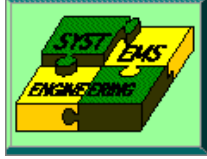
George Mason University



SYST 101: Intro to Systems

Lecture 2:

Jan. 22, 2004

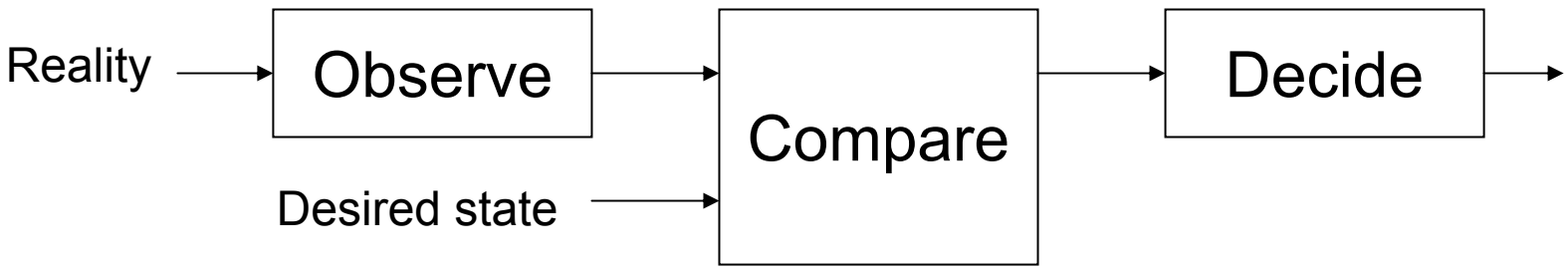
C. Wells, SEOR Dept.

Agenda

- Objective for Today:
  - Discussion of basic design processes
    - "How things get built"
  - Introduce "Functional Decomposition"
  - Discussion of Robotic Projects

Beginnings . . .

- It starts with an evaluation
  - Something is not right or could be better



Welcome to Ambiguity

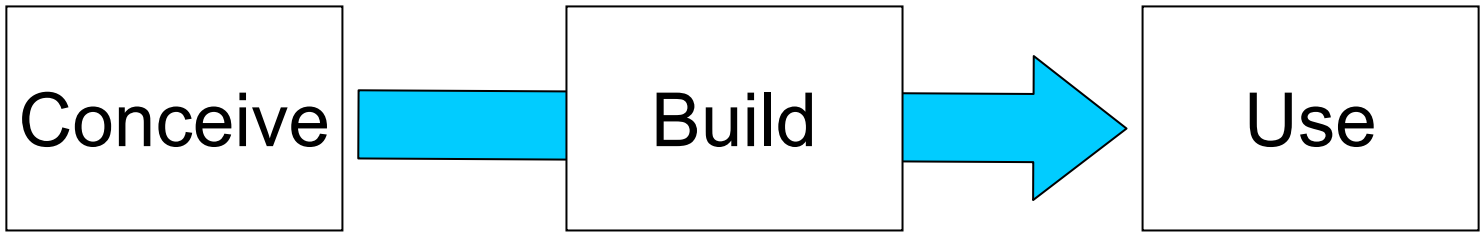
- Key concept is necessary and sufficient
  - It depends
- When we decide, how good is "good enough"
  - It depends
- When we observe, how good is "good enough"
  - It depends

Trial and Error . . .

- After you evaluate, you try something and see if it will work

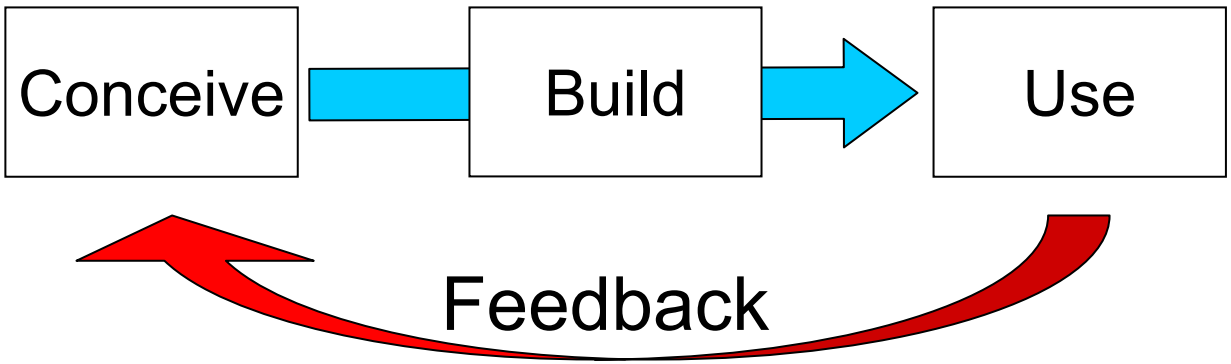
  - Where “evaluate” is the observe, compare and decide process

