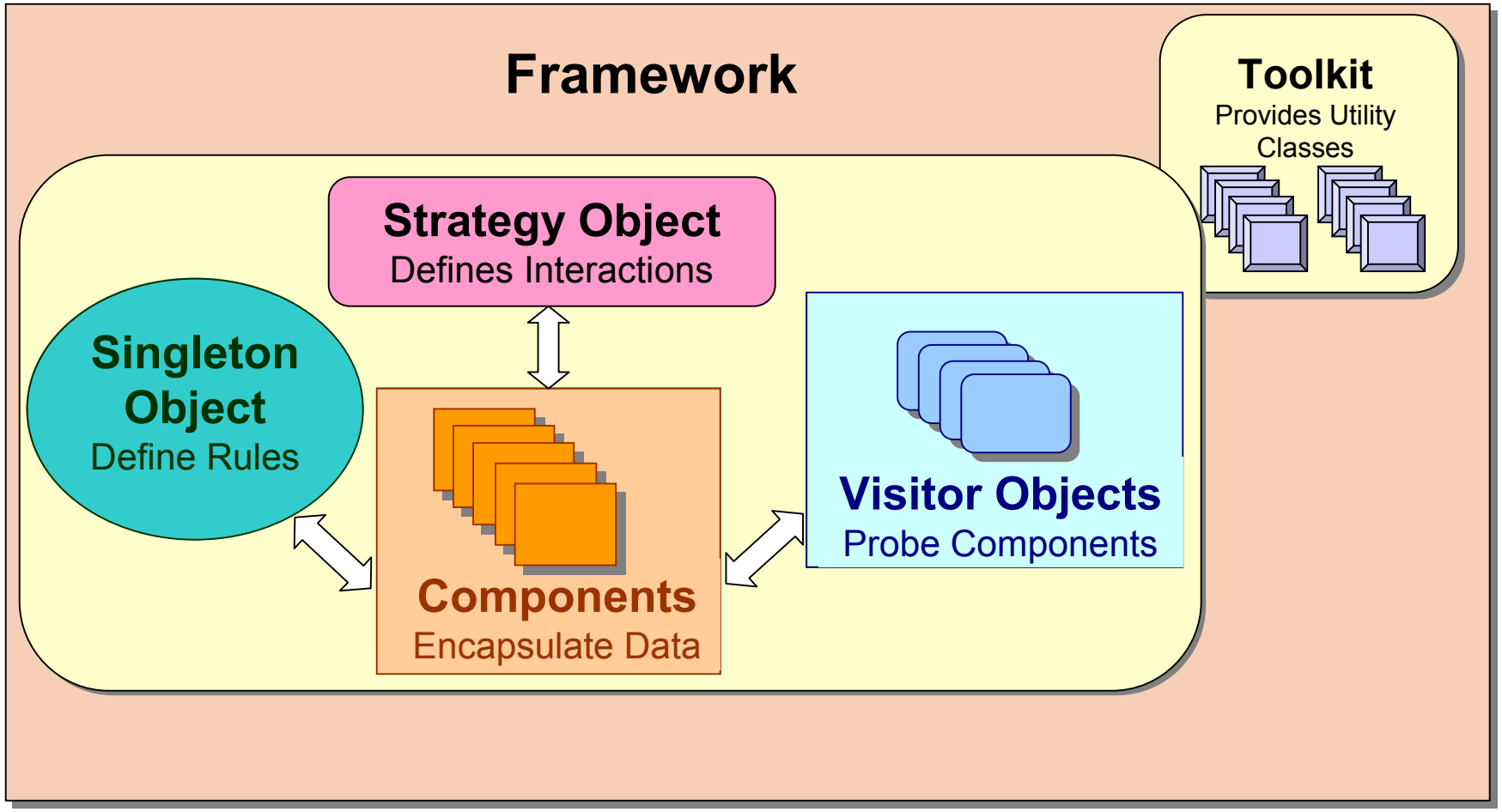


Applets when used in conjunction with traditional lectures help approach an ideal teaching style

