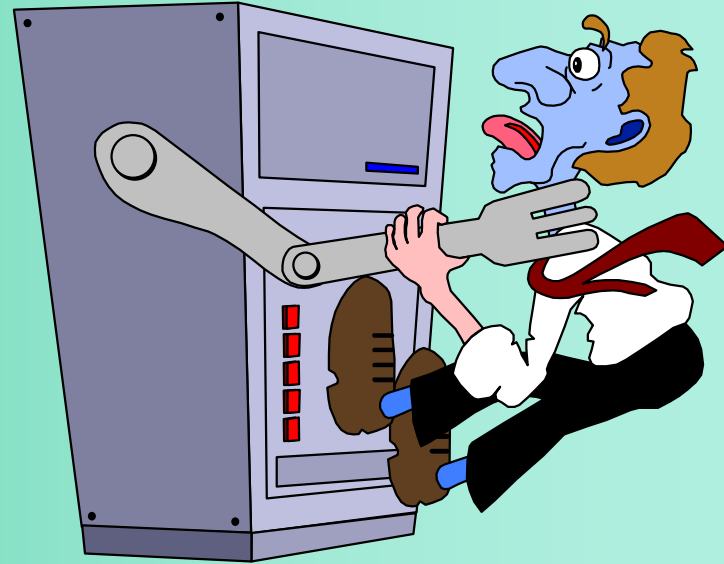


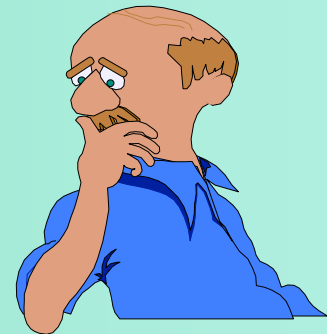
Modelling



Simon Carson

What are Models?

- Physics is about modelling the world!
- Models are imagined worlds
 - simplified
 - essential features preserved
 - inessential features missing
- They are therefore limited and approximate



Why are models useful?

- Prediction (Engineering design)

- what happens next?
- what happens there?
- what happens if...?



- Explanation (Physics)

- that happened because.....



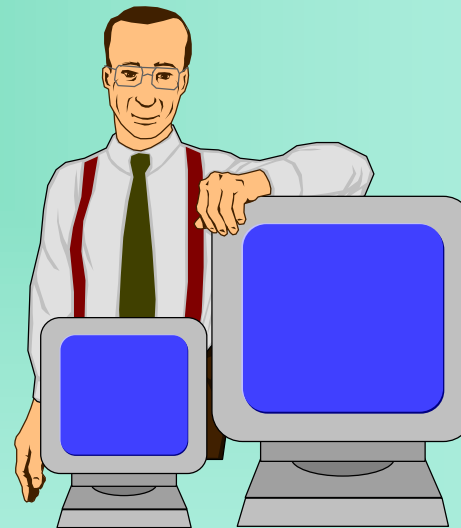
Mathematical Models

- Allow quantitative work
 - analysing data
 - formulating laws
- Physical systems are simple
 - the mathematics does not always look simple!



Computational Models

- Derived from mathematical models
- Different types:
 - deterministic
 - probabilistic
- Different purposes:
 - phenomenological
 - explanatory

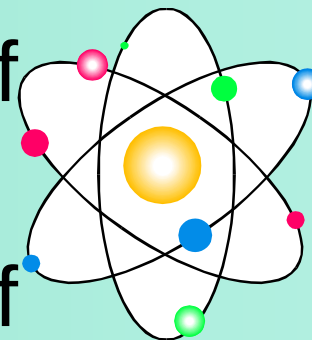


Limitations of Models

- Models simplify
- Models may produce spurious results
 - assumptions in mathematical models (eg kinetic theory)
 - numerical artefacts in numerical model (SHM)

Conclusions

- Physics is about modelling - the nature of science
- Modelling should be explicit in teaching
- Modelling can aid understanding of physics
- Modelling can aid understanding of mathematics
- Modelling could motivate students



Models in *Advancing* Physics

- Modern Physics uses both mathematical and computational modelling extensively
- -both are vital to an education in physics



