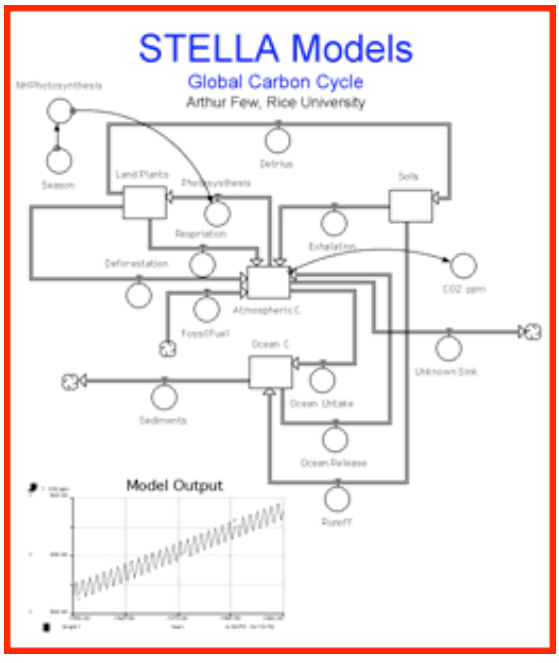
Modeling in the Classroom, Hands-on Systems Learning

Arthur Few, Rice University, Houston, TX

Models as an educational tool creating an active-participant learning environment

I could say that modeling is hard wired in the human brain; however, I think that there is actually more to it than that. Whenever we use a scientific model, we collect information, organize our understanding of the system of interacting components, and run the model, hoping for an appropriate outcome. Isn't this what the passer and receiver are doing in running a football play? The passer must observe the motion of the receiver; both must observe the motions of pursuers and anticipate the location where the ball will be caught, and if they have correctly "modeled" the "system" (play) the pass will connect. What about the lioness pursuing a zebra and bringing it down (or, in some cases, not)? The labrador catching a Frisbee in the air? A bird catching an insect on the wing? And on and on. These activities are all forms of mental modeling, and this capability is, I contend, hard wired in the brain and necessary for survival.

Humans have added an additional twist to mental modeling; we apply this activity to abstract systems. When we use modeling as an educational tool, we can leverage this inherent "modeling" capability to create a hands-on, active-participant learning environment.



A number of processes were converging in the early 1990s at Rice University. I had been exposed to STELLA™ (graphic-based software for modeling) and had immediately recognized its educational value. I was developing classroom modeling applications. We had formed an informal group of faculty and students interested in developing a program of study in Earth system science. We had a dozen or so faculty—representing at least six different departments, from physics to English—who participated regularly in our weekly lunch meetings. We had no official "standing" in the university structure, and of course we had no budget. Nonetheless, we were enthusiastic, and we were experimenting with new courses and new formats and bypassing the academic departments by using all volunteer faculty. In this same time frame, the University Corporation for Atmospheric Research (UCAR)

initiated the Global Change Instruction Program (GCIP); I took a one semester sabbatical with GCIP to complete the first edition of my book *System Behavior and System Modeling*, which emphasizes modeling as a means of understanding how systems work. In 1993, this book won the EDUCOM award for the best educational innovation using computers in the natural sciences.

In the summer of 1992 in Boulder, Colorado, the Earth System Science Education Program (ESSE) and GCIP jointly sponsored a Workshop on Modeling in the Classroom that I organized; we used *System Behavior and System Modeling* as the text for the workshop. In the ensuing years, I have conducted workshops at several universities in the ESSE program. Most recently, John Snow and I led two modeling workshops at the ESSE21 meeting in Fairbanks, Alasaka.

When the University Space Research Association (USRA) selected Rice to be in the first group of ESSE universities, it gave our "volunteer program" at Rice a great boost in morale and focus (not to mention a budget). We began introducing new Earth systems courses at lower and upper undergraduate levels, and the number of participating faculty grew. We now have a Center for the Study of Environment and Society (CSES) and an Environmental Science Double Major. The diversity of interests in CSES is exemplified by its Advisory Committee, whose members represent 14 different departments and entities at Rice and within the Houston Community.

From small acorns great oaks may grow. Thank you ESSE.

STELLA Modeling Software
http://www.iseesystems.com/
System Behavior and System Modeling
http://www.uscibooks.com/fewnb.htm
Center for the Study of Environment and Society
http://www.ruf.rice.edu/~cses/cses.html
ESS at Rice
http://esse21.usra.edu/ESSE21/essel_rice.html
Arthur Few's Home Page
http://www.ruf.rice.edu/~few