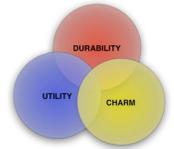


# Class 9 CIS 573

## (lecture 8)

Gregg Vesonder  
University of Pennsylvania  
Penn Engineering - Computer & Information Science  
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# Roadmap

- Anti-Patterns
- HCI
- Readings this class: Sommerville chapters 2 & 16, Andersson, et.al., chapter 16
- Readings next class: Sommerville chapters 15, 30 & 31; Brooks Chapter 16-end and Andersson, et.al., chapter 14
- Readings next week -NONE!!!

# Critical Dates

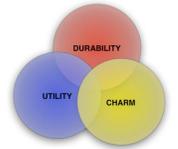
- Every class project review
- ~~July 23<sup>rd</sup> Mid Term~~
- **August 6<sup>th</sup> log books due - by Midnight**
- August 11<sup>th</sup> project presentations
- August 13<sup>th</sup> Final

# Teams

- Team 1 - Klein Keane, Beck, Buchman, Richardson, Nunez
- Team 2- Wilmarth, Caputo, Xiang, Francis, Nanda
- Team 3- Noronha, Fang, Huang
- Team 4-Whitehead, Liu, Ratnakar

# Project Reports

- Presentation each class
  - Green, yellow, red -simplified model + gaps
  - Current pressing issues
  - What was done since last class
  - What will be done before next class
  - Gaps



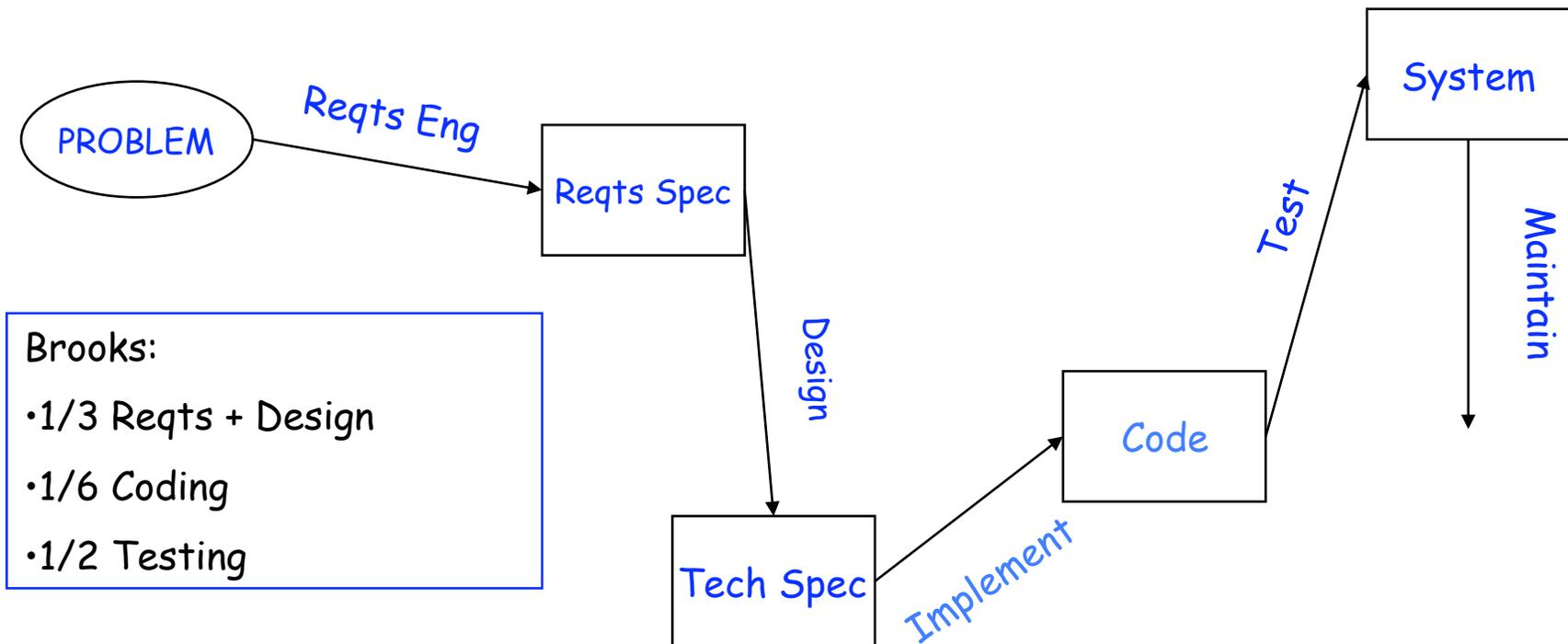
# Log Book

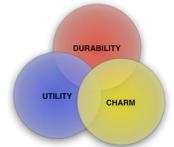
- Heads or tails?
- Yours?

