


Modeling

Why Make a Models?


1




Modeling

- *"The sciences do not try to explain, they hardly even try to interpret, they mainly make models."*
- *"By a model is meant a mathematical construct which, with the addition of certain verbal interpretations describes observed phenomena."*

John von Neumann (1903-1957)




2




Modeling

- *For those, like me, who are not mathematicians, the computer can be a powerful friend to the imagination.*
- *Like mathematics, it does not only stretch the imagination, it also disciplines and controls it."*

Richard Dawkins



3



Modeling

What is a model?

- A model can come in many shapes, sizes, and styles.
- It is important to emphasize that a model is not the real world but merely a human construct to help us better understand real world systems.


4




Modeling



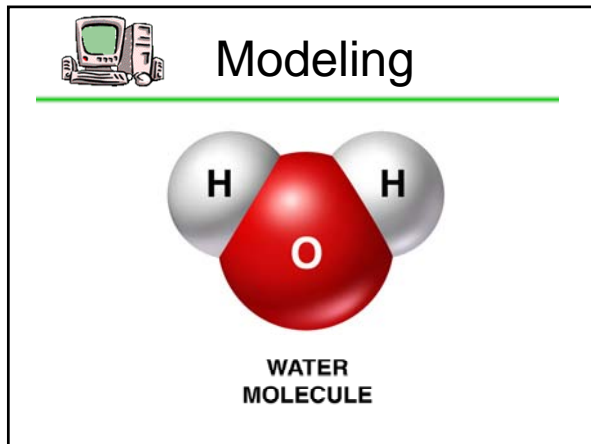
5



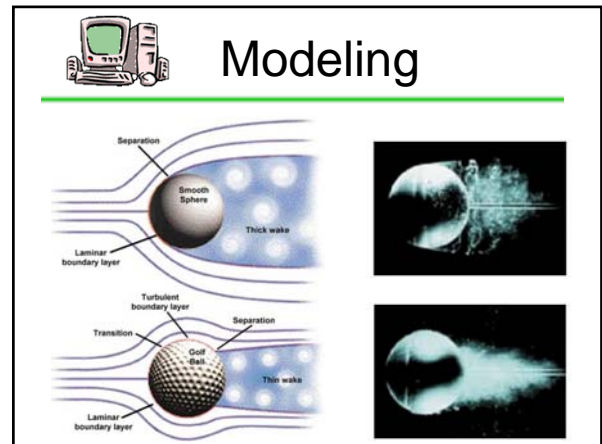
Modeling



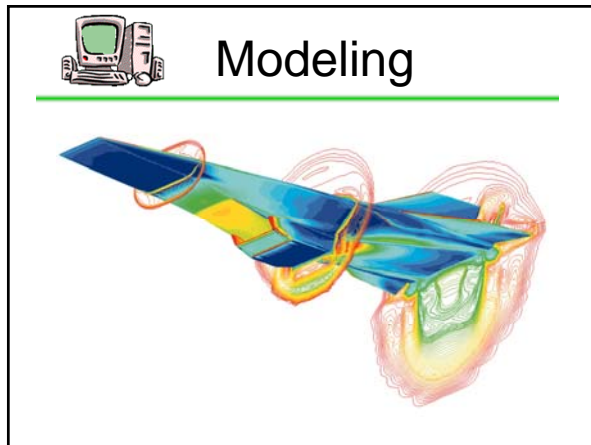
6



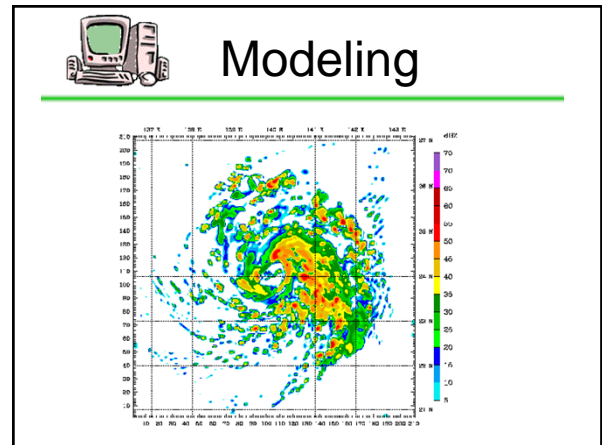
7



8



9

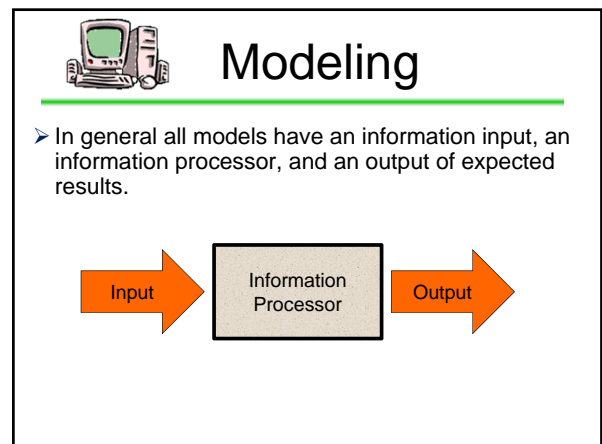


10


Modeling

- **Model, models, or modeling** may refer to: a pattern, plan, representation, or description designed to show the structure or workings of an object, system, or concept.
- It is important to emphasize that a model is not the real world but merely a human construct to help us better understand real world systems.

11




12



Modeling

- People receive information, process this information, and respond accordingly many times each day.
- This sort of processing of information is essentially a conceptual model (or mental model) of how things in our surrounding environment work.


13



Modeling

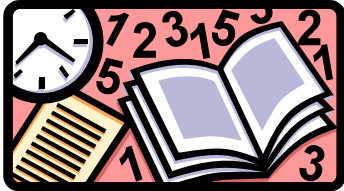
- A computer model is a computer program, or network of computers, that attempts to simulate an abstract model of a particular system.
- Computer simulations have become a useful part of mathematical modeling of many natural systems in physics (computational physics), astrophysics, chemistry and biology, human systems in economics, psychology, social science, and engineering.

14




What is a Model?

