Properties of People

(as they impact interaction technique design, implementation and use)

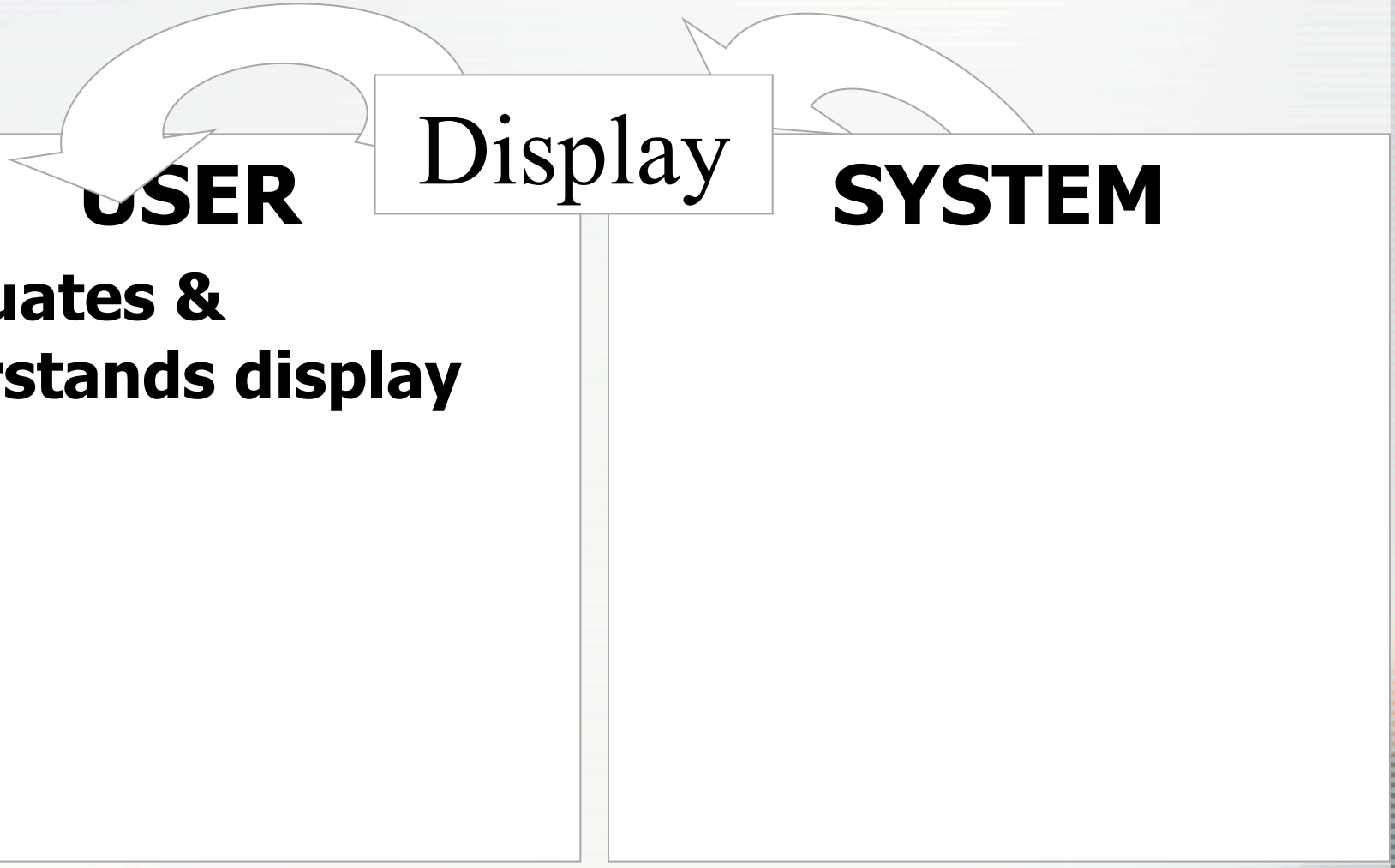
Administration

- **Assignment #6 set today**

Three Main Issues

- Mental Models
- Performance Characteristics of People
- Errors
- Cover again some past material
  - Some topics that are really important
  - Tie together some concepts that may seem separate
  - Think about these as we go through lecture

The "interface cycle"



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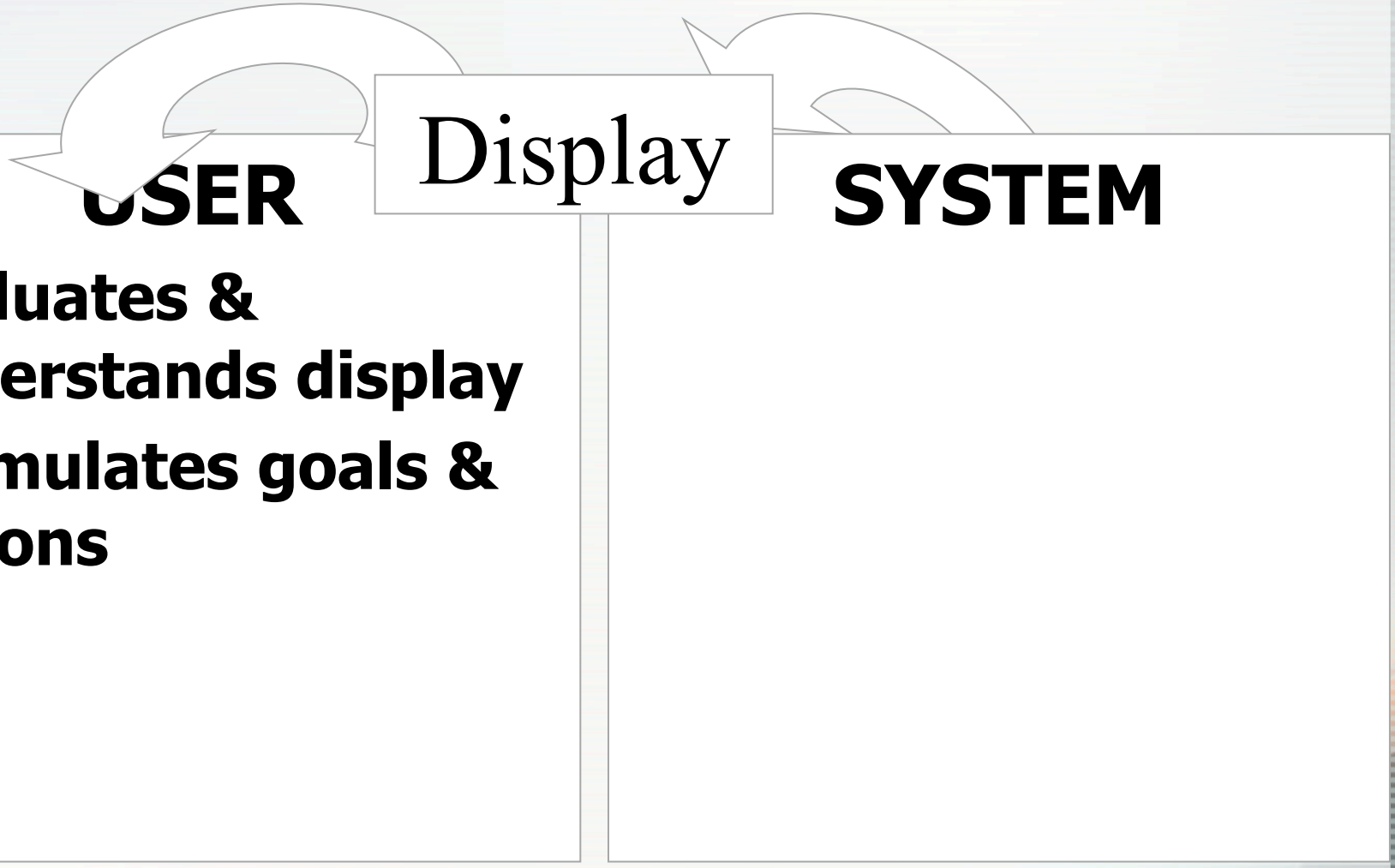

