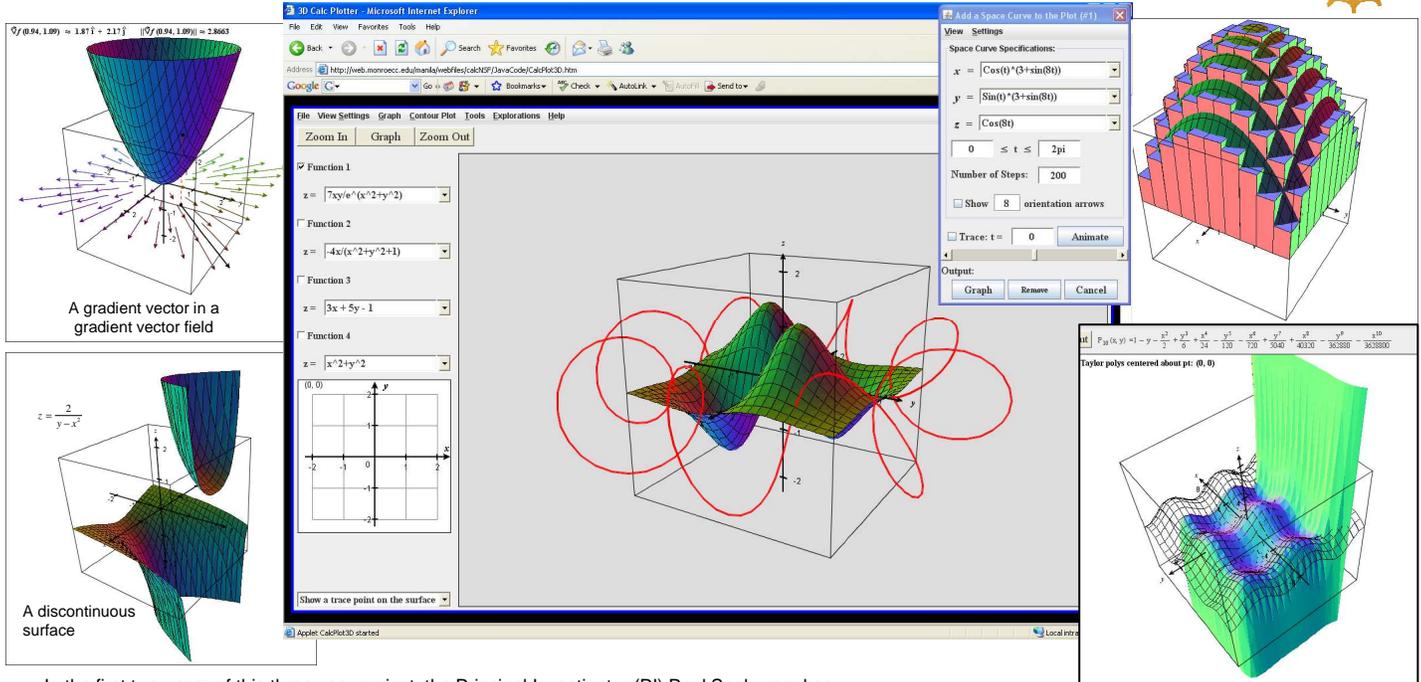


Dynamic Visualization Tools for Multivariable Calculus

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 With support from the National Science Foundation: NSF-DUE-CCLI #0736968



In the first two years of this three year project, the Principal Investigator (PI) Paul Seeburger has:

- Created the Multivariable Calculus Visualization applet using Java and published it on a website: web.monroecollege.edu/calcul3d
- Developed a series of **five** guided exploration/assessments to be used by students.
- Given a 4-hour minicourse at MathFest 2009 on the project.

10th degree Taylor polynomial of $z = \cos x - \sin y$

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Current Features of the CalcPlot3D applet, a Multivariable Calculus Exploration Environment:

The following graphs/objects can be created and explored using this applet:

- Up to four **surface plots** of functions of two variables can be graphed at the same time in Cartesian, cylindrical, or spherical coordinates. At this point, each function can be of the form: $z = f(x, y)$, $y = f(x, z)$, $x = f(y, z)$, $r = f(\theta, z)$, or $\rho = f(\theta, \phi)$.
- Multiple **parametric space curves** can be graphed simultaneously along with the surfaces. Motion along these space curves can be animated for a given time interval, showing the position vector and optionally, the velocity and/or acceleration vectors, the TNB-frame, the osculating circle, or the curvature value.
- **Contour plots** can be graphed in 2D and also in 3D on the surface. (A level plane can be moved through the surface to demonstrate that contours are cross-sections of the surface.)
- **Vector fields** can be graphed in both 2D and 3D. These can be laid out using a rectangular or circular grid in 2D and a rectangular, cylindrical, or spherical grid for 3D.
- **Regions of integration** can be created and graphed. First the 2D region is created using a dialog which shows the graph of the region in the xy -plane. The bottom and top (left and right) functions can be entered in either $y = f(x)$ form or $x = f(y)$ form, along with bounds on x or y , respectively. Once this region is created, the user can choose one of the four surfaces to use for a "top" for the solid region, and this solid region can be graphed on the 3D plot. (See example in the lower left corner.)
- **Parametric Surfaces** can be graphed using two parameters. Numerous examples are provided.
- Unlimited **points** and **vectors** can be added to the plot.
- **Tangent planes** and **tangent lines** (in the x - and y -directions) can be displayed and dynamically moved around the surface using the trace plane in the lower left corner of the applet.
- A **gradient vector** can be displayed in this trace plane and moved around a contour plot or surface.
- **Taylor polynomials** in two variables, $P_n(x, y)$, can be calculated and stepped through for any function, $z = f(x, y)$. Depending on the complexity of the partial derivatives, these can be viewed from degree 0 to as high a degree (less than 16) that the processor can handle for the given function. The polynomial formula is also shown along the top of the applet where it can be scrolled left or right to see all of its terms.