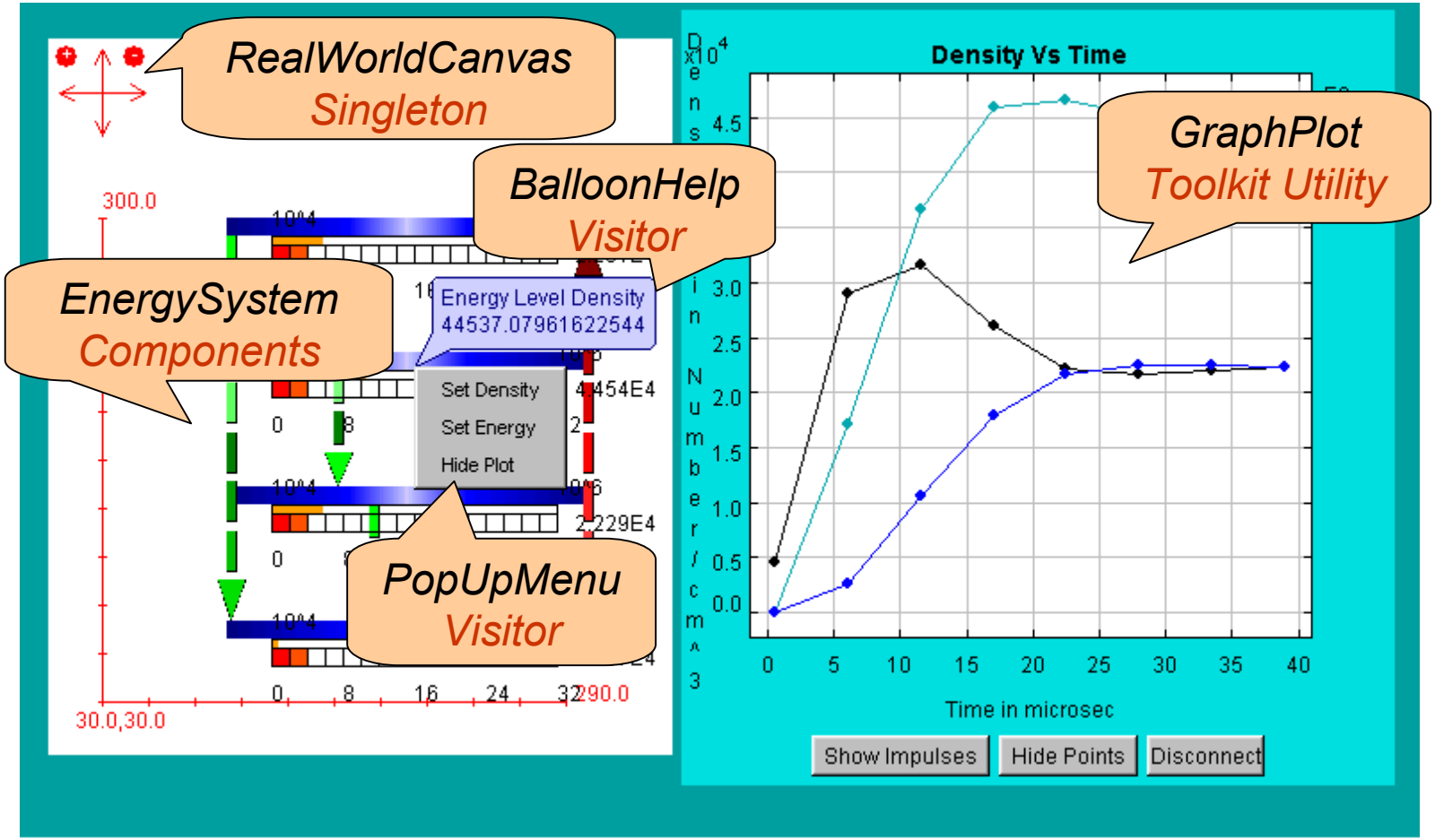
OOD : Design Patterns and Frameworks

- Essence of true Object Oriented Software
  - Simplicity, Modularity, Reusability, Extensibility
- OO languages provide implementation support
- Design Patterns Provide:
  - Insights required for making reusable software
  - Experiences required for Robust and Scaleable solutions
- Frameworks
  - Collection of domain specific design solutions
  - OO reuse technique serving as the skeleton of an application
  - Reusable “semi-complete” application with built-in flexibility to transform itself into custom applications
  - Help in rapid, minimal effort, development of similar applications