- **Evaluates & understands display**
- **Formulates goals & actions**

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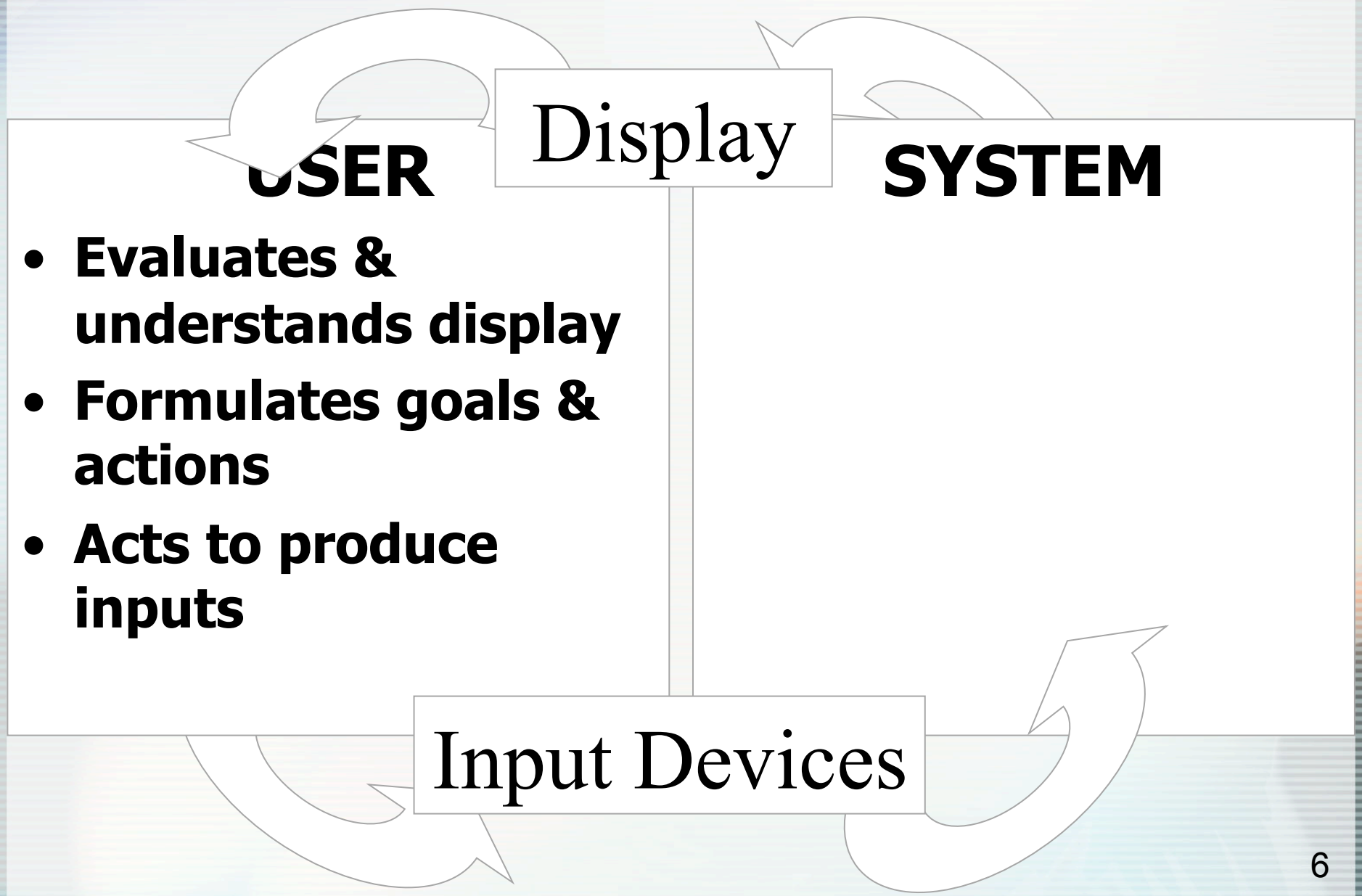

- **Evaluates & understands display**
- **Formulates goals & actions**
- **Acts to produce inputs**

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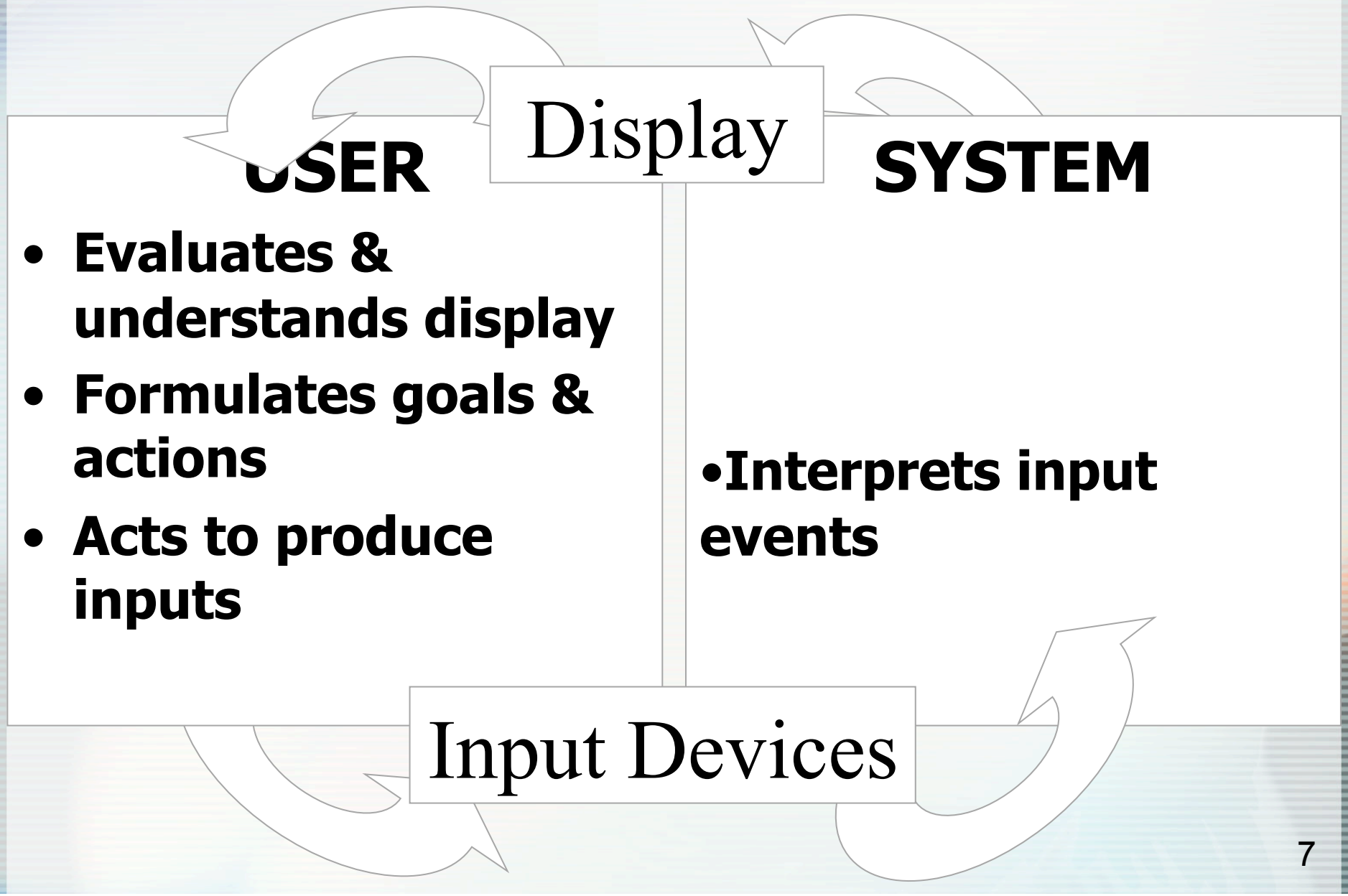