The Most Basic Creative Process
(the Trial Part)

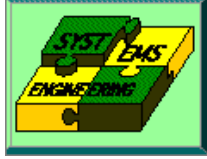


- Suitable for anything from stone chisels to life in general . . .
- But how do you Conceive?
  - You make an **educated** guess at the solution!

How Do Things Get Improved?



- By Feedback, where the use of the first version provides input to the second version
- Driven by evaluating the trial
- When do you stop? When is it good enough?
  - It depends

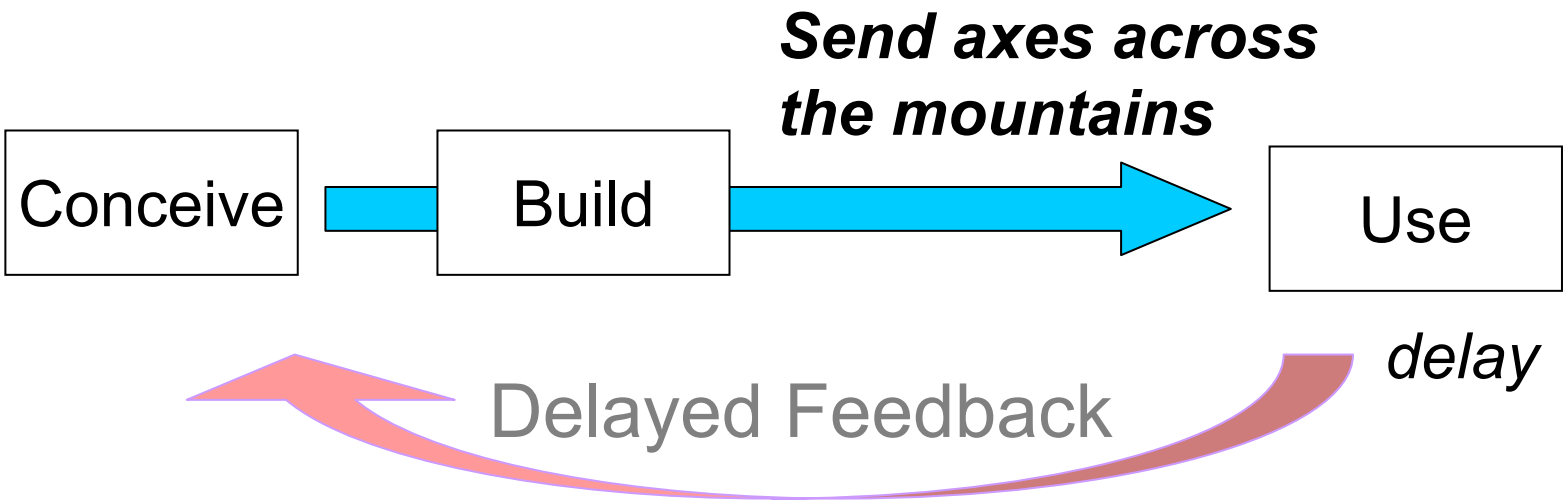


So...

- You make your first stone axe ...
- It works okay, but it could be better ...
- You make your second stone axe ...
- You have a happier consumer

Altering the Feedback Loop

- What happens when the feedback is inefficient or significantly delayed?