Key Elements Of The Framework



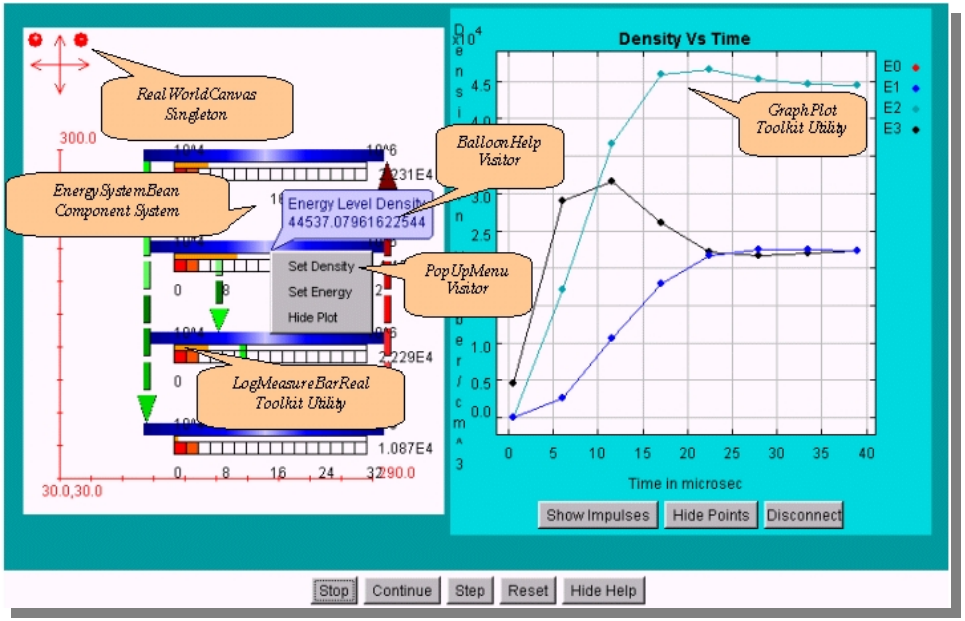
Example Implementation of the Framework



This Applet the Gain Mechanism using Rate Equations in a 4 level Energy System.Examples of the various elements of the framework are labeled

Key Elements Of The Framework

- Components
  - Encapsulate Data
  - Either Active or Passive
  - Typically have a graphical interface
  - Developers: Undergraduate students

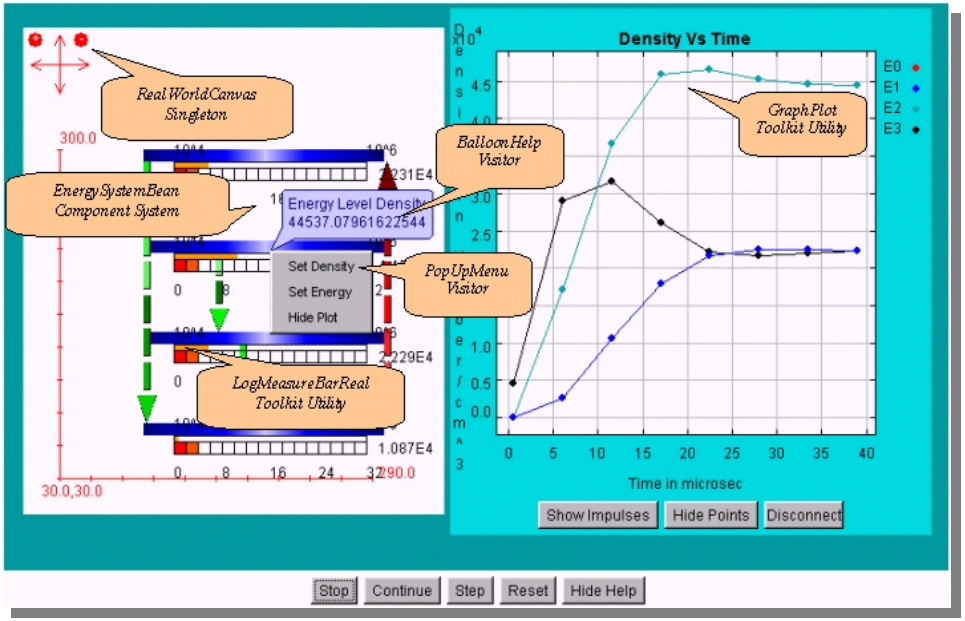


- Strategy Objects
  - Define governing principles for component-to-component interaction
  - Handle computational algorithms
  - Developers: Experienced programmers

- Singleton Objects
  - Define rules(units) for uniformity
  - Provide global access to rule information
  - Developers: Experienced programmers