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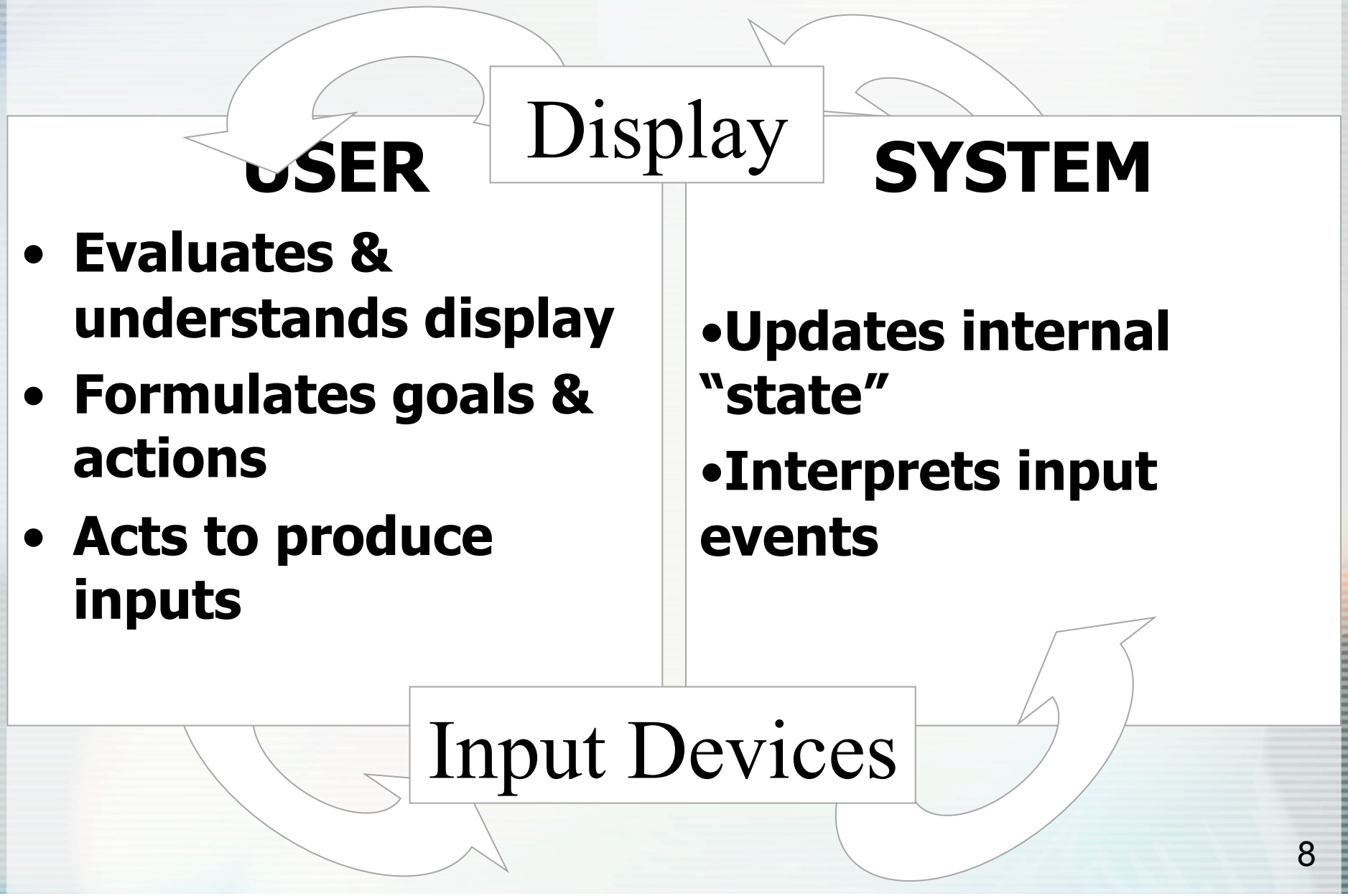
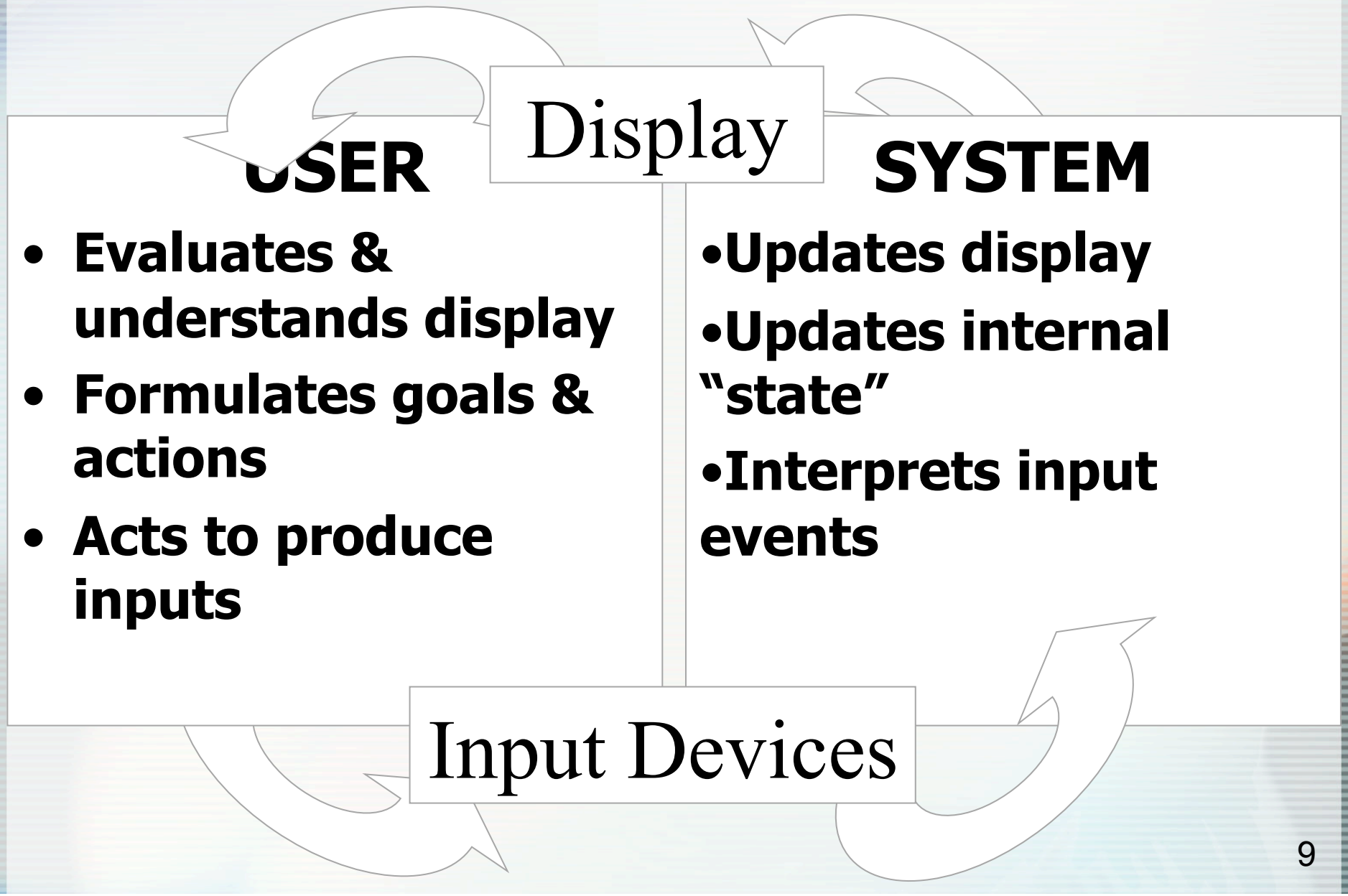


