

A theory may be so rich in descriptive possibilities that it can be made to fit any data.

- *Phillip Johnson-Laird*  
*The Computer and the Mind*

Other Business

# Groups

- ~ Team 1 - Bioprocess
  - ~ Abbie, Nick, Brian
- ~ Team 2 - Ecological/Disease
  - ~ Jake, Jeremy, Neil
- ~ Team 3 - Ecological/Human/Disease
  - ~ Heather, Dave, Dolly
- ~ Team 4 - Biomedical Engineering
  - ~ Robert, Floyd
- ~ Team 5 - DNA & Disease Spread

# Homework Protocol

- ~ Class
  - ~ Homework assigned on Thursday
  - ~ Homework due the following Thursday
  - ~ ALL team member signatures must be on the homework (no signature = no credit)



# Homework Protocol

- ~ Assignment Team
  - ~ Choose relevant problems (2-4 problems depending on length) and have solutions ready
  - ~ Tuesday before assignment meet with Dr. Schreuders to get approval on choices
  - ~ Thursday before class post problems to homework discussion group
  - ~ Next Thursday post solutions in MS word format to homework discussion group

# Homework 1

- ~ Due Thursday, September 8
- ~ Log in to WebCT
  - ~ Team Discussion Group (private)
    - ~ Individual contact information
  - ~ Main discussion group (public)
    - ~ Group name
    - ~ Model design topic

# The Design Process:

*Modeling as Design*

## Engineering design is...

- ~ The organized *process* of creation
- ~ A *process* to create a product that...
  - ~ meets a given set of goals
  - ~ functions within a set of constraints

## What are the qualities of good design?

- ~ Functionality - Answers the right question
- ~ Quality - Gets the right answer
- ~ Safety - Operates within the limits of the data
- ~ Programmability - Matches the available software tools
- ~ Maintainability - Well documented modular design
- ~ Economical - Time is money
- ~ Ease of Use - Can someone else use your model?

So... How do we get there?

# The Stages of Model

- ~ Stage 1: Definition and specification of the model
- ~ Stage 2: Data acquisition and analysis
- ~ Stage 3: Discussion of solutions
- ~ Stage 4: Development and testing of the models

# The Stages of Model Design

- ~ Stage 5: Decide on the best model
- ~ Stage 6: Model implementation
- ~ Stage 7: Do it better next time

## *Stage 1: Definition and specification*

~ Questions????

## Define the product

- ~ What question are you going to answer?
- ~ What does the model do?
- ~ How does it perform its function?
- ~ How long does it have to last?
- ~ What are the limits of the model's use?

# Things to consider...

- ~ Models can be a revenue source or sink  
(my wife's previous company made  
~\$1M selling the results of 1 model)
- ~ Models can have significant political  
impact
- ~ Wrong results can have significant  
negative impact even resulting in death

# The model's specifications

- ~ What is the...
  - ~ Available hardware?
  - ~ Available software?
  - ~ Available personnel?
  - ~ Required accuracy?
  - ~ Penalty, if the answer is wrong?
  - ~ Maximum Cost?



# The model's specifications

- ~ What are the...
  - ~ Input Parameters?
  - ~ Output Parameters?
  - ~ Missing Data?
  - ~ Computational issues?

## *Stage 2: Data acquisition & analysis*

- ~ Answer the following questions from the literature...
  - ~ What do existing models do?
  - ~ Can I buy one?
  - ~ What models/similar models exist?
  - ~ How do they work?
  - ~ How can they be adapted to meet your specifications?

# Where can I find the information?

- ~ The library
  - ~ Books
  - ~ Research and Trade Journals
  - ~ Newspapers
  - ~ Government publications
  - ~ Engineering and biology textbooks

# Where can I find the information?

- ~ On-line sources of information...
  - ~ Open source software
  - ~ Professional associations
  - ~ Governmental agencies
  - ~ Manufacturers of similar products

# Where can I find the information?

- ~ People including...
  - ~ Faculty
  - ~ Collaborators
  - ~ Other Students

## *Stage 3: Discuss & generate creative ideas*

- ~ The Rules of Brainstorming
  - ~ Think outside the box
  - ~ Invite different kinds of people to generate ideas (e.g. friends, other engineers, biologists)
  - ~ Write down every idea that comes to mind (there are no bad ideas)
  - ~ Don't pass judgment on ideas or people

