

Using Models to Teach Math and Science

IEEE User Conference

Providence, RI

October 5, 2010

Dee Baker, Virginia Beach City Public Schools
Jim Batterson, NASA Langley Research Center (retired)
Mark Clemente, National Institute of Aerospace

Modeling and Simulation

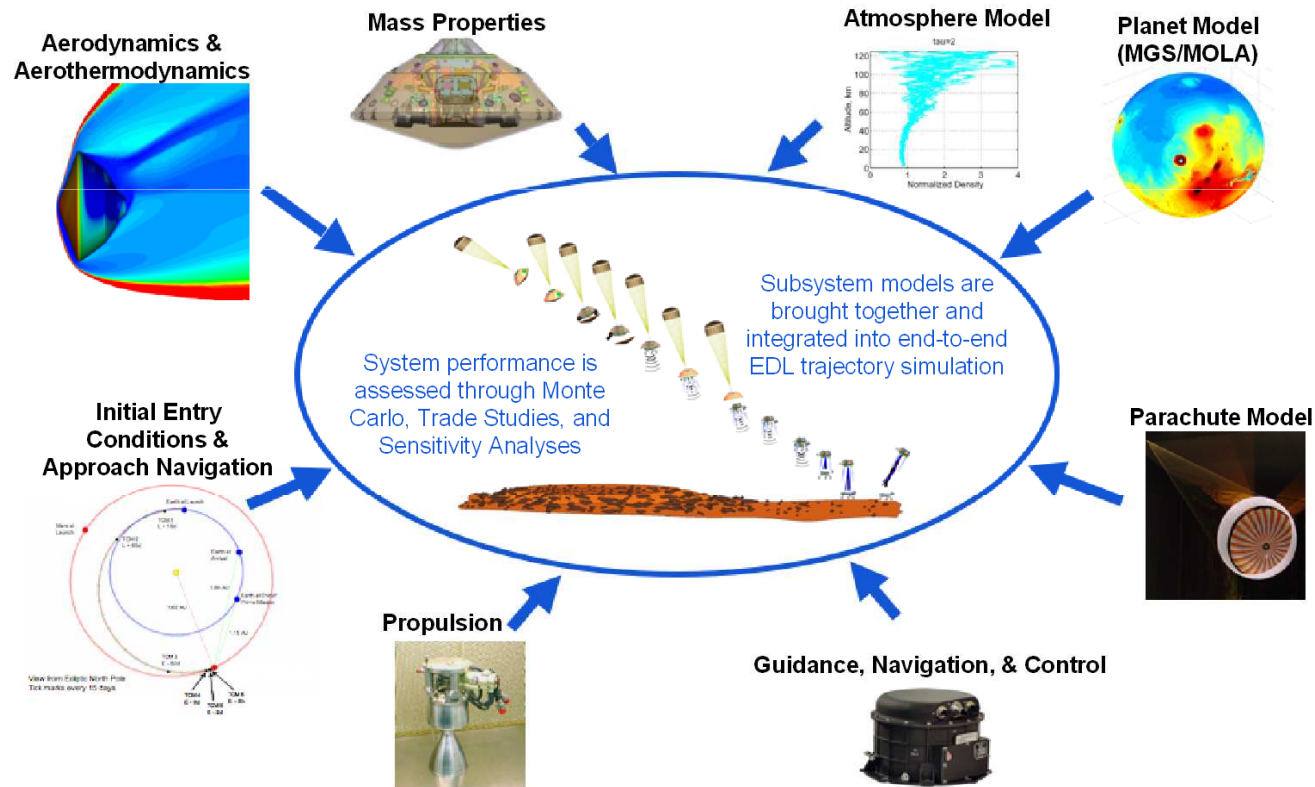
- Modeling and Simulation is just a scaled physical or mathematical approximation to a real world situation and consists of two components
 - A physical or mathematical “model” that approximates the system under study
 - A simulation that approximates the conditions the system will experience in the real world over time
- M&S can be totally computational, totally experimental, or a mix of the two
 - Computational
 - Simple cartoon (static picture - mental model computation - “Roadrunner with rock”)
 - Animation (dynamic “behavior over time”)
 - Full physics-based equations (e.g. Mars landers in Martian atmosphere)
 - Experimental
 - Wind tunnel model
 - Scaled river/bay model
 - Hybrid
 - Piloted flight simulator
 - NASACAR or Formula 1 X-box

Roadrunner Math Models (Algebraic Eqns) of Increasing Complexity

- Static cartoon
- Animation (rock simply falls)
 - Constant acceleration by gravity (32 ft/sec/sec)
- $D = 1/2 at^2$
 - Time of flight
- $D = 1/2 at^2 + (\text{air resistance})$
- $D = 1/2 at^2 + (\text{air resistance w/variable density})$
- $D = 1/2 a(\text{with variable gravity})t^2 + (\text{air resistance w/variable density})$
- Etc.... (rotating earth, spherical earth,...)

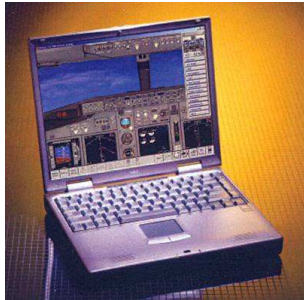
Example of a Complex NASA Planetary Lander System Simulation

Integration of multiple models as noted in a typical Mars Entry, Descent, and Landing Simulation

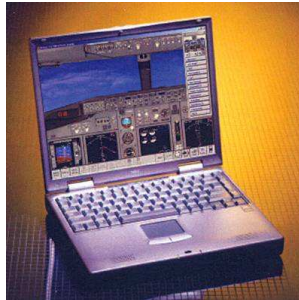


Boeing 787 Flight Training

Enhanced CBT



CBT/SBT



Flat Panel Trainer



Full Flight Simulator



Distance Learning WBT
and Training Center



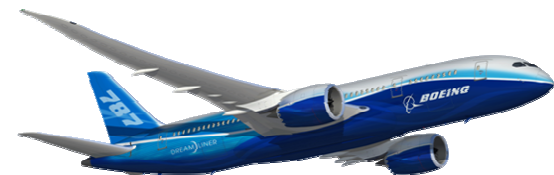
Training Center

The Real World! →



Airplane Training, IOE, Line Assist

Delivery Center/ Airline



The Model Matters

- Best “fit” is not necessarily best model
 - Noisy data
 - Data from outside range of interest
- Model should be adequate for your needs
 - Run sensitivity studies
- Often models and modeling information from diverse disciplines must play together (units?)
- Know the source of your model data



6 Teachers

➤ 3 math

➤ 3 science

1 Coordinator



Goals of the project:

- MODSIM as strategy
- Integrated lessons
- Student-centered lessons



STELLA[®]



Excelets



SCRATCH

Lesson

F
L
O
W

- intro
- model
- questions

How I Came to Teach Modeling



- I was asked to do so!

Why I Incorporate Modeling



“When am I ever going to use
this???”

Why I Incorporate Modeling



- Critical Thinking and Problem-solving
- Collaboration & Communication
- Sustainability & Global Thinking
- Information & Technological Literacy

Lessons Learned

- Be willing to take risks
- Build your “expert” group
- Expect messiness
- Seek out training
- Tap into ALL resources available
 - grant \$
 - parents
- Use the best platform for the task at hand (State, National and Local standards included)