- **Evaluates & understands display**
- **Formulates goals & actions**
- **Acts to produce inputs**

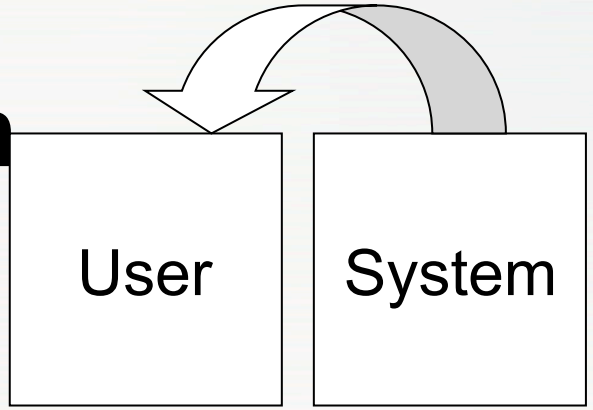
- **Updates internal "state"**
- **Interprets input events**

The "interface cycle"



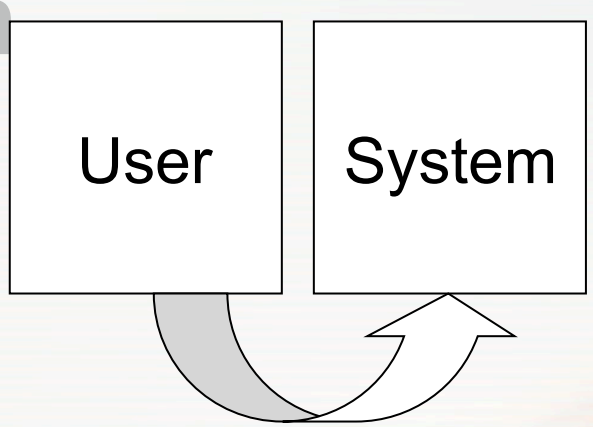
Norman's "Gulfs"

- **Norman describes 2 user activities as bridging**
  - **The Gulf of evaluation**



Norman's "Gulfs"

- **Norman describes 2 user activities as bridging**
  - **The Gulf of evaluation**
  - **The Gulf of execution**



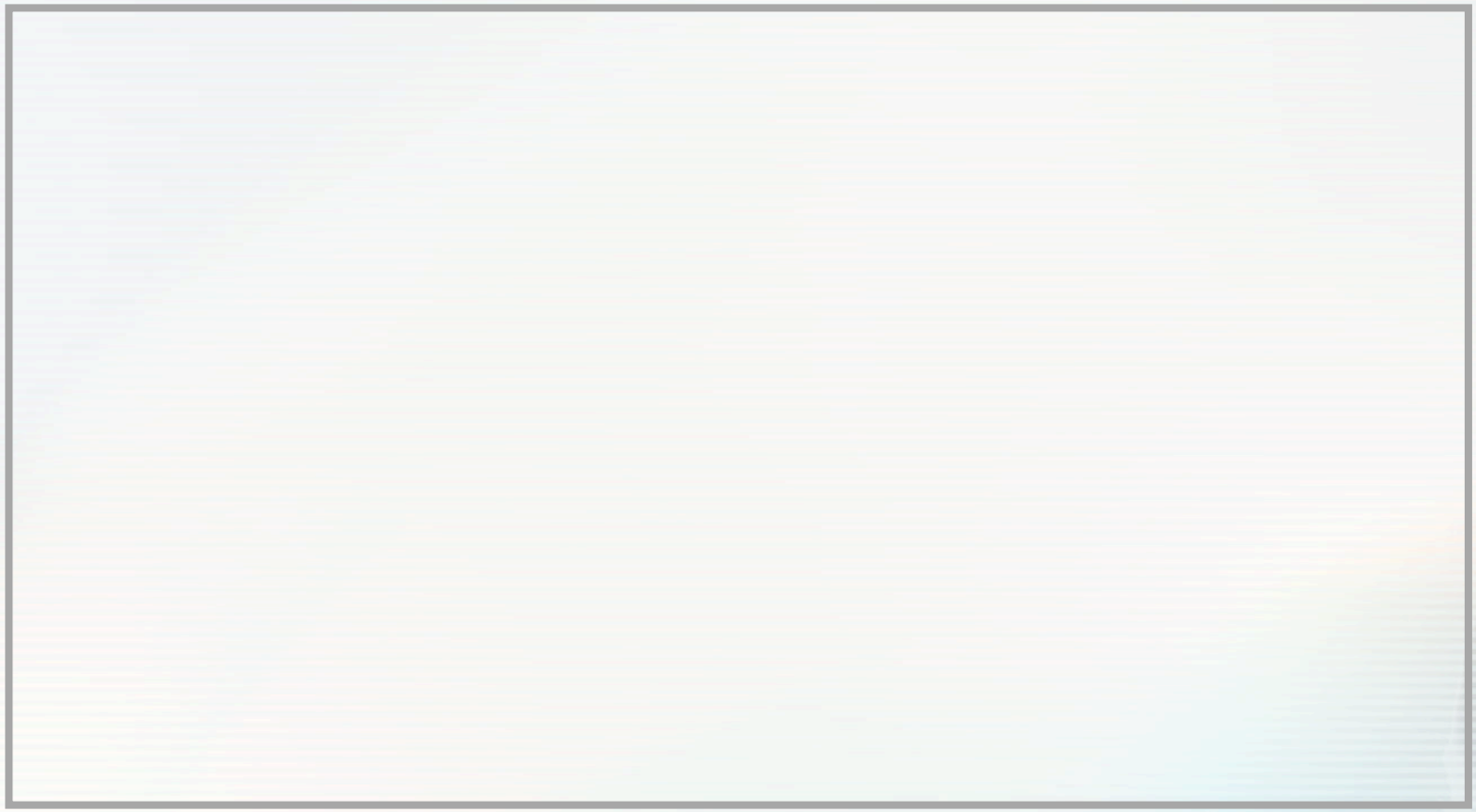
- **Making these "gulfs" (mappings) small makes the interface much easier to use**