- Consider developing a model for an engineering textbook

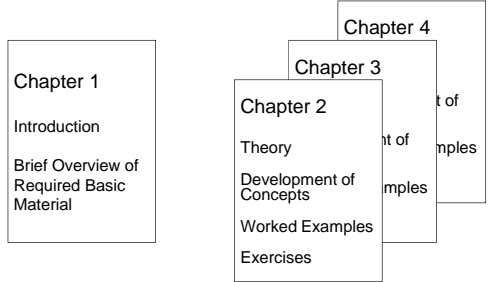


15



What is a Model?

- A pictorial representation of a textbook




16

Is This a Good Model?

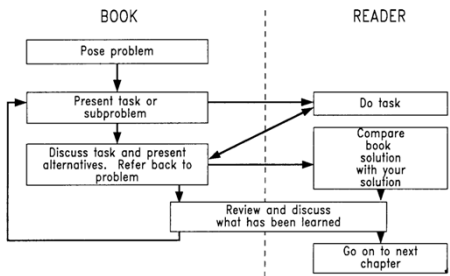
- This is a difficult question.
- Maybe a modeling heuristic may help
 - Is the model **useful** in predicting what you would find in the textbook?
 - How well does the model **describe** the situation?

17



What is a Model?

- A descriptive model of a textbook



18



A Predictive Model

How much time will you need to work your way through your textbook?

Keep in mind:

- Describe your thoughts in words, diagrams, equations, or whatever you need to conceptualize your model
- Different people build different models
- How important is your *perspective*?

19

Time Required To Read Your Textbook - Model 1

- Assume it takes r time to read a page and there are P pages in the book, then an estimate of the time required to read a book T is:

$$T = Pr$$

- Is this equation a “good” model?

20

Time Required To Read Your Textbook - Model 2

- Assume it takes w time to work through each task and that there are W tasks per page:

$$T = Pr + wWP$$

- How does this model compare with Model 1 or with your model?

21

Some Weak Points of the Model

- Does r take into account the special properties of the reader?
- Does the model accommodate a thoughtful reader?
- How *accurate* is the answer?
- How reliable are your estimates for r , w , and W ?

22



What is a Model?

- A model is a *representation*
- A model does not have to be a *complete representation*, it may be an *idealization*
- A purposeful model includes only features that are *essential*


23




Example



24




Example

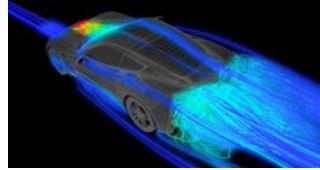


- This descriptive model would be preferred by:
 - Advertisers?
 - Car Buyers?
 - Engineers?

25



Example



- This descriptive model would be preferred by:
 - Advertisers?
 - Car Buyers?
 - Engineers?

26

Some Modeling Terminology

- Recall the predictive model:

$$T = Pr + wWP$$

- What changes in the model from book to book?