# Software Engineering Knowledge

- SWEBOK, SoftWare Engineering Body Of Knowledge:
  - ~~Software requirements analysis~~
  - ~~Software design~~
  - ~~Software construction~~
  - ~~Software testing~~
  - ~~Software maintenance~~
  - ~~Software configuration management~~
  - ~~Software quality analysis~~
  - ~~Software engineering management~~
  - ~~Software engineering infrastructure~~
  - ~~Software engineering process~~

# Simplified Model





# "Sync and Stabilize"

Cusmano and Selby (1997)

- Scale up loosely structured teams (3-8 developers)
- The "Process"
  - Vision statement - defining goals of new product
  - Program managers create functional specification
  - During development team members revise feature set and details
- Sync involves daily builds, Stabilize involves milestones
- "Always" a deliverable project

# 10 OO Development Anti-Patterns

- **THE BLOB** - Procedural style design leads to one object with Lion's share of responsibilities, while most other objects hold data or execute simple processes - redistribute and refactor
- **LAVA FLOW** - dead code and forgotten design information is frozen in a dynamic design - configuration management process to eliminate dead code
- **FUNCTIONAL DECOMPOSITION** - FORTRAN in a class structure! - hard to determine at times, back to design and look for keys, e.g., if a class has a single method try to incorporate in other classes

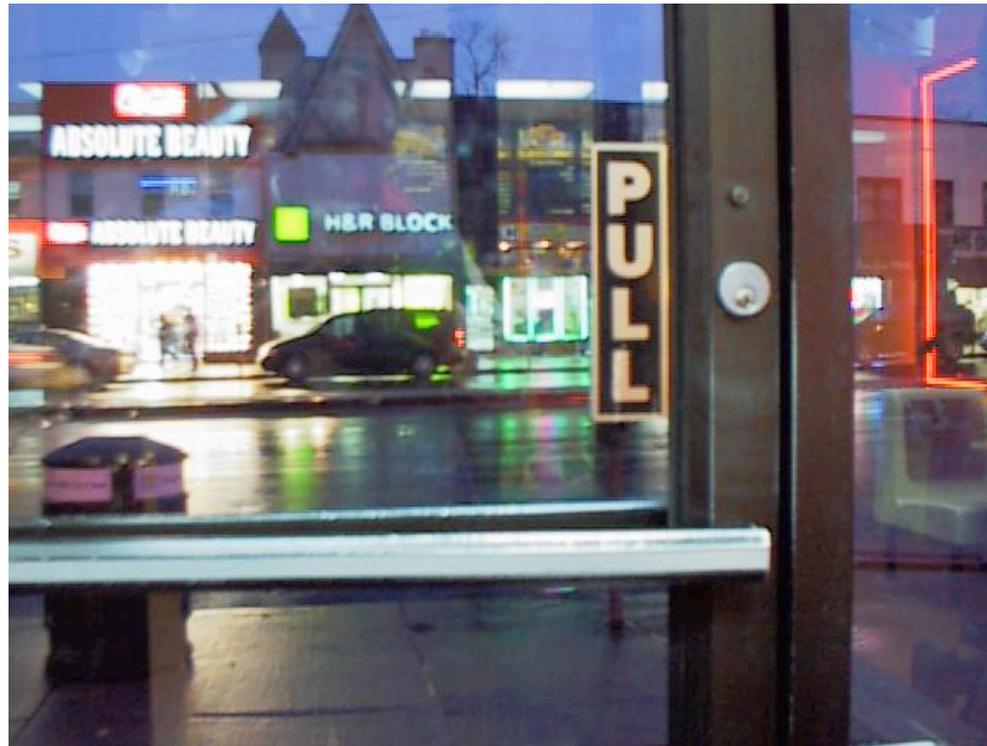
# More AntiPatterns

- POLTERGEISTS classes with very limited roles and effective life cycles, start processes for other objects - place responsibility in more long-lived objects
- BOAT ANCHORS a piece of software or hardware that serves no useful purpose on project, usually very costly
- GOLDEN HAMMER - familiar technology or concept applied obsessively - education to expand technical horizons
- SPAGHETTI CODE - ad hoc software structure with very little clarity caused by excessive patching - rewrite it
- DEAD END modifying a reusable component no longer maintained by the supplier, lost the original reason for it - replace