Mental models

- To evaluate and act, people inevitably build models of how the system works
  - can't help but do it
  - may be highly detailed and functional
  - may be quite naïve
- Generally are not complete, not necessarily "logical", …

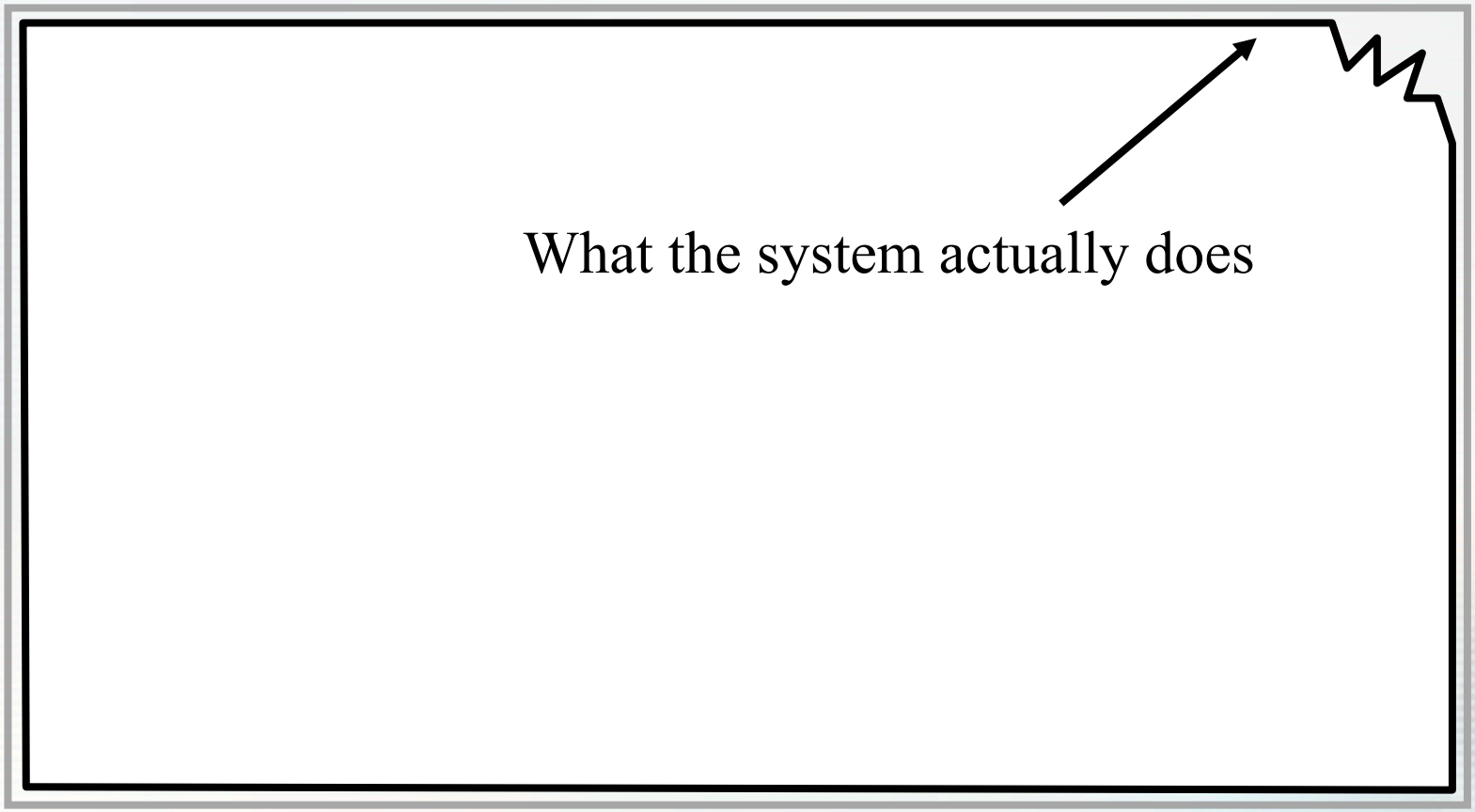
Model of mental models
(from Gerhard Fischer, U of Colo.)

What the system designer thinks the system does



Model of mental models

What the system designer things the system does



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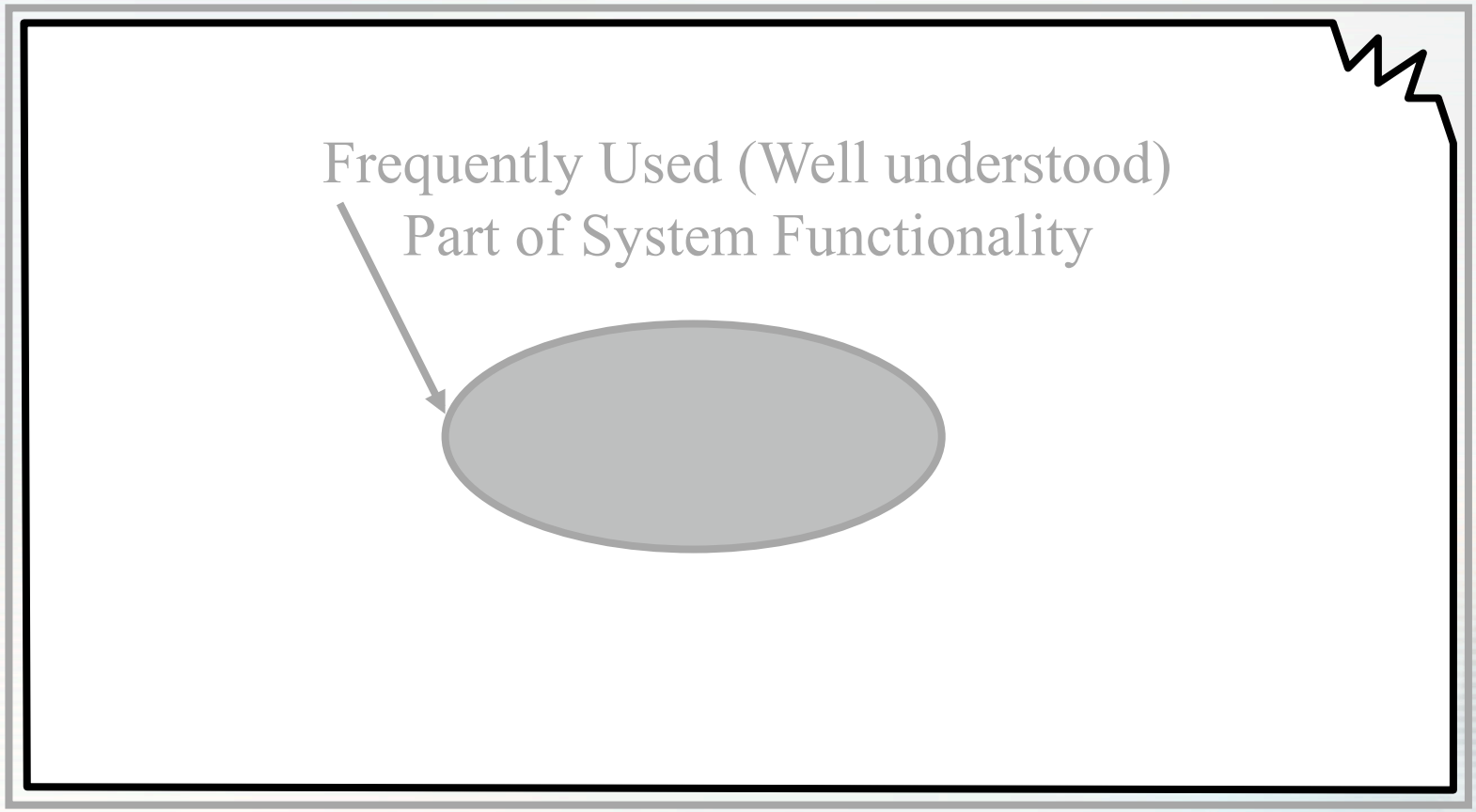