# Sifting through your ideas

- ~ Sifting the Ideas
  - ~ Examine the list to eliminate duplicates
  - ~ Clarify each idea on the list
  - ~ Evaluate each of the ideas
  - ~ Consider combining ideas
  - ~ Pick the best 3-4 ideas

# Refining your best ideas

- ~ Refine the Best 3-4 Ideas Using...
  - ~ Common sense/WAG/SWAG
  - ~ Economic analysis
  - ~ Engineering analysis
- ~ You may need to eliminate or add solutions at this stage

## *Stage 4: Develop & test your ideas*

- ~ Build quick and dirty models of 3-4 best choices
- ~ Models can include
  - ~ Analytical Models
  - ~ Analog Models
  - ~ Experimental Models

## *Objectively evaluate your models*

- ~ Things to consider in evaluating your idea
  - ~ Does it meet the product goals?
  - ~ Does it meet the product specifications



## *Stage 5: Decide on your model's design*

- ~ WAG/SWAG check
- ~ Occam's Razor
- ~ Validation
- ~ External Evaluation/Peer Review

## Occam's Razor

- ~ William of Occam - 14th century English philosopher
- ~ *Non sunt multiplicanda entia preter necessitatem*
- ~ "Things should not be multiplied without good reason"
- ~ Eliminate all nonessential components

# WAG/SWAG Check

*Scientific Wild Aardvark's Guess*

- ~ Is the answer reasonable
- ~ Are the results consistent for minor changes in parameter
- ~ Would I look stupid presenting this result?
- ~ Would I look stupid not presenting this result

# Peer Review

- ~ Within the team
- ~ Outside the team
- ~ Outside the organization
- ~ Publication

## *Stage 6: Design implementation*

- ~ Documentation
- ~ Make any final improvements to the best design (don't be afraid to take ideas from your other designs)
- ~ Documentation
- ~ Build your final version of the design (this one should look nice)
- ~ Documentation

## *Stage 7: Do it better*

- ~ The goal of stage 6 is to improve your future models.
- ~ It is not a complain, whine, and moan session
- ~ In it you examine 3 topics
  1. People
  2. Process
  3. Product



## *Postmortem Questions*

- ~ You should ask the following questions for each of the 3 topics:
  - ~ What did we do right? (how do we do it again)
  - ~ What did we do wrong? (how do we stop from making the same mistake again)
  - ~ How do we prevent the problems from occurring again?

## The Stages of Modeling

1. Definition and specification
2. Data acquisition and analysis
3. Discussion of solutions
4. Development and testing
5. Decide on the best model
6. Model implementation
7. Do it better next time

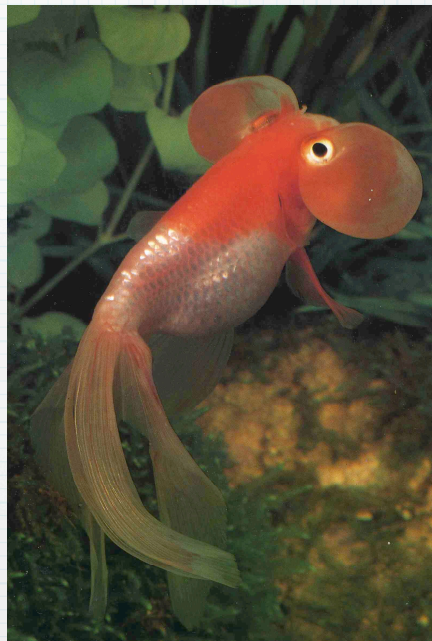
# Goldfish Breeding

- \* Breeding Cycle ~1/year
- \* 2-3 spawnings/cycle
- \* 200 eggs/spawn
- \* 80% fertilization rate
- \* 25 larvae/cu ft water



# Goldfish Adults

- \* 1% mortality in adults/month
- \* 25% loss due to genetics in high quality fish
- \* low quality fish = 1/4 value of high quality fish
- \* Value of high quality fish = \$20/lb



# Goldfish Summary

- \* Breeding Cycle ~1/year
- \* 2-3 spawnings/cycle
- \* 200 eggs/spawn
- \* 80% fertilization rate
- \* 25 larvae/cu ft water
- \* time to sale 6-12 months
- \* 1% mortality in adults/month
- \* 25% loss due to genetics in high quality fish
- \* low quality fish = 1/4 value of high quality fish
- \* Value of high quality fish = \$20/lb
- \* food conversion rate = 1:1 @ \$5.00/lb