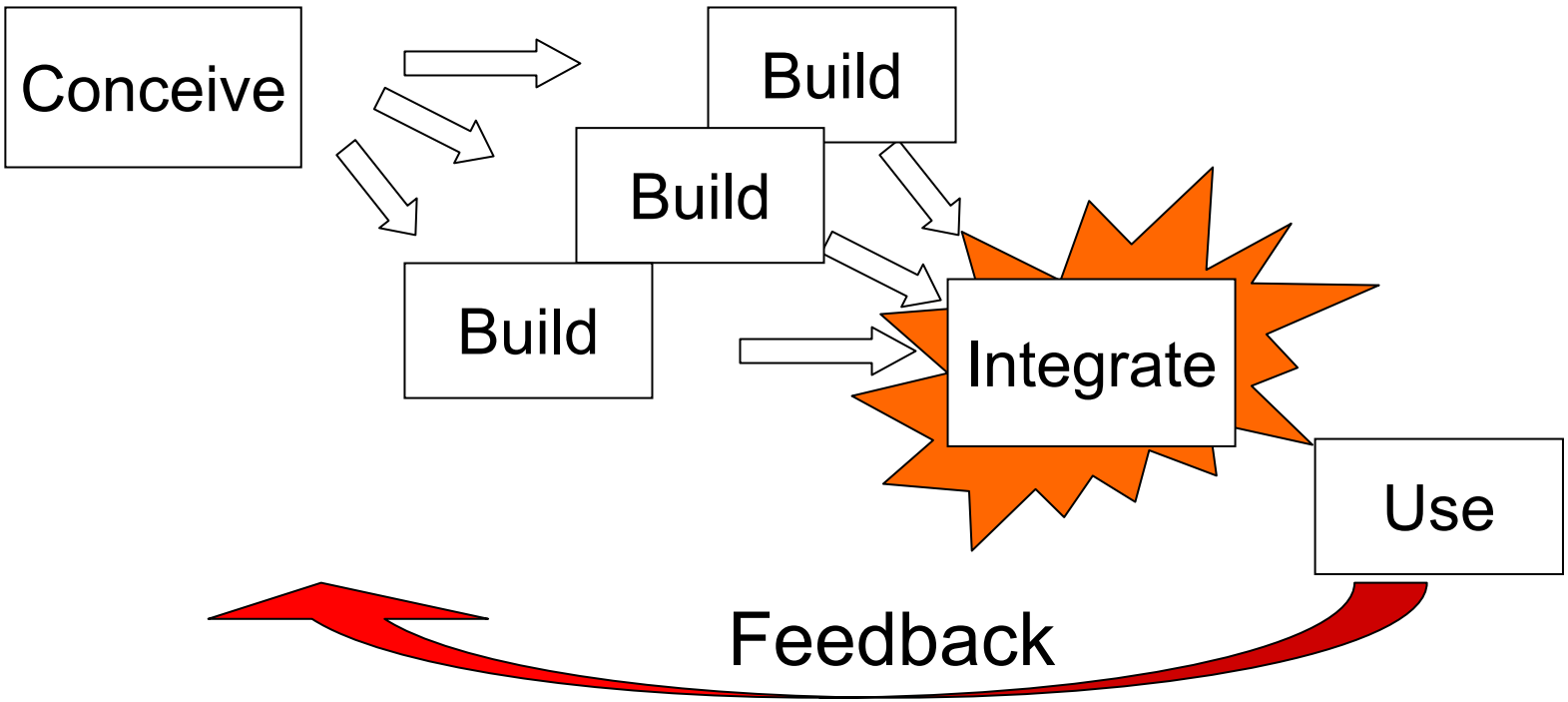
Feedback slowly and rarely comes back over the mountains from the users

Result

- You don't learn from your errors
- You keep making things the way you always did
- Product improvement is slow, erratic, if at all

A More Complex Build Process

- Our product now has three parts, built separately, that we need to fit together...

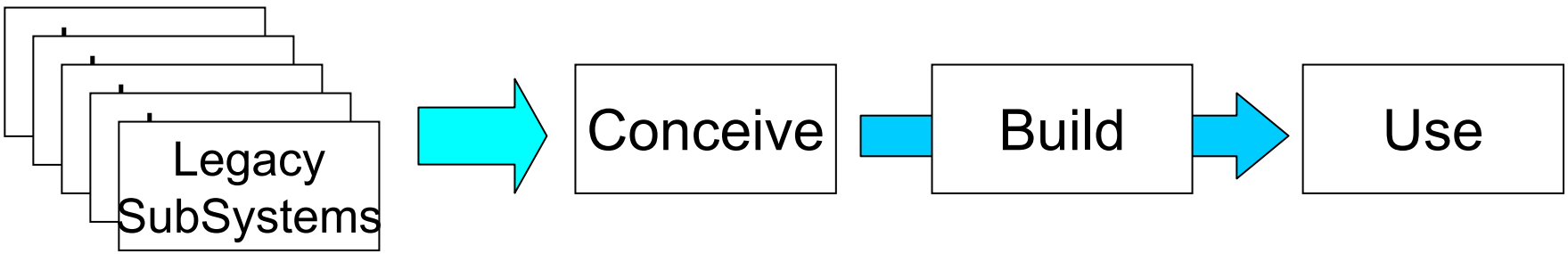


Integration Step

- If clear, unambiguous instructions haven't been given to each component builder, then integration doesn't go very well

