

# i213 User Interface Design and Development

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School of Information, UC Berkeley

October 17

Affordances and Mental  
Models

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Cognitive approach to UI design

Focuses on cognitive aspects like

affordances, constraints, models,

feedback and visibility



# PARADOX OF TECHNOLOGY

Technologies start off complex, while designers struggle to balance need and technical capabilities.

Eventually, a simple and elegant design wins.

Competitors introduce new features, at the expense of added complexity...



# AFFORDANCES



# AFFORDANCES

“Affordances are properties of the world that are compatible with and relevant for people’s interactions”

*Physical affordances* are more relevant for product designers (and for mobile app developers)

On a virtual display, *perceived affordances, conventions and constraints* play a bigger role

# AFFORDANCES

“actual and perceived properties... that determine how the thing could be used.”

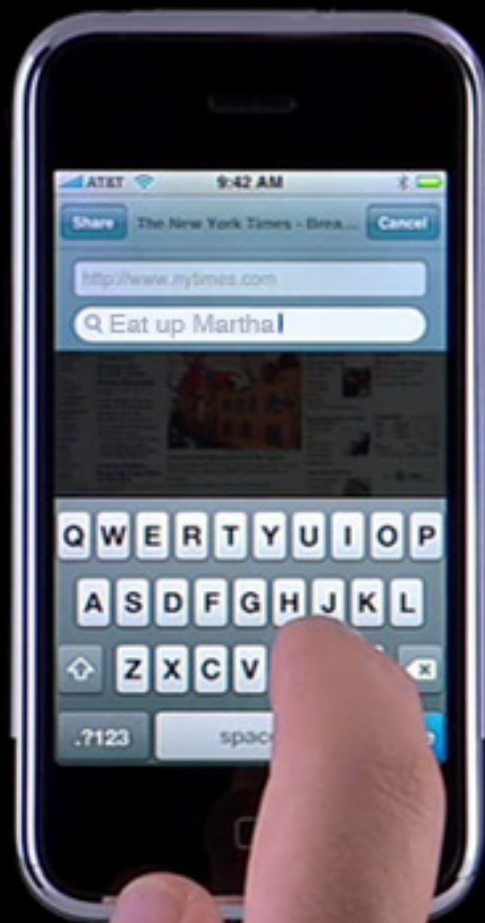
Based on J.J. Gibson's research in psychology

Focused on immediate cognitive aspects of the environment, as opposed to memory-based information processing









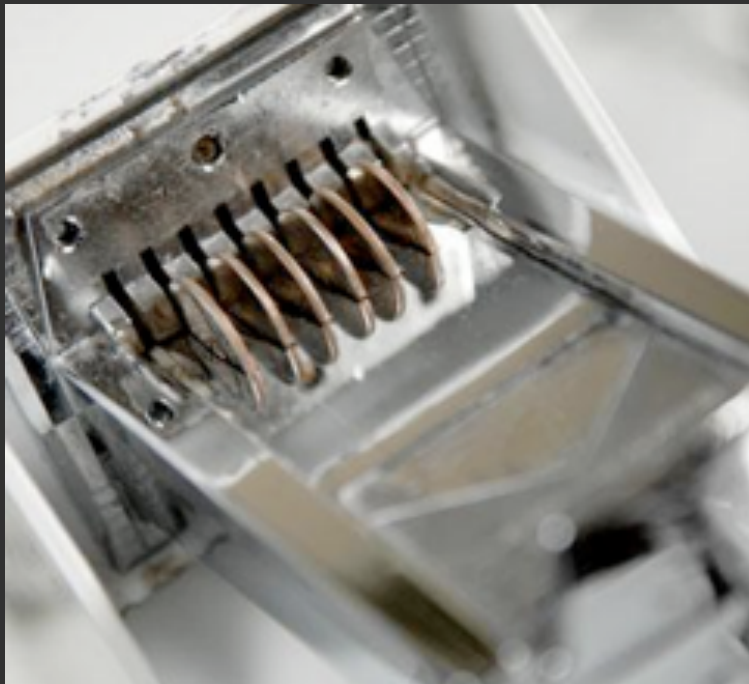
# PERCIEVED AFFORDANCES

Useful to separate existence of an affordance with its perception

	Perceived	Not Perceived
Affordance	Perceptible Affordance	Hidden Affordance
No Affordance	False Affordance	Correct Rejection