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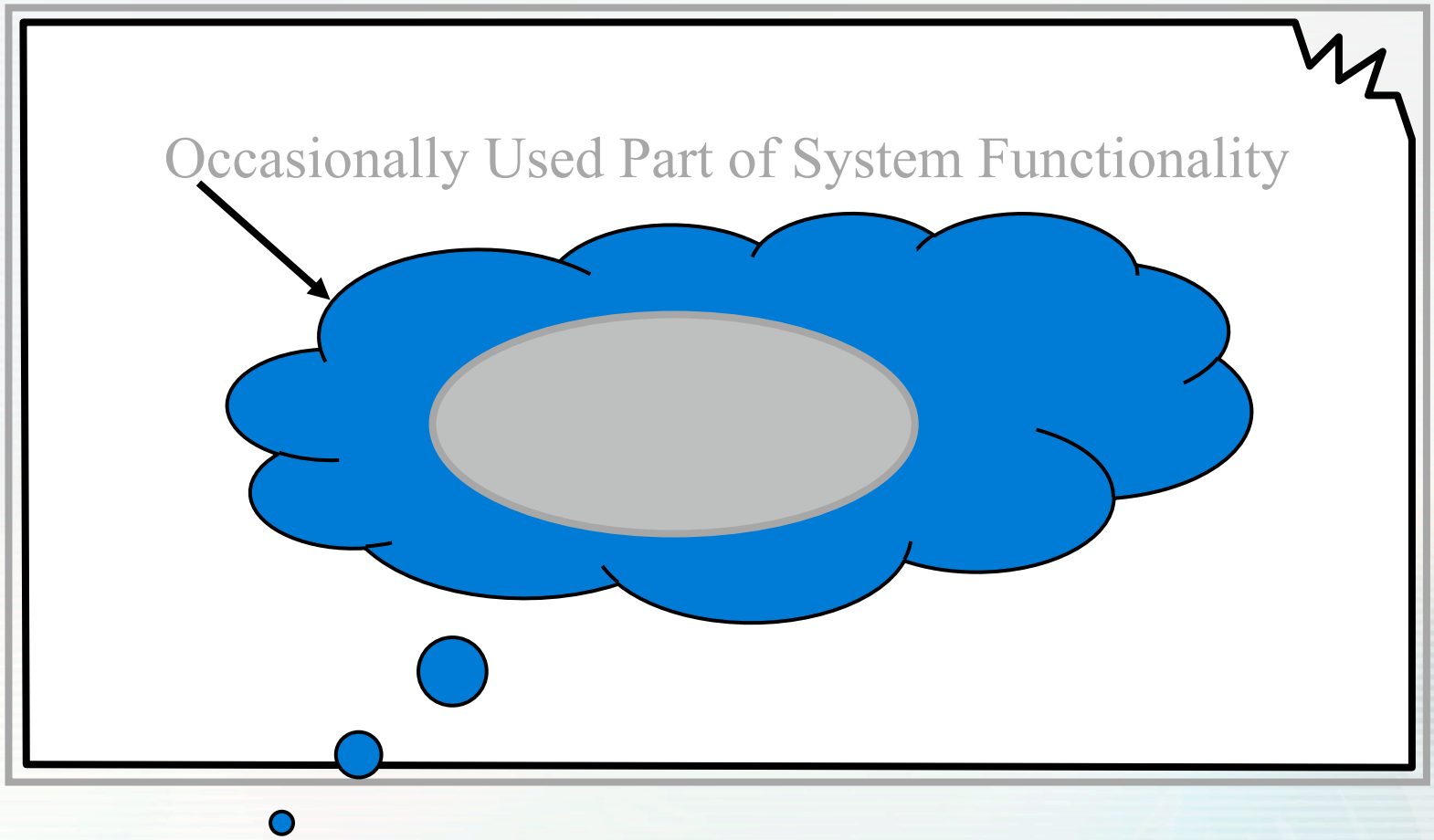