# End of AntiPatterns

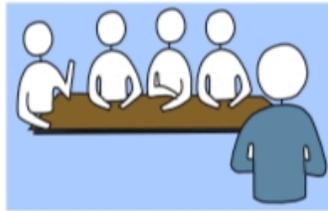
- CUT AND PASTE PROGRAMMING code reused by copying source statements - black box reuse and alternate forms of reuse
- MUSHROOM MANAGEMENT - system developers isolated from system's end users - connect them!
- BONUS patterns - DEATH BY PLANNING and ANALYSIS PARALYSIS

# Example: Horrid Design



For some reason Coffee Shops excel in this, especially when you are leaving!

# HCI Techniques



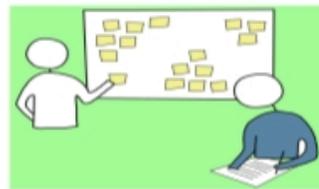
**Focus Group**



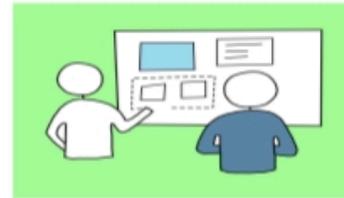
**Side by Side  
(Contextual Inquiry)**



**Interview**



**Card Sort**



**Participatory Design**



**Paper Prototyping**

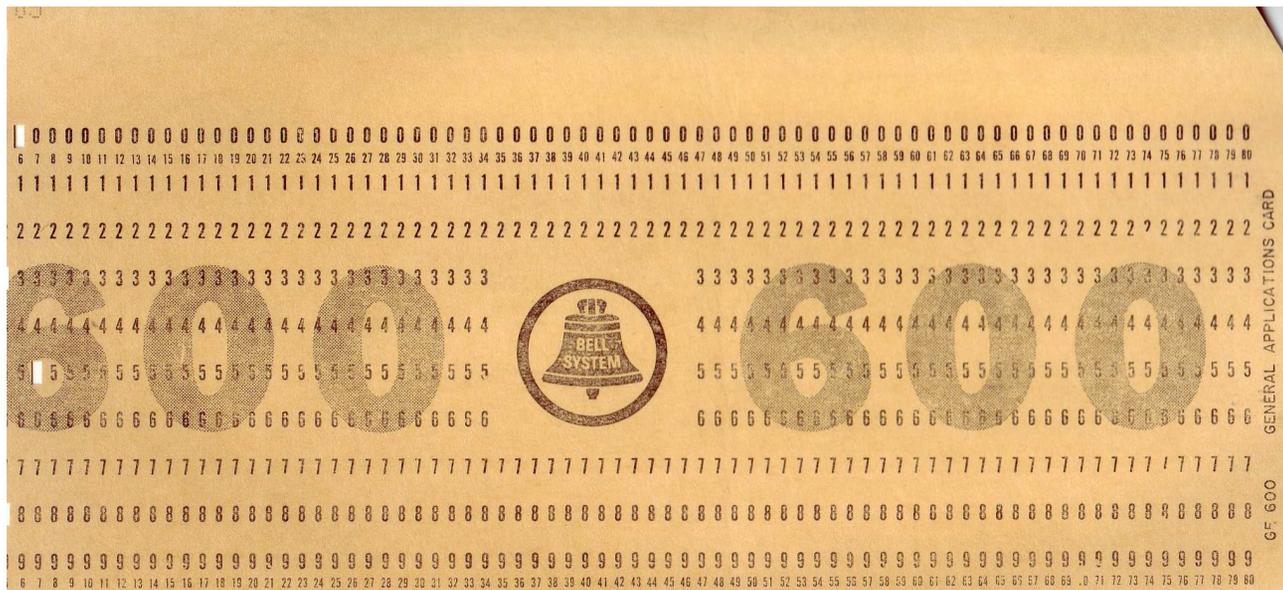


**Usability Test**



**Data Analysis**

# Initial HCI-1