# NESTED AFFORDANCES

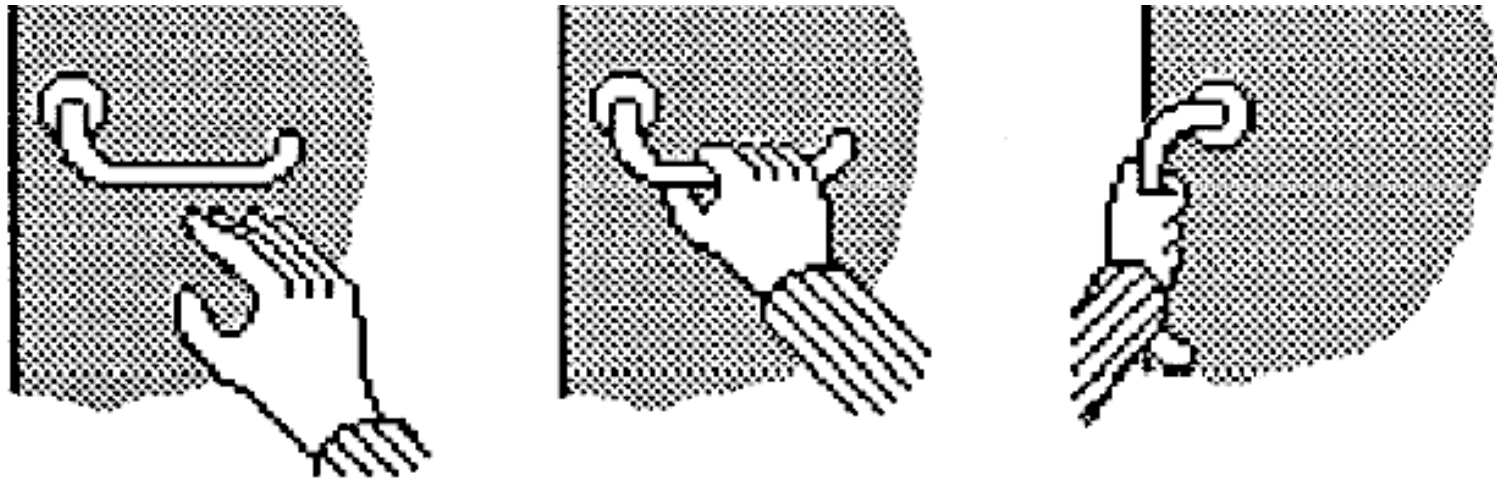
Affordances that are grouped in space, where knowledge of one improves understanding of another



# SEQUENTIAL AFFORDANCES

“...situations in which acting on a perceptible affordance leads to information indicating new affordances”

“Affordances are not passively perceived, but explored... Learning is a matter of attention rather than inference.”



# AFFORDANCES ACROSS SENSES

Visual  
Tactile  
Auditory  
(can be sequential)



# MAPPING

Mapping is the relationship between controls, their movements and results in the world. Natural mappings draw upon physical analogies and cultural standards, leading to immediate comprehension









## VISIBILITY

Make the important functions immediately visible to the user

Becomes more difficult when the number of functions exceeds the number of controls