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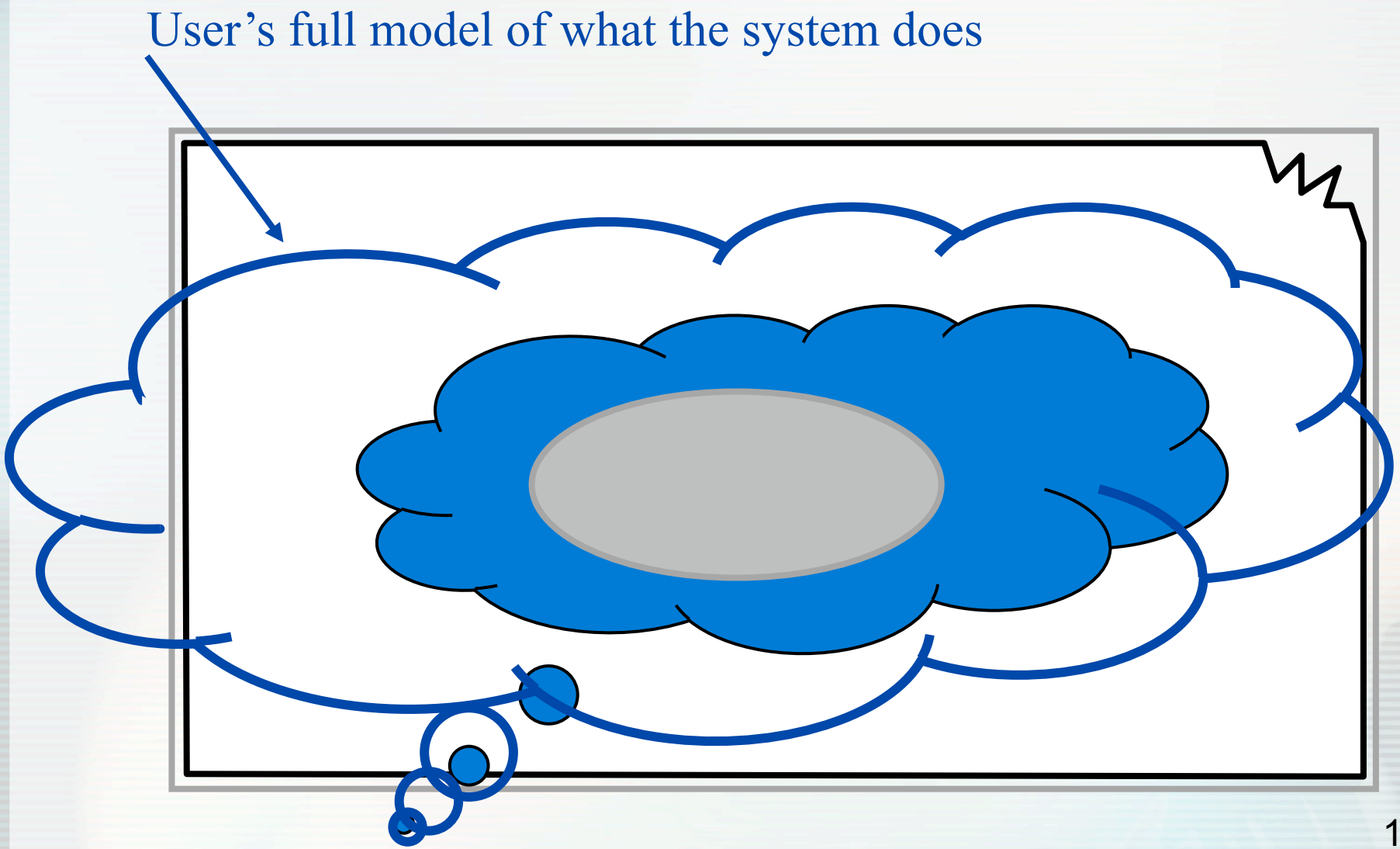
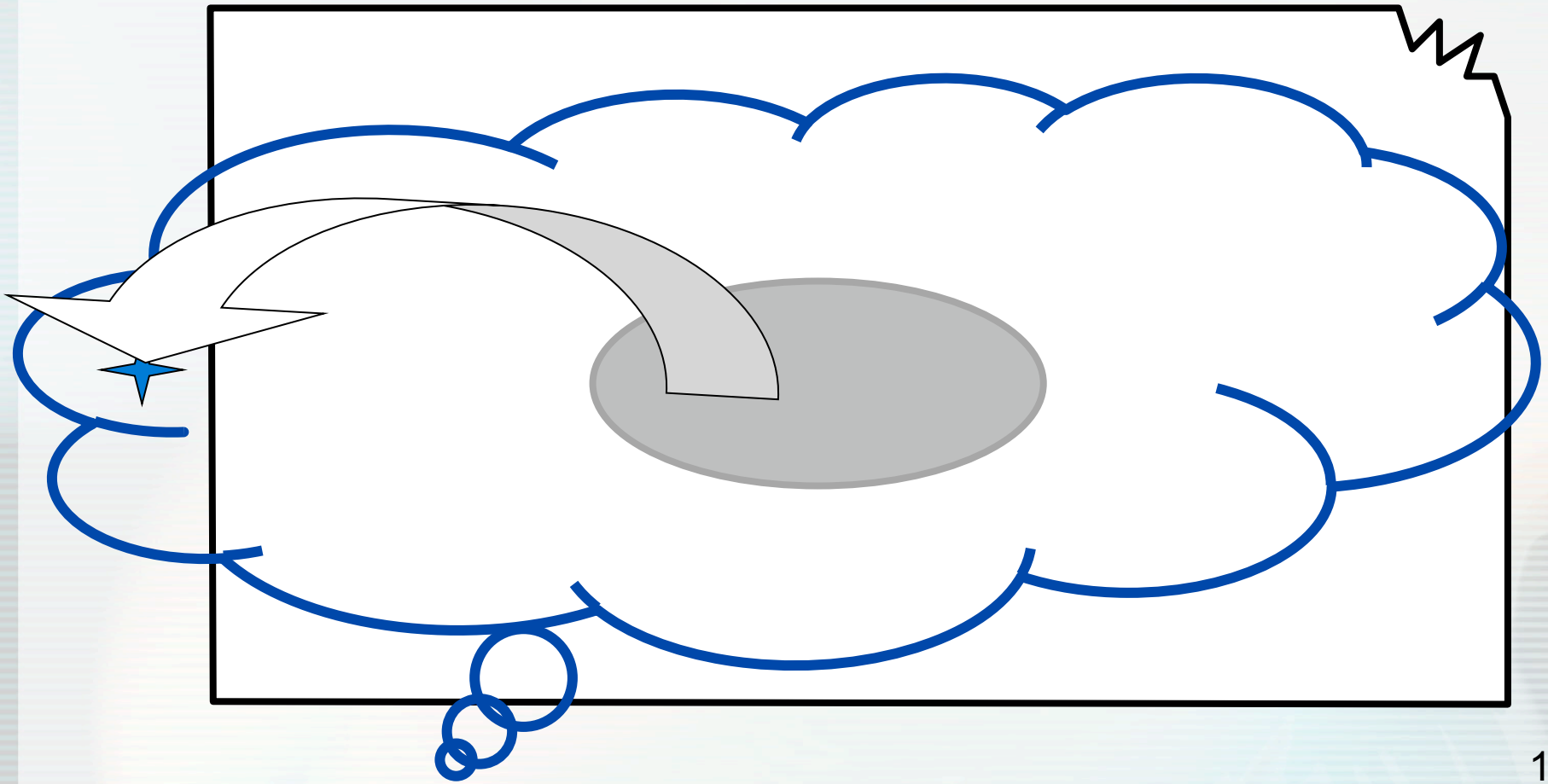


Key points about mental models

What happens here is very important



Key points about mental models

- The system designer has too good a mental model
  - Nearly perfect mental model
  - Really good prediction of what system does
  - Real user's can't ever have that good a model

UI Design Guideline

A system implementor cannot pretend to be a user

- **You know too much**
- **You can't forget**

→ HCI Mantra:

"The user is not like me!"

Design is only part of the process

- Design is important
  - Get close to real thing
  - Right conceptual framework, etc.

- But only part of overall process
  - Can't get it completely right *a priori*
    - Just too hard
  - Need overall iterative process
    - *i.e.* the full HCI process

Good User Interfaces

- **A user interface is good if:**
  1) **It offers (convenient access to) the functionality needed to perform the task efficiently**

  2) **The user's mental model accurately predicts interface action**

Good User Interfaces

- From traditional CS point of view
  1) is fine: "design in the right things"
  2) is a big problem
  - Good UI is not a function of the software!
  - Good UI is (mostly) a property of the user!

Good UI is a property of the user

- On a per user basis
- We don't even have control over much of this
  - e.g., baggage from existing mental models
- Aaaargh!
  - But this is reality

How do we deal with this?

- Carefully and explicitly structure our designs to try to induce the right mental model in the user
  - and test that it does!
  - and fix it when it doesn't (full process)
- Have explicit "conceptual model"
  - view of what mental model we are trying to give

Principle:

- **People can't form very good mental models of things they can't see**

Two specific things to worry about

- **Affordance**
- Feedback

Affordance

- Opportunities to act which are readily apparent to the user
  - Form "affords" certain actions and makes that apparent
  - Allows and promotes certain actions
    - Door knobs afford turning
    - Handle of hammer affords grasping in a particular way

Affordance

- **Example: Knurling**
  - **Small ridges typically found on knobs**

- **Increases friction => Affords grip**

"Virtual affordances"

- Don't typically have much physical form in a GUI

- But, visual appearance can still suggest function

"Virtual affordances"

- **Don't typically have much physical form in a GUI**

Note that you don't have to know about knurling for this to afford "grip" with the mouse

- **Reminders of the real world work**

Two specific things to worry about

- Affordance
- **Feedback**

Feedback

- Response by the system to the actions of the user
  - Cause and effect
  - Essential for forming mental models
- Making "system state" visible

UI design guideline

- Explicitly design a conceptual model and use
  - affordance
  - feedback
- (and everything else you have) to reinforce it

Performance properties of people (as related to interaction)

- (Only a few here)
- How long will things take?
  - e.g., physical movements
- How much can people remember?
- How fast are thing perceived?