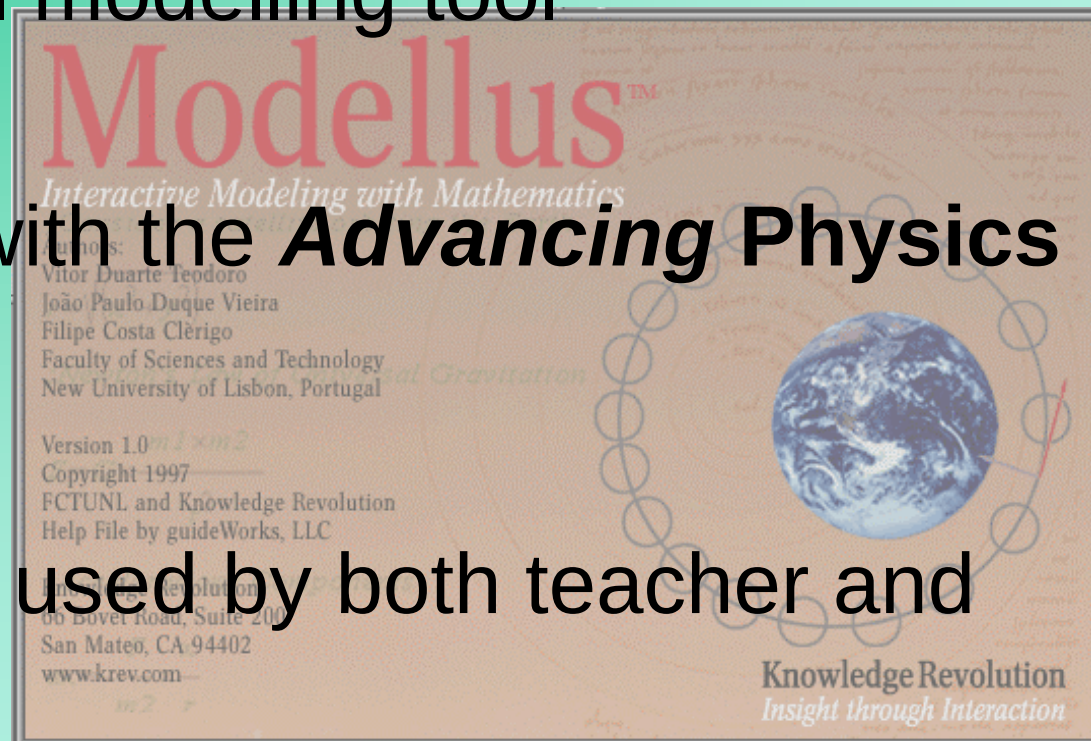
Models in *Advancing Physics*

- Computational models (simulations) can give insight into physical systems
- Computational models can help in understanding mathematics



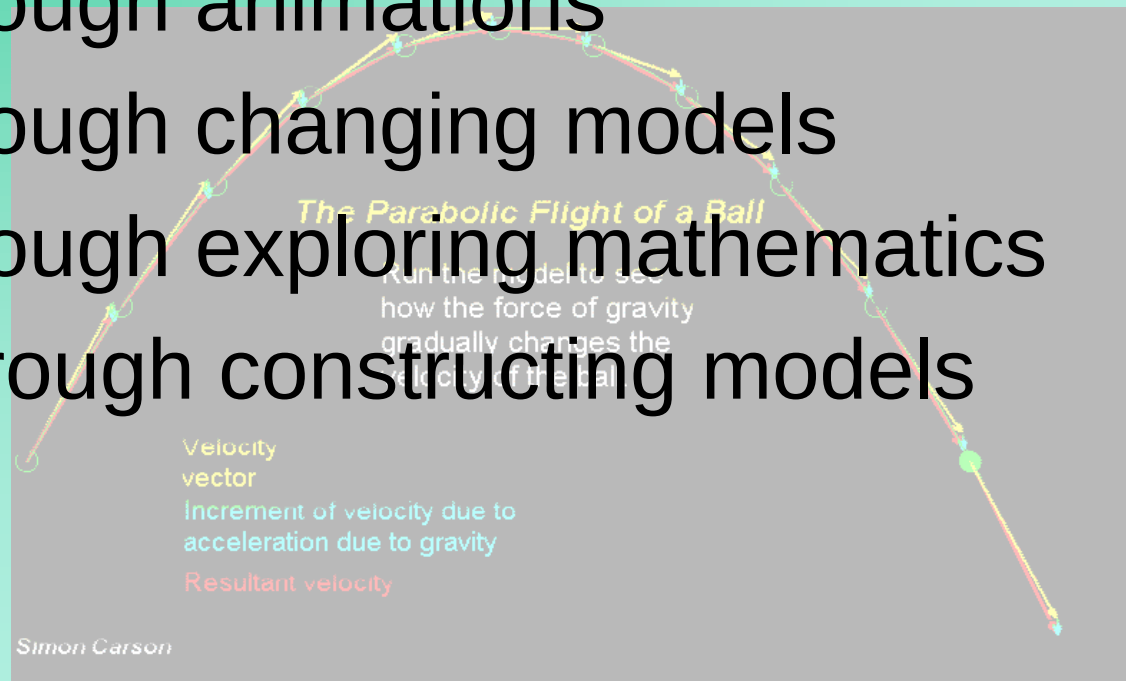
Modellus - What is it?

- A numerical modelling tool
- Packaged with the **Advancing Physics** CD-ROM
- A tool to be used by both teacher and student



How can Modellus be used?

- To teach through simulations
- To teach through animations
- To teach through changing models
- To teach through exploring mathematics
- To teach through constructing models

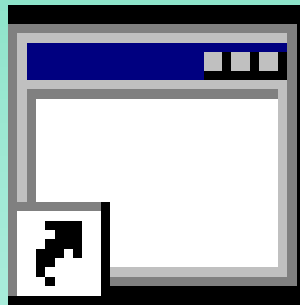


Examples

- Chaotic pendulum (simulation)
- Definition of resistance (animation)
- Boat on a river - vector addition
(changing the model)
- Vector addition (mathematics)
- Gradients of tangents and chords
(mathematics)

Building a model

- An oscillating mass on a spring
 - set up the equations
 - look at a graph
 - make an animation



Modellus.lnk

$$F = -kx$$

$$\frac{dv}{dt} = \frac{F}{m}$$

$$\frac{dx}{dt} = v$$

Summary

- Modellus allows:
 - algebraic programming in a natural way
 - display of numerical results as tables or graphs
 - animations to illustrate ideas
- The program is (relatively) easy to learn
- The ***Advancing Physics*** CD-ROM will contain many examples