27

Some Modeling Terminology

$$T = Pr + wWP$$

- P , W , and w are the variables of the model
- Your reading speed, r , is unlikely to change from book to book - this is a parameter of the model

28

Distinctions Between Variables and Parameters

- Often it is a matter of perspective?
- **Variables** are factors in the model that are actively changing
- **Parameters** are factors that mediate the effect of the variables
- Parameters that cannot change are called constants

29

Trade-Offs and Sensitivity

- Which would be a better choice?
 - Take a speed reading course, or
 - Improve your reasoning skills
- Using a spreadsheet or a computer program run the predictive model and conduct some experiments

30

Trade-Offs and Sensitivity

r	P	w	W	T
1.5	150	5	2	1725
1.5	150	10	2	3225
1.5	150	15	2	4725
3	150	5	2	1950
3	150	10	2	3450
3	150	15	2	4950

From this analysis should you spend your time on speed reading or developing your reasoning skills?

31

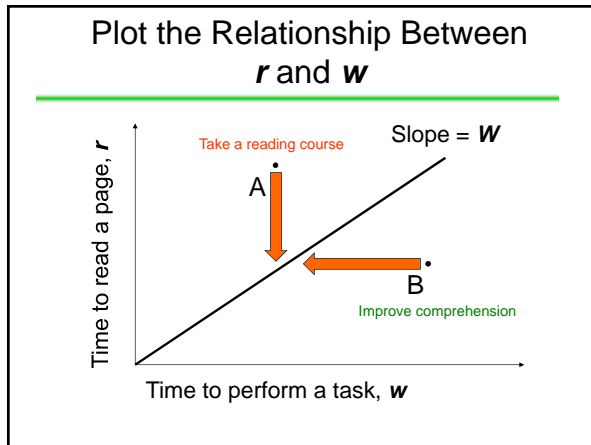
Trade-Offs and Sensitivity

Another method to determine the sensitivity of variables in this model is to compare the reading component of the model with the comprehensive component.

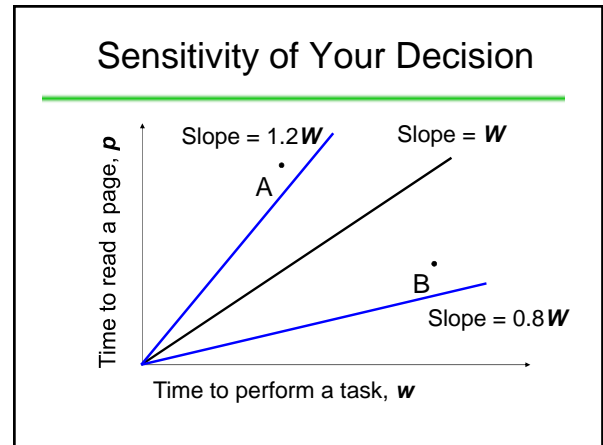
$T = Pr + wWP \rightarrow rP > wWP$

or **$r > wW$**

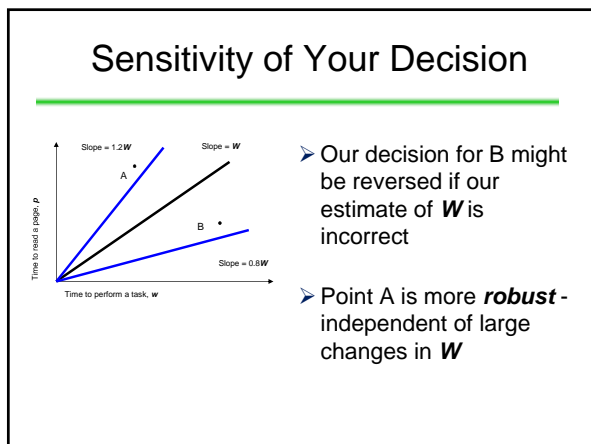
32



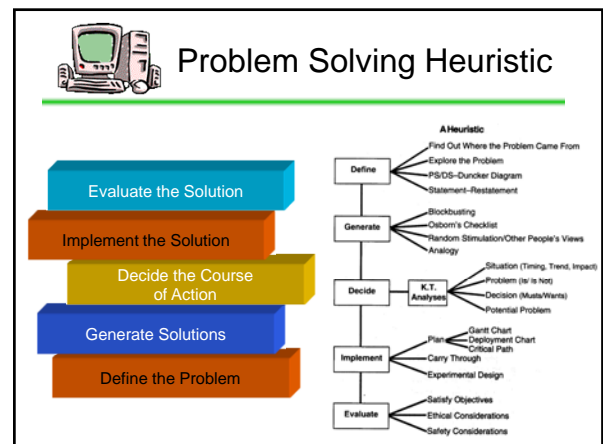
33




34



35



36



Modeling

Questions?

