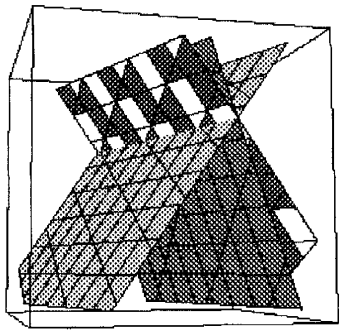
Use 3D Mathematica to motivate interest in topics from multivariable Calculus



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A CAS helps to meaningfully foreshadow multivariable calculus in the earlier calculus classes. Examples presented include linearization of curves extended to linearization of surfaces; parameterizing the intersection of three planes. Conclude with examples from multivariable calculus: surfaces in cylindrical and spherical coordinates; method of LaGrange multipliers; the Divergence Theorem.

My teaching interests which led to this presentation:

A computer algebra system provides a fun yet technologically meaningful way to investigate and demonstrate mathematics beyond course requirements. Math teachers can use CAS to help motivate students to take the next math course in sequence, even if not required by their major.

The first challenge is to get more students taking multivariable calculus. One motivating factor for students is that employers will examine a college transcript for rigorous courses. For college graduates in today's competitive job market, advanced math courses and computer programming skills can be beneficial to getting the desired job in the desired location.

Another motivating factor for students is the three-dimensional aspect of multivariable calculus. With help of a CAS, today's technologically-intuitive students can be motivated to take multivariable calculus. In my presentation I share my original work using 3D Mathematica. I selected examples that worked for me in the classroom to enhance student learning of Calculus III, Calculus I, and pre-Calculus.

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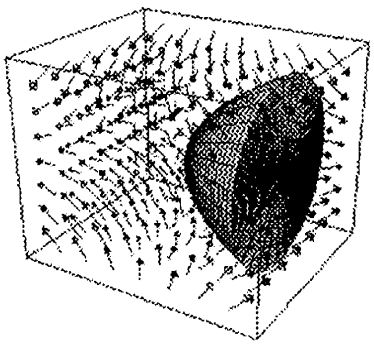

The presentation:

1. *Quick overview of Mathematica.* How to create and edit a notebook; use the Help Browser; some basic commands like Contourplot3D, Plot3D, RealTime3D, and 3D Viewpoint Selector.

2. *Foreshadowing multivariable calculus.*

    a. Solve a dependent system of linear equations in three variables. Show the intersection of the three planes with 3D graphics, and graph the line of intersection using parameterization of (x,y,z).

    b. Consider the graph of a complicated surface. Illustrate linearization of the surface at a fixed point by showing the tangent plane to surface at that point. View the surface and its tangent plane from various perspectives and zoom-in pictures. Point out similarities to the linearization of complicated curve on the $xy-$plane.

3. *Using CAS in multivariable calculus class.*

    a. Graph surfaces in spherical and cylindrical coordinates. Consider these equations: $r=\theta$, $\phi=\frac{\pi}{4}$, $z=r$, $\rho=\phi$, $\theta=\frac{\pi}{4}$. Use parameterization of (x,y,z) to graph these surfaces with CAS. Change the parameter values to see corresponding change to surface.

    b. Use level curves and CAS computation to illustrate method of LaGrange multipliers for finding the extrema of a surface.

    c. Illustrate flux across several surfaces. Use Divergence Theorem and CAS to compute flux. Observe net sum of obtuse or acute angles formed by the vector field in relation to the surface.