Fusion

- A New System is envisioned that joins existing, independent pieces into a new kind of system
- Somewhat like a jigsaw puzzle, seeing how these pieces can fit together



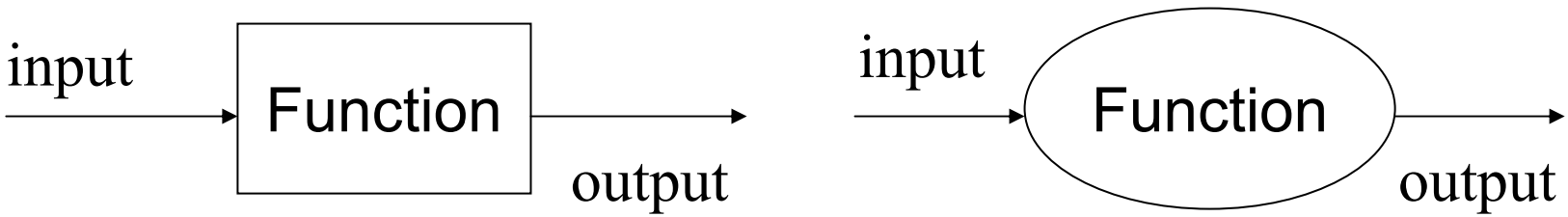
Knowledge & Understanding

"Legacy"

- In the sense of "inherited" from your ancestors. What has been left to you by those who have gone before
- Systems or components that
  - already exist
  - cannot be easily changed
  - must be included in or connected to your new system
- Using "off the shelf" elements can lead to similar problems

Processes, Activities, Functions

- All essentially mean the same thing
- A function *does* something
- A function has *inputs* and *outputs*
- Often graphically represented as a box or ellipse