# Google



Google Search

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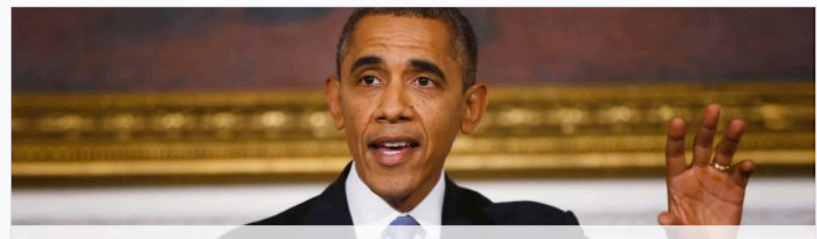


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**Obama: Americans 'completely fed up'**

As the government reopens, the president moves to assure the world the U.S. will get a bigger budget deal done. **'We'll bounce back'** »

College football mutiny

NBA's young power broker

Mitch McConnell's big deal

Obama: Citizens 'fed up'

True cost of shutdown

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Each week the Noise highlights 10 somewhat un-obvious names who he believes are destined to implode leave egg on his face. To qualify, each player must be Roto Arcade

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**Arkansas would like you to know how Bret Bielema courted his wife**

The most fun college football love story may be Bret and Jen Bielema. Well, they hold the title until Kliff Kingsbury is spotted dating an actress or something. And Dr. Saturday

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Seattle Seahawks standout Richard Sherman is never shy about proclaiming he is the NFL's best cornerback. Sherman is also not afraid to give another cornerback a

Trending Now [Watch the show »](#)

- |                     |                           |
|---------------------|---------------------------|
| 1 Soleil Moon Frye  | 6 Pat Summitt             |
| 2 Kenan Thompson    | 7 Maria Kang              |
| 3 Yeti bear         | 8 50 Shades               |
| 4 LAX police arrest | 9 Oregon Ducks            |
| 5 Epinephrine       | 10 Harley-Davidson recall |

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63°F Fair

Today 77° 53°	Tomorrow 75° 53°	Saturday 77° 53°
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Quotes Yahoo Finance

S&P 500	1,727.84	↑	0.37%
NASDAQ Composite	3,852.53	↑	0.34%
Dow Jones Indust...	15,326.12	↓	-0.31%

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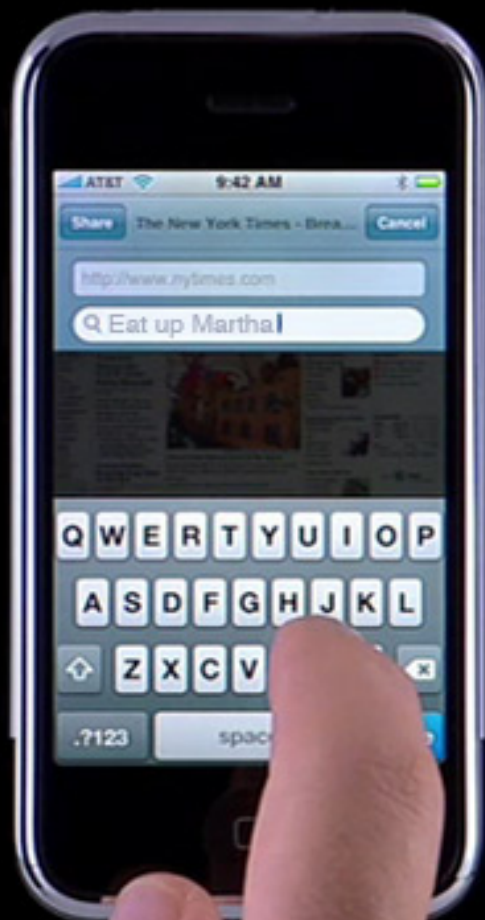
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“Sending information back to the user about what action has been done, what result has been accomplished”

Allows the user to understand the incremental results of his actions





# MAPPING, VISIBILITY & FEEDBACK

Mapping: Maintain logical or semantic correspondence between controls and their effects

Visibility: Make relevant parts visible

Feedback: Give each action an immediate and obvious effect

(Sounds can and should also be used for visibility and feedback)