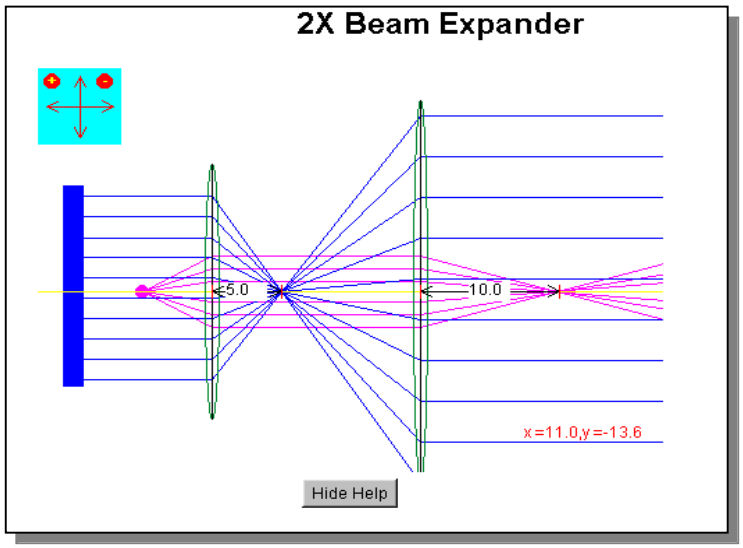
Key Elements Of The Framework

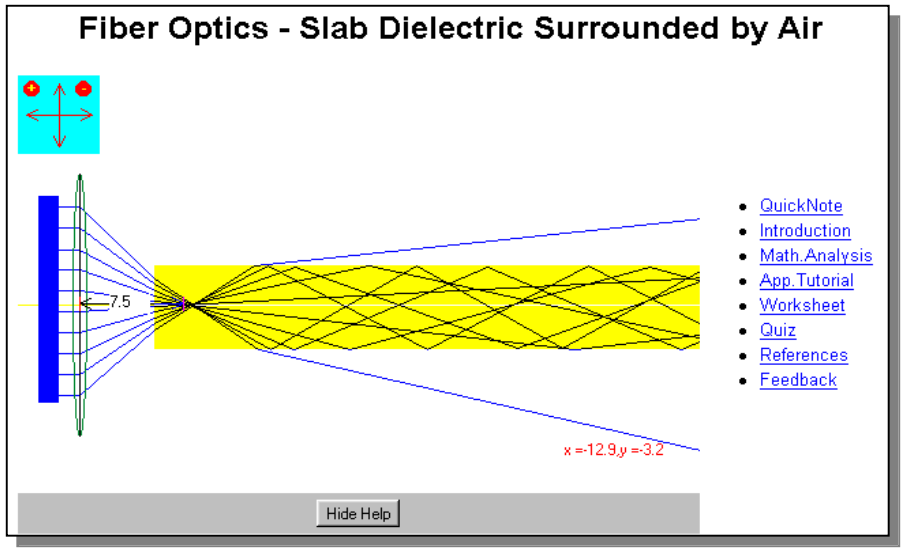
- Visitor Objects
  - Probe and change the status of components
  - Allow dynamic run-time configuration
  - Employ graphical user interface objects
  - Developers: Experienced programmers
- Toolkit
  - Comprised of utility classes
  - Evolve over time with new additions from users
  - Developers : Depends on complexity

