



## Maple Case Studies Series

### Maple adds an 'out of this world' touch to math learning

#### Mathematical software used to digitize Star Wars character Yoda

Professor Tim Chartier is a hero to his four-year old son and his friends. Who else's dad can create an image of the favorite Star Wars character Yoda on a computer and move him around?

An applied mathematician, Chartier is passionate about finding relevant, exciting examples of using mathematics. He knows that examples engage students. One of his trusted assistants in this project is Maple, Maplesoft's world-leading computation engine, which offers the breadth and depth to handle every type of mathematics.

A professor of mathematics at Davidson College, Chartier realized that the popular movie character was a sure way to get the attention of students across the country. "Math is so often simplified in academics to the point that many students cannot associate what they are learning to their lives or career goals," he said. "Many of them don't understand the significance of learning mathematical equations or formulae." In 2004, he contacted a research and development engineer at Industrial Light & Magic, the special effects division of Lucasfilm, Ltd., and together they wrote an article explaining the mathematical processes behind digitizing and animating Yoda.

Chartier then put Maple to work illustrating these mathematical concepts in a hands-on way. He was supported by William Bauldry and Sarah Greenwald of Appalachian State University, who helped him enhance the Maple code.



"I want to show students how math can be applied in many interesting areas of our lives," said Chartier, reflecting on his philosophy behind introducing applications of mathematics in the classroom and the use of technolo-

gy tools. "These topics can make math a dinner time conversation. Today's students could someday tell their children and grandchildren about the impact and importance of mathematics". Chartier was recently named a winner of the *2007 Henry L. Alder Award for Distinguished Teaching by a Beginning College or University Mathematics Faculty Member*, established by the Mathematical Association of America.



#### How was Maple used?

Yoda has a physique that is literally built for linear algebra. In order to operate this Jedi master by a computer, as opposed to the hand of a puppeteer, the character must be digitally created, via a wire frame, or tessellation, as seen in the image.

The wireframe model is defined by two types of information: the location of each vertex, and the connections between the vertices that determine each face. The more vertices, the better the image. Maple's 3-D plotting tools take this information and render the image of Yoda.

Maple's linear algebra routines can then be used to make Yoda move. With the vertex information stored in a matrix, matrix multiplication can be used to modify the model, resulting in a new 3-D image. For example, multiplying by a rotation matrix rotates the image by a specified amount. Maple's formidable numeric linear algebra routines make the operations feasible, even though there are thousands of points.

Maple's strong interactive 3-D plotting capabilities add further dimensions to the exploration. Users can rotate, scale, or pan the image interactively, and try out different lighting



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models, levels of glossiness, and transparency to make their very own customized Yoda.

### *The digitization of Yoda*

Yoda first appeared in the Star Wars saga in the 1980 film, *The Empire Strikes Back*. In this film, Yoda was represented by a puppet, and his voice and movements were controlled by Frank Oz. More recently, the character was produced by computer animation, employing mathematical concepts from such areas as linear algebra, calculus, differential equations, and numerical analysis.

"The Yoda image created using Maple is really a cool one," said Chartier. "Maple's symbolic power and what it can do in numerics is astounding. Simply put, it is the ultimate calculator and goes beyond one's mathematical intuition to give some excellent results. As a professor, I use tools like Maple to bring math to life for my students. Technology can produce amazing results in the classroom."



As a little boy, Chartier enjoyed Star Wars and collected some Star Wars toys, at no small expense to his parents. Now thanks to Maplesoft's advanced technology, his son and friends experience 3-D images of Yoda. Not only are they easy on Chartier's wallet, but they also enable the kids to better understand mathematics.

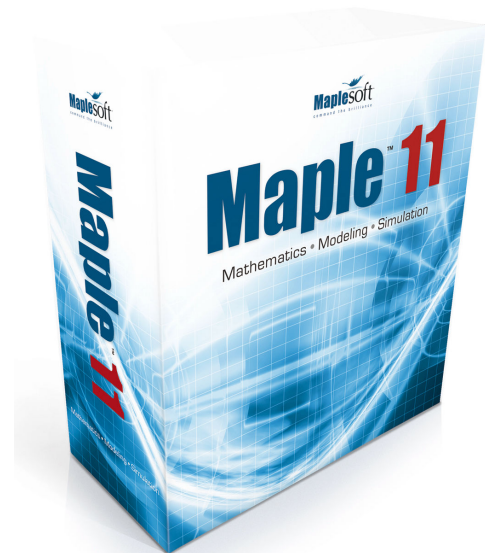
### *About Maplesoft*

Maplesoft™ is the leading provider of high-performance software tools for engineering, science, and mathematics. Our product suite reflects our philosophy - given great tools, people can do great things. Maplesoft has transformed the way engineers, scientists, and mathematicians use math, enabling them to work better, faster, and smarter.

Organizations across the world have applied Maple in nearly every technical field, including Engineering Design, Operations Research, Scientific Research, and Financial Analysis. Maplesoft's commercial customer base inclu-

des Allied Signal, BMW, Boeing, DaimlerChrysler, DreamWorks, Ford, General Electric, Hewlett Packard, Lucent Technologies, Motorola, Raytheon, Robert Bosch, Sun Microsystems, Toyota, and Tyco.

We believe that if you touch math, you need Maple.



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