CONSTRAINTS



# CONSTRAINTS

*Affordances* provide opportunities for action

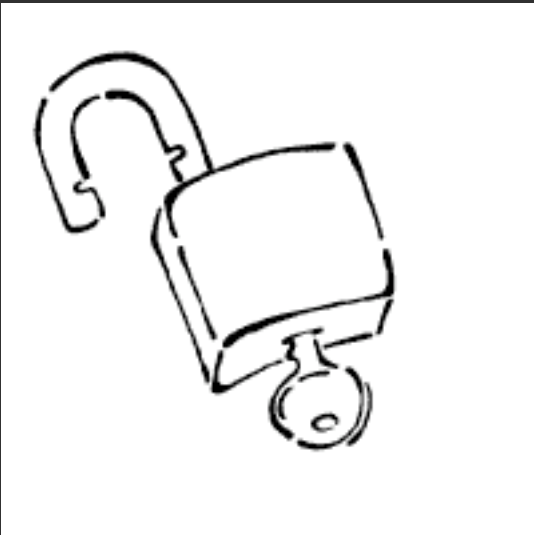
*Constraints* limit the acceptable actions; allowing the designer to guide the user

- Physical constraints
- Logical constraints
- Cultural constraints

# PHYSICAL CONSTRAINTS

Physical constraints physically limit the possibilities for action

“Closely related to affordances”





# LOGICAL CONSTRAINTS

“Use reasoning to determine the alternatives”

“Go hand in hand with a good conceptual model”



# CULTURAL CONSTRAINTS

“Rely on accepted cultural conventions”

“They evolve and require a community of practice”

facebook

I Am:

✓ Female

Male

Show my sex on my timeline

Google+

Gender

Female ▼

Male

Female

Other

# Mental Models

## THE TROUBLE WITH MEMORY

It is hard to remember things! (especially arbitrary, detailed things)

Short-term memory is small and unreliable

Long-term memory is slow and complicated to access

It is difficult to get stuff from STM into LTM, and vice versa

# KINDS OF MEMORY

## For Arbitrary Things

- Requires rote learning
- Cannot be extrapolated

## Based on Analogy

- Analogy to something we know makes it easier to learn and remember
- Only need to remember the relation / difference

## Based on Understanding

- Allows for extrapolation
- Can be self-evident



# KNOWLEDGE IN THE WORLD

We don't have to memorize every detail about what we do, because there are reminders in the world

- Labels
- Affordances
- Mappings
- Constraints
- Conventions

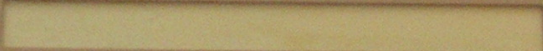
Examples: Hunt-and-Peck Typing, mnemonics



**SMITH  
CORONA**

Spell-Right Dictionary  
WordProcessing Typewriter  
**XD 7700**

End of Page    Pitch    Line    Indentation    Keyboard



Contrast    **AUTO**    **TAB**    **AUTO**    Cursor Back

MEM.  
LINE  
TYPE

ON

Tab 9	1	2	3	4	5	6	7	8	9	0	Back Space
Tab	Q	W	E	F	T	Y	U	I	O	P	Return
Lock	A	S	D	F	G	H	J	K	L	:	Retoc
Caps Lock	Stop	Find	KB II	List	:	:	:	:	:	:	Retoc
Shift	Paper In	Z	X	C	V	B	N	M	:	?	Shift
Code	Margin	L	R	Half Space	Word Eraser	Correct	Line Eraser	Correct	Adv		

# TRADE OFFS

	Knowledge in the World	Knowledge in the Head
Retrievability	Whenever present in the location	Requires memory search or reminder
Learning	Not needed	Needed
Efficiency	Requires finding and interpreting	Can be immediate
Immediate Usability	Yes	No, requires learning
Aesthetics	Can be cluttered	Can be elegant