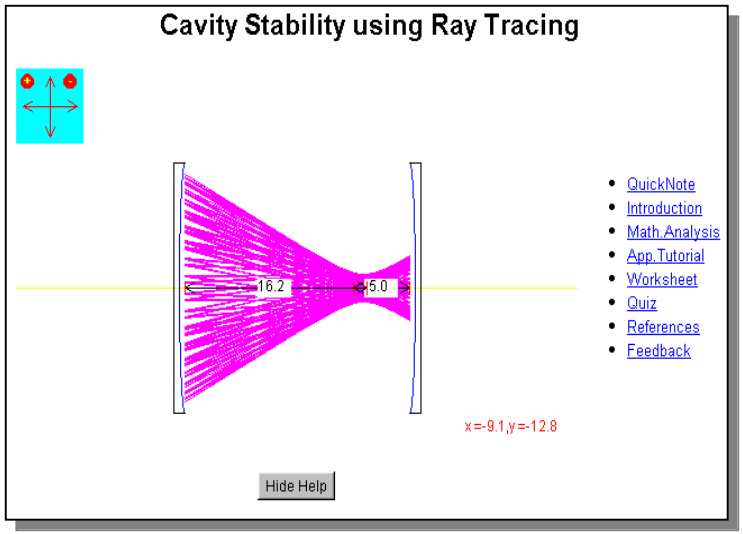


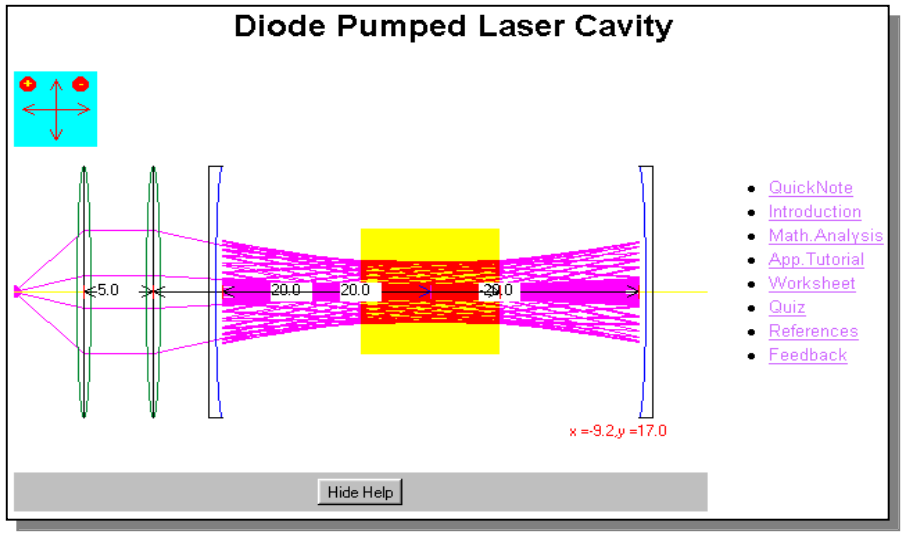
- Container
  - Placeholder for interdependent elements
  - Makes constituent elements aware of each other
  - Designer : Domain expert