How long will user actions take

- Strong models for physical movement
- Again: Fitts' law predicts movements as a function of distance and required accuracy:

$$T = A \log_2(D/S + 0.5) + B$$

How much can a person remember

- Short term (working) memory
  - Famous 7± 2 "chunks"
    (Somewhat outdated model)
  - For us just: "very limited"
- Long term
  - Essentially unbounded
  - But requires effort and may not always work on cue
  - Can't explicitly forget!

How much can a person remember

- **Implication:**

  Generally better to rely on recognition (seeing it in front of you) than just recall (having to pull it out of long term memory)

- **Novice / expert differences**

How fast are things perceived?

- < ~20ms (1/50 sec) discrete images/flashes merge into continuous perception
  - Image you are looking at flickers 60 times per second
  - Differences in peripheral vision across users

How fast are things perceived?

- < ~20ms (1/50 sec)
- Displays update at 50-75hz
- Don’t ever have to be faster than this for user response!

How fast are things perceived?

- < ~100ms seems like "instant response"
  - Hard to tell response times below this apart

How fast are things perceived?

- 100ms (1/10 sec)
- Except some animation, most things don’t need to be faster than this

How fast are things perceived?

- < 1-2 seconds typically "good response time"
  - Similar times in conversational turn taking protocols
  - Longer delays ~5 sec have to say something to keep conversation alive

(Note: numbers fuzzier as we go out)

How fast are things perceived?

- **> 10-15 sec is typically "bad response time"**
  - **–STM decay effects**

A little about response times

- Good vs. bad response time is very dependent on expectation
  - If you can't meet the goals, manipulate user expectations!
- Consistency of response is very important
  - Can be more important than time

Advice/Guideline (from Donald Knuth):

- **Premature optimization is the root of all evil**
  - **Build it and refine usability first**
  - **Only optimize if usability tests say you have to**
  - **CS intuitions about this misleading**

How long do other cognitive activities take?

- Unfortunate, but…
  - Not as well understood
  - Much harder to apply what is understood
  - See other HCI courses for some of this

We do know essentially minimums

- "Cycle" times for "Human Processor"
  - Perception, Processing, and Motor cycles
  - Ballpark: ~100-200ms each
- Can be used to predict reaction times and highly routine actions
  - ➡E.g., it takes at least ~250ms to act on something
- Harder to use for complex things and/or with learning

Final property of people: Errors

- People make lots of mistakes!
  - A fundamental property of people
    - Lots of errors
    - Everyone
    - All the time
- If you are designing for real people then…

UI design guideline

- Errors are not exceptional events!
  - Part of the expected and normal
  - Despite nomenclature
  - System has to be designed from the bottom up to deal with errors at least as effectively as other actions
- Sharp contrast to how I was taught to program

Handling errors is critical to mental model formation

- How do people learn?

Handling errors is critical to mental model formation

- How do people learn:
  - Read the manual

    (not if they can help it!)

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  - Get help from friend / expert

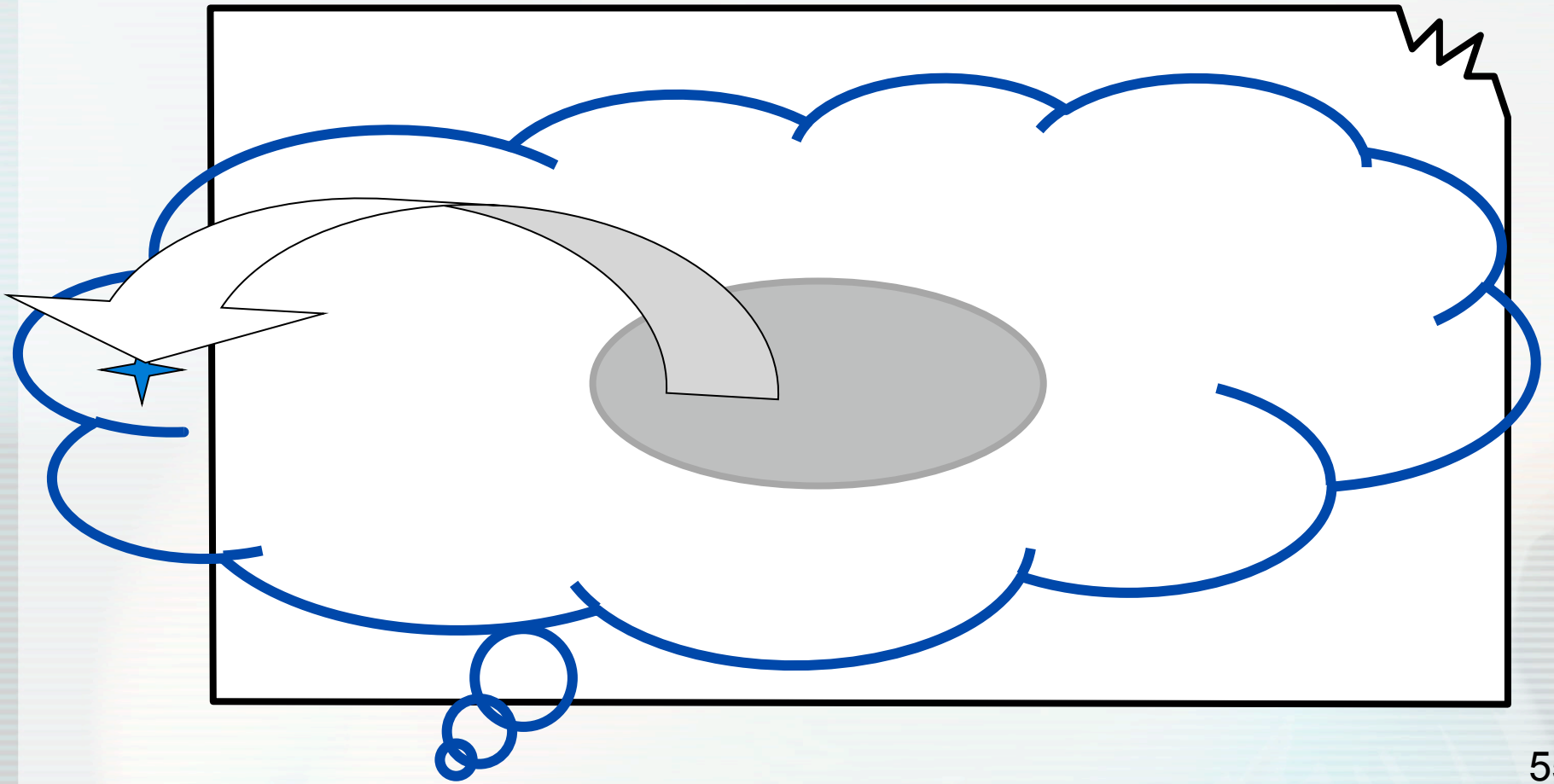
    (more likely, but expensive)

Handling errors is critical to mental model formation

- How do people learn:
  - Read the manual
    (not if they can help it!)
  - Get help from friend / expert
    (more likely, but expensive)
- Explore!

Handling errors is critical to mental model formation

Does this make things better or worse!?



Undo and errors

- Perceived danger of straying outside known strongly affects willingness to explore
  - Hence ability to learn
- Various forms of undo have a major effect

Summary UI design guidelines

- **Pay attention to:**
  - **Affordance**
  - **Feedback**
  - **Performance**
  - **Likely errors**

Questions?