## GUI versus KEYBOARD SHORTCUTS

	GUI	Keyboard Shortcuts
Retrievability	Apparent from the design	Requires memorization
Learning	Not needed	Needed
Efficiency	Requires visual search	Can be immediate
Immediate Usability	Yes	No, requires learning
Aesthetics	Can be cluttered	Can be elegant

# MENTAL MODELS

*A mental model* allows users to understand and remember the mapping between actions and the resulting effects

Based on analogy and understanding

Affordances, Mapping, Feedback, Constraints, Conventions and Visibility can help users establish a mental model

# COOPER'S THREE MODELS

Implementation Model: The way the thing actually works

Manifest Model: How the designer intends the user to believe it works

Conceptual Model: The way the user actually thinks it works

# MANIFEST MODELS

“The closer the manifest model comes the user’s mental model, the easier it will be to use and understand”

Most software UIs are designed by engineers, so conform to the implementation model

By making the manifest model *simpler and closer to current practice*, we can make it easier to learn and understand



# METAPHOR

Metaphors build on analogy with some existing concept or idea

- “Files” , “Folders” , “Windows” , “Trash” ...
- User must *recognize* the metaphor, and understand how to *translate* it
- Can be hit or miss...
- Physical world metaphors can limit their virtual equivalents

Do visual metaphors help us understand file systems?



My Computer

Set Up The  
Microsoft  
Network



Network  
Neighborhood



Inbox



Recycle Bin  
Microsoft  
Internet



The Internet



My Briefcase

My Computer

File Edit View Help



3 1/2 Flo



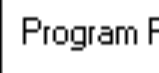
Control



1 objec

(C:)

File Edit View Help

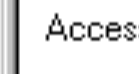
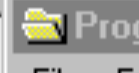


Config.wi

1 object(s)

Program Files

File Edit View Help



Plu

1 object

Plus!

File Edit View Help



Microsoft  
Internet

1 object(s) selected

Microsoft Internet

File Edit View Help



cache



lexplore



Inetwiz



Pnclient



Pnfront

2 hidden)

949KB



My Computer

(C:)

Program Files

Plus!

Microsoft Int...

11:56 AM


# WINDOWS 7

52°  
Fair  
55° - 37°  
Redmond, WA

MSN.com - Windows Internet Explorer  
http://www.msn.com/

MSN.com

Search that pays you



Hotmail  
Messenger  
My MSN  
MSN Directory

Sign in  
Make MSN your home  
Customize your page













Hotmail

http://login.live.com

Computer > Pictures > Sample Pictures

Organize New Folder Share with Slide show Burn

Pictures library Arrange by: Folder 2 library locations

 Autumn Leaves.jpg	 Creek.jpg	 Desert Landscape.jpg	 Dock.jpg
 Forest Flowers.jpg	 Forest.jpg	 Frangipani Flowers.jpg	 Garden.jpg
 Green Sea	 Humpback	 Oryx	 Toco Toucan.jpg

15 items

Windows 7 taskbar with icons for Start, HomeGroup, Internet Explorer, Mail, People, Windows Media Center, and system tray (volume, network, clock: 10:10 AM 9/30/2010)

## Apps

- Calendar
- Camera
- CineTrailer
- Desktop
- Euro Cup
- Finance
- Internet Explorer
- Mail
- Maps
- Messaging
- Music
- News
- People
- Photos
- SkyDrive
- Sports
- Store
- The
- Twee
- Vide
- Wea
- Winc
- Winc
- Xbox

## Search

Apps

- Apps
- Settings
- Files
- Store
- CineTrailer
- Euro Cup
- Finance
- Internet Explorer
- Mail





# IDIOMS

“All idioms must be learned. Good idioms only need to be learned once”