User Configurable Virtual Laboratory Applets

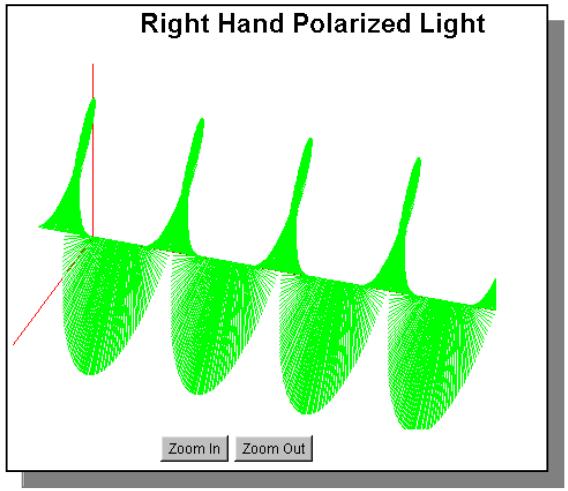


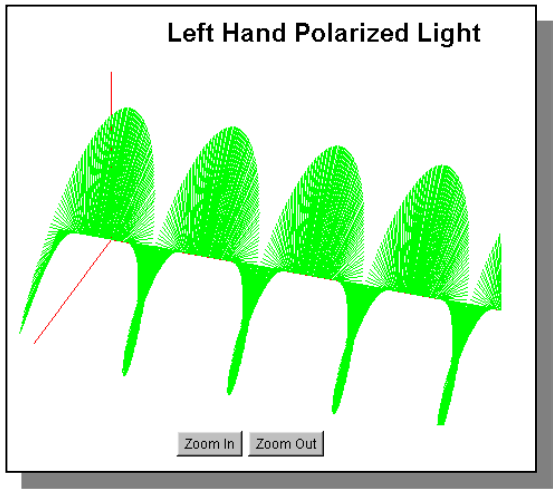


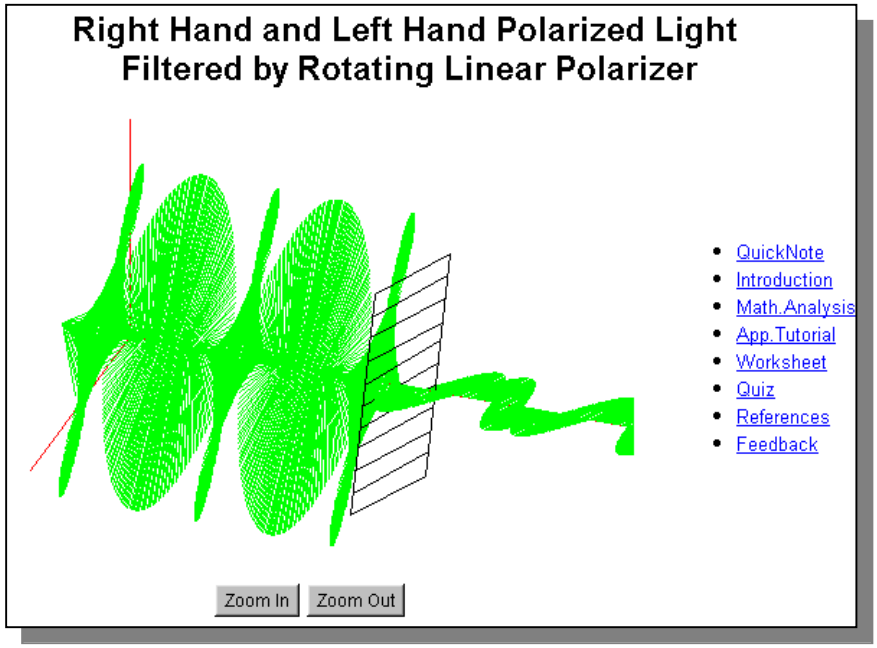


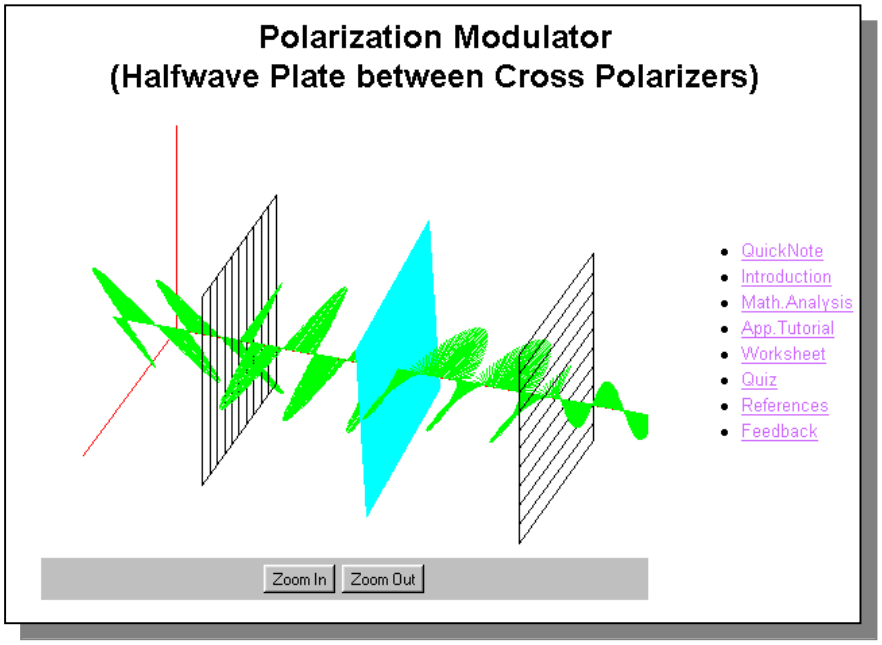


User Configurable Virtual Laboratory Applets

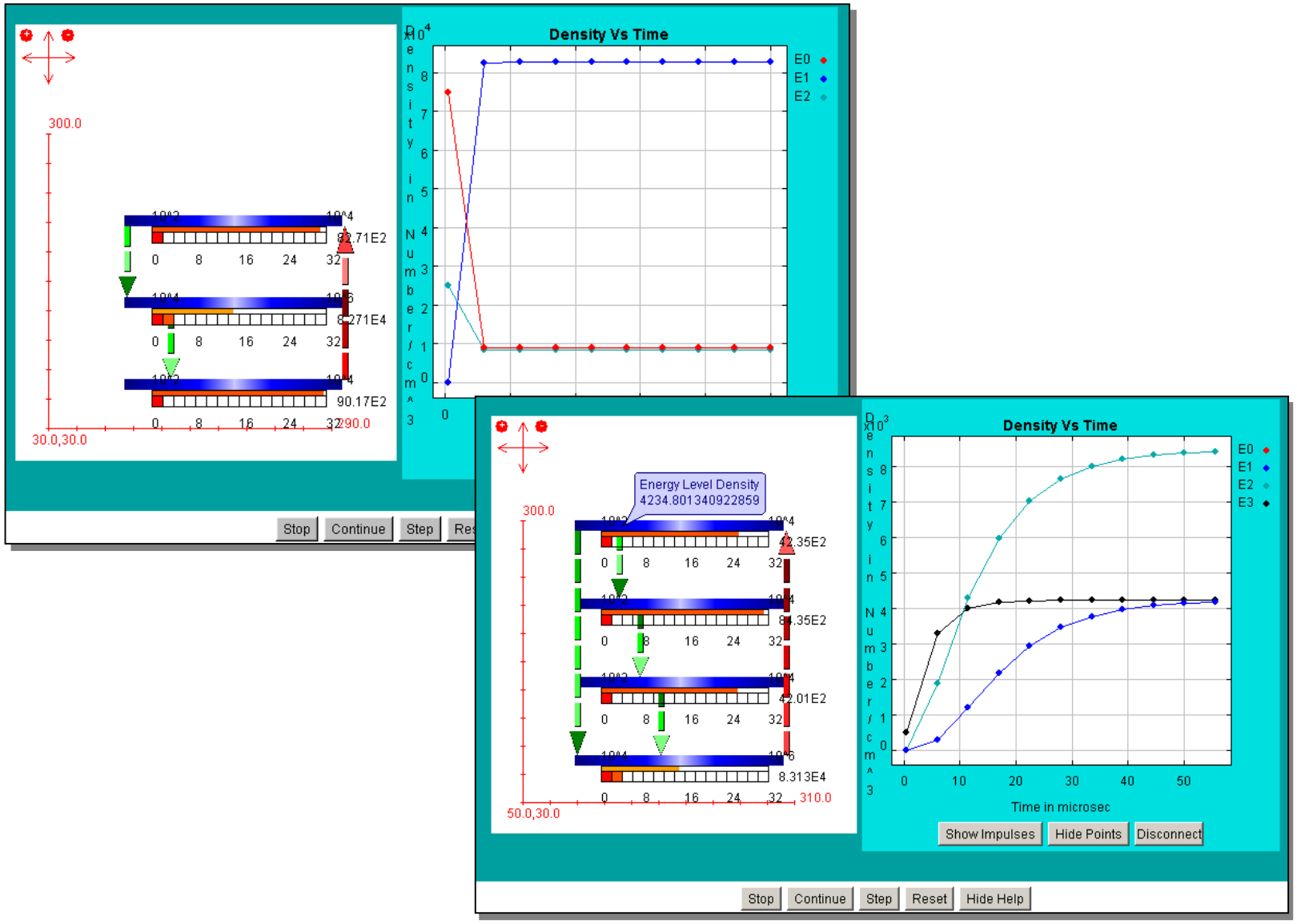








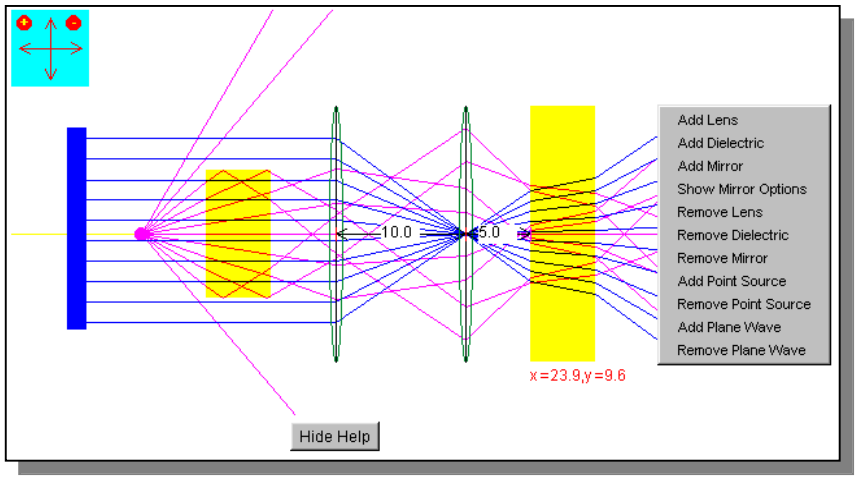
User Configurable Virtual Laboratory Applets



Camp website : www.ee.buffalo.edu/~camp

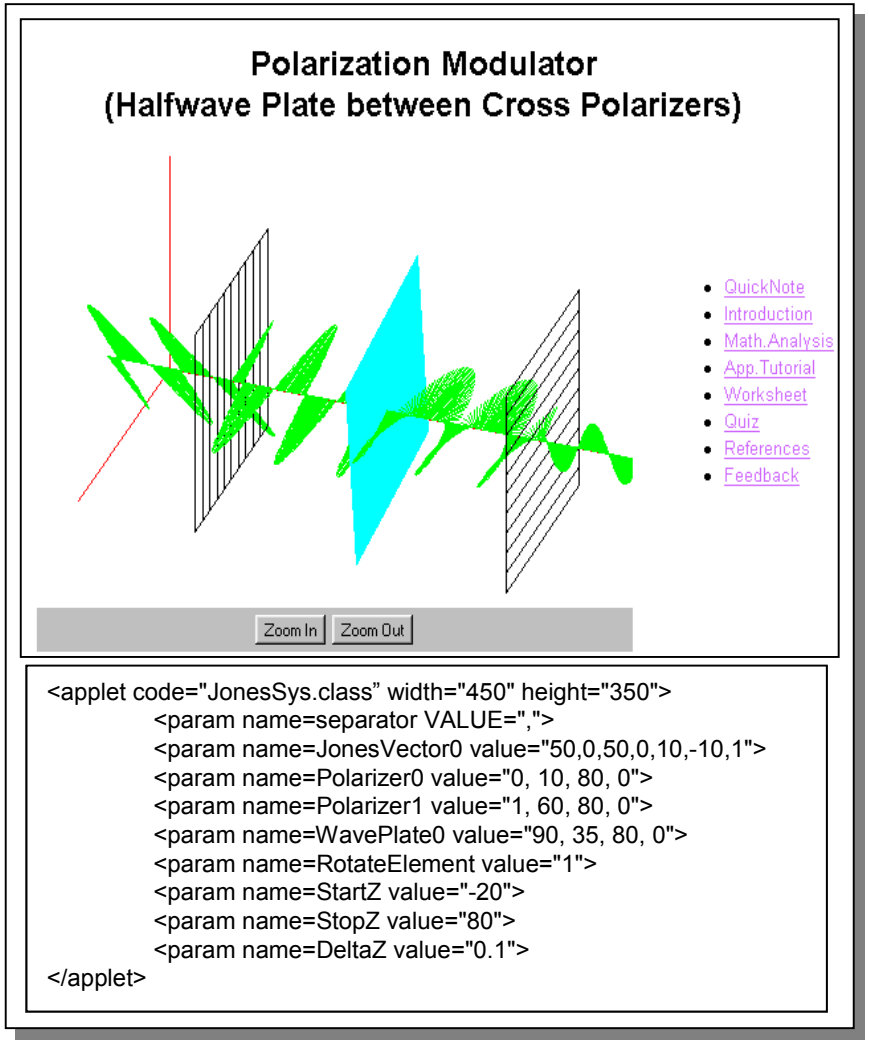
User Configurable Design Applets

Optical Design System



- Optical components
  - Graphically represented.
  - Menus used to dynamically change parameter values
  - HTML tags used to statically design systems
- Students are allowed to experiment with various configurations of lenses, mirrors polarizers and sources

Polarization Applet




```
<applet code="JonesSys.class" width="450" height="350">
        <param name=separator VALUE=",">
        <param name=JonesVector0 value="50,0,50,0,10,-10,1">
        <param name=Polarizer0 value="0, 10, 80, 0">
        <param name=Polarizer1 value="1, 60, 80, 0">
        <param name=WavePlate0 value="90, 35, 80, 0">
        <param name=RotateElement value="1">
        <param name=StartZ value="-20">
        <param name=StopZ value="80">
        <param name=DeltaZ value="0.1">
</applet>
```

Conclusions

- Developed a number of Education Java Applets as learning aids in Photonics

  www.ee.buffalo.edu/~camp/applets/index.html
- Developed a generic, portable, set of objects for the proposed framework that can be effortlessly used by other educators
- Successfully used these Applet based simulation systems in an undergraduate course on Lasers and Photonics(EE 492)

Future Work

- Standardize the development of user configurable virtual laboratory environments to serve as supplementary educational resources for various science and engineering subjects
- Furthermore, extend them to be used as simulation tools in research
- Adopt the software component technology using JavaBeans™ to further enhance the developed framework

Applet Resources for E-Laboratories

- E-Laboratory
  - An online environment to support Internet-based scientific collaboration
    - Sharing of research instruments.
    - Dissemination of basic knowledge (through Applet resources)
  - Applets could provide
    - Simulation tools
    - Information-rich learning environments
    - Guidance and reference

Acknowledgements

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