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The MIT TEAL Simulations and Visualizations in Electromagnetism

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The Technology Enabled Active Learning (TEAL) Project at MIT has developed a broad range of 3D visualizations and simulations to foster student intuition about electromagnetic fields and phenomena (see http://web.mit.edu/8.02t/www/802TEAL3D/). In this talk we discuss the software approaches we use to create these simulations, including Macromedia Shockwave and Java 3D applets for interactive visualization, passive animations created with 3ds max, and the Dynamic Line Integral Convolution (DLIC) method for constructing time dependent representations of the electromagnetic field at close to the resolution of the computer display (Sundquist, 2003). The DLIC method, in particular, is far superior in delineating the spatial and temporal structure of fields as compared to e.g. field line displays or vector field grids. We also report on the use of these visualizations in instruction at the freshmen level. Our strong opinion is that for effective student learning, such visualizations must be embedded in a software framework for their interactive delivery. This "guided inquiry" framework is essential to influence and optimize what students take away from the visualizations. In our current research, we are delivering our visualizations using a commercial package, Addison Wesley's MasteringPhysics (MP), although any guided inquiry delivery system such as MP will be able to interact with our simulation software. We have released our Java 3D simulation software as open source with a liberal open source license (see http://jlearn.mit.edu/tealsim/), with support from the Davis Educational Foundation.