Idioms focus on being easy to learn and recognize

We learn many UI features as idioms, rather than metaphors

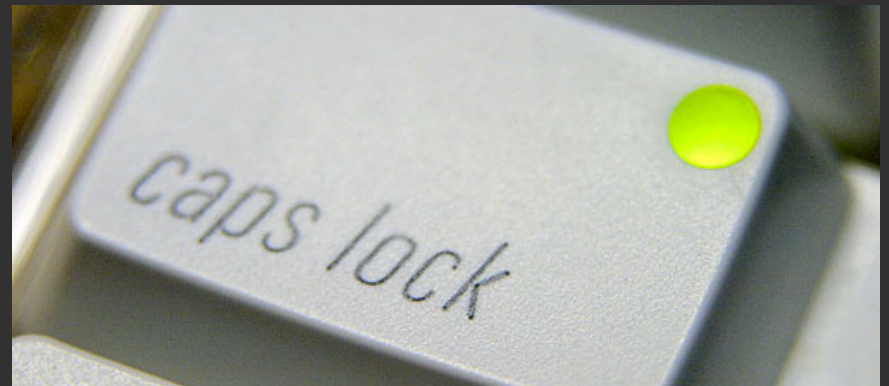
The WIMP metaphor succeeded because of its visual idioms and limited vocabulary of primitive actions

# MODES

A mode is a state the program can enter where the effects of a user's actions change from the norm''

Active (SHIFT) or Passive (CAPS LOCK)