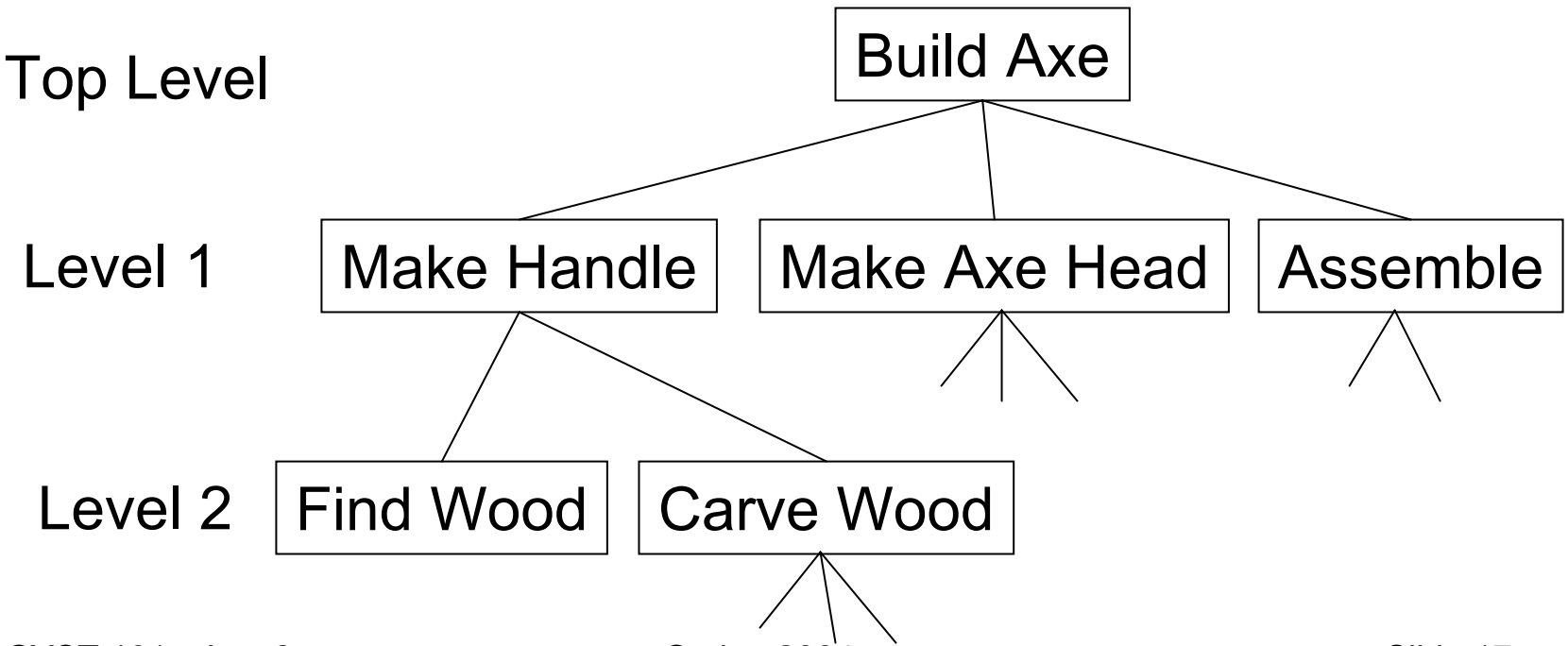


Functional Decomposition

- Any activity can usually be broken down, or decomposed, into smaller activities
- And those are broken down into more detailed activities, and so on...
- And the result is a hierarchical "decomposition" tree of functions

Details of "Build Axe"

- The hierarchy branches out as it gets more detailed, resembling an upside-down tree



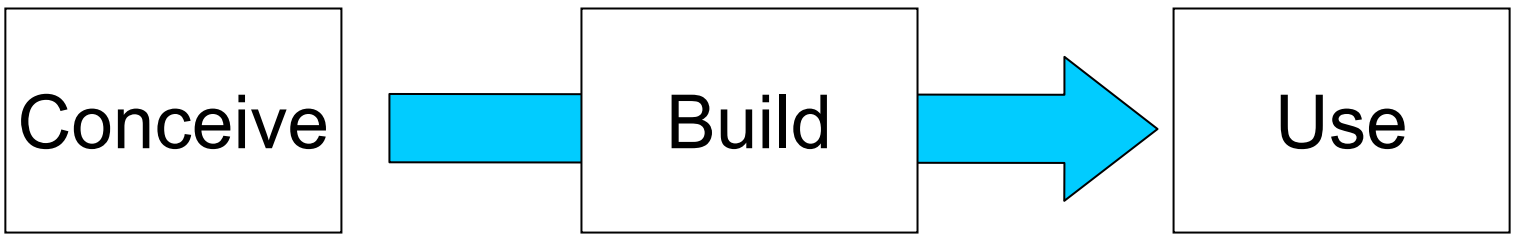
Applicability

- This “decomposing” of a job into smaller and smaller jobs (functions, activities) is key to
  - Systems engineering
  - Business process re-engineering
  - Biological life
  - Government
  - ...

Example: Building a Birdhouse

- Each phase will be broken down

"I'd like to build a birdhouse
for my little friends"



Build birdhouse in workshop

Install birdhouse in back yard

Birdhouse Concept
(part of initial evaluation)

- "Birdhouse" by itself is not specific enough
- Need to ask questions before a design can begin
- What kind of bird?
  - Large? Small?
  - Solitary nest or big group?
- House on a pole, or in a tree?

Concept to Design

- A well-conceived idea (i.e., a well defined concept) can then be turned into a design
  - beginning with an educated guess
- Design: a plan, drawings, a definition of the parts and their inter-relationships

Lego Mindstorms

- Kits contain:
- Software on CD
  - Install to your own computer
- Infrared transmitter & cable
- Mindstorms CPU (the yellow brick)
- Motors, sensors & cables
- Lots of Lego parts - bricks, axles, wheels, etc.

Two Phase Project
(Using System Engineering Processes)

- Phase I
  - Build a computer controlled robot that runs around in circles
- Phase II
  - Build a computer controlled robot that can
    - Follow a track
    - Run a maze

Assignments

- Reading
  - Invention By Design, Chapters 1 and 2
    - Ch. 1 is a very short introduction
    - Ch. 2 manages to make paper clips interesting!
- Homework
  - Petroski, exercise on pg. 28. Just draw your results, please don't turn in prototypes. ;-)
- Send your demographic e-mail !