Make it easy to change the mode and to see which mode you are in



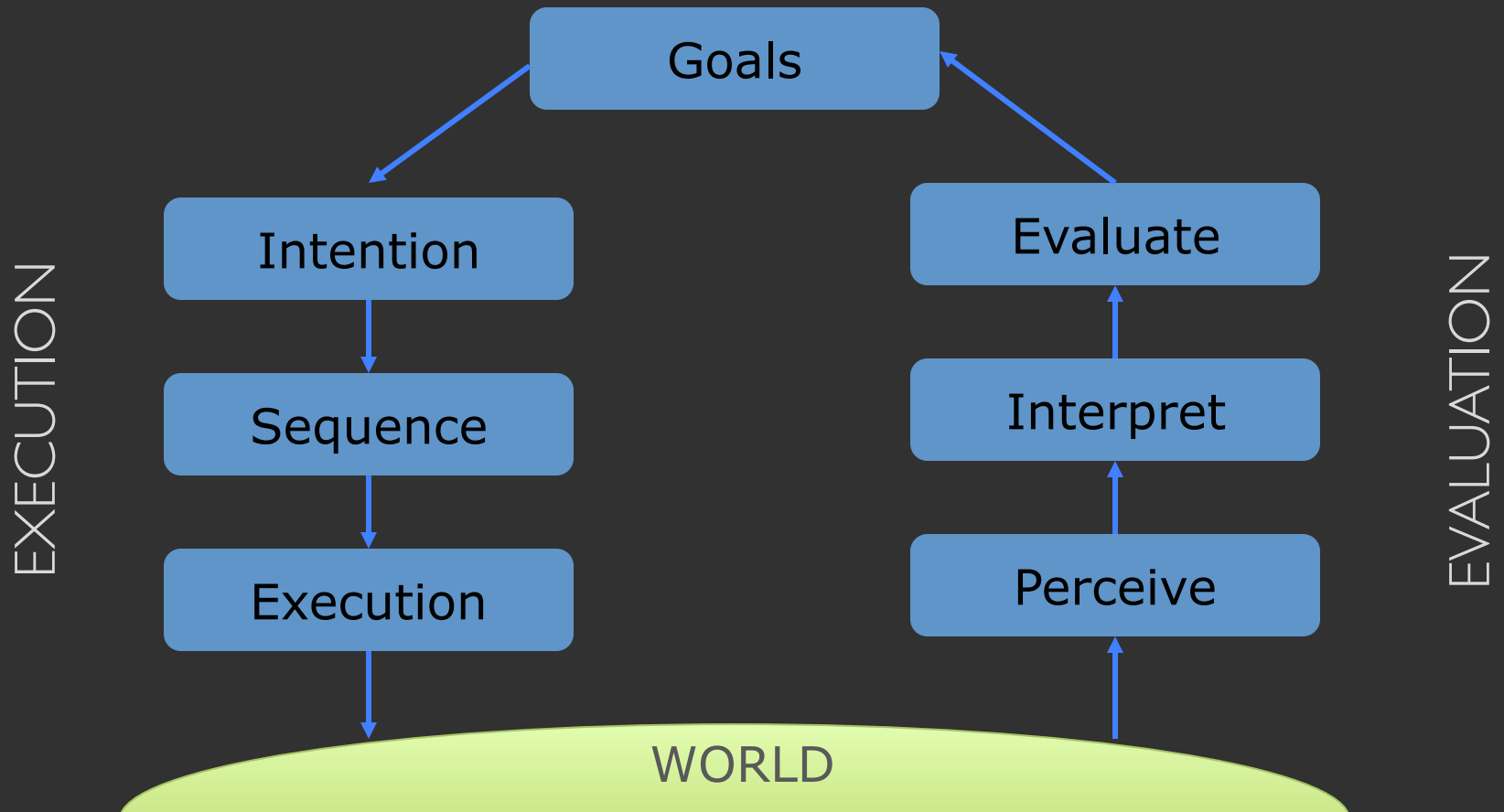
# Action Cycle



# ACTION CYCLES

EXECUTION: *Doing something to the World*

EVALUATION: *Compare what happened with what we wanted*



## EXAMPLE: TURNING ON A LAMP

GOAL: Increase light in the room

INTENTION: Turn on the lamp

SEQUENCE: Walk to lamp, turn knob

EXECUTE: [*Walk to lamp, turn knob*]

PERCEIVE: [*Hear “click”, see light*]

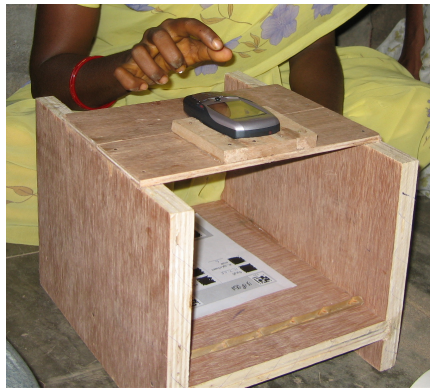
INTERPET: Lamp clicked and started emitting light

EVALUATE: Light in the room increased. Success!

# GULF OF EXECUTION

“What do I do now?”

By providing affordances, constraints, visibility and a good mental model, designers can bridge the Gulf of Execution





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**Men's Swimming:** [Cal Invitational](#) 1/21

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### Berkeley prof puts the 'care' in healthcare

Jodi Halpern strives to humanize medicine, and more

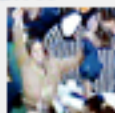


### When science borders on science fiction

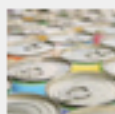
Bouso, Marcy receive grants to explore big questions



30 years after The Play: Paging Fan X Cal Magazine looks for fan that signaled The Call



BPA linked to thyroid hormone changes in pregnant women, newborns Study adds to health concerns over chemical found in many consumer products



Berkeley Lab hosts open house on Oct. 13 Fox squirrels show long-term investment savvy when hoarding nuts

### THE Berkeley Blog

The digital divide: New trends affecting equitable access



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Lecture: How Afghans look at 2014, 10/9

Documentary: *Watershed*, 10/9

Film: *The Italian Straw Hat*, 10/9

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# GULF OF EXECUTION

“Did I succeed?”

By providing feedback and a mental model, designers can bridge the Gulf of Evaluation





## DESIGNING FOR ERRORS

When a task *appears* simple or trivial, users will most often blame any errors or mistakes on themselves

When this happens repeatedly, the user may decide that they are *incapable* of performing this task (Norman calls this *learned helplessness*)

Designers should account for errors in their designs

For next time

Formative evaluation due

Balsamiq time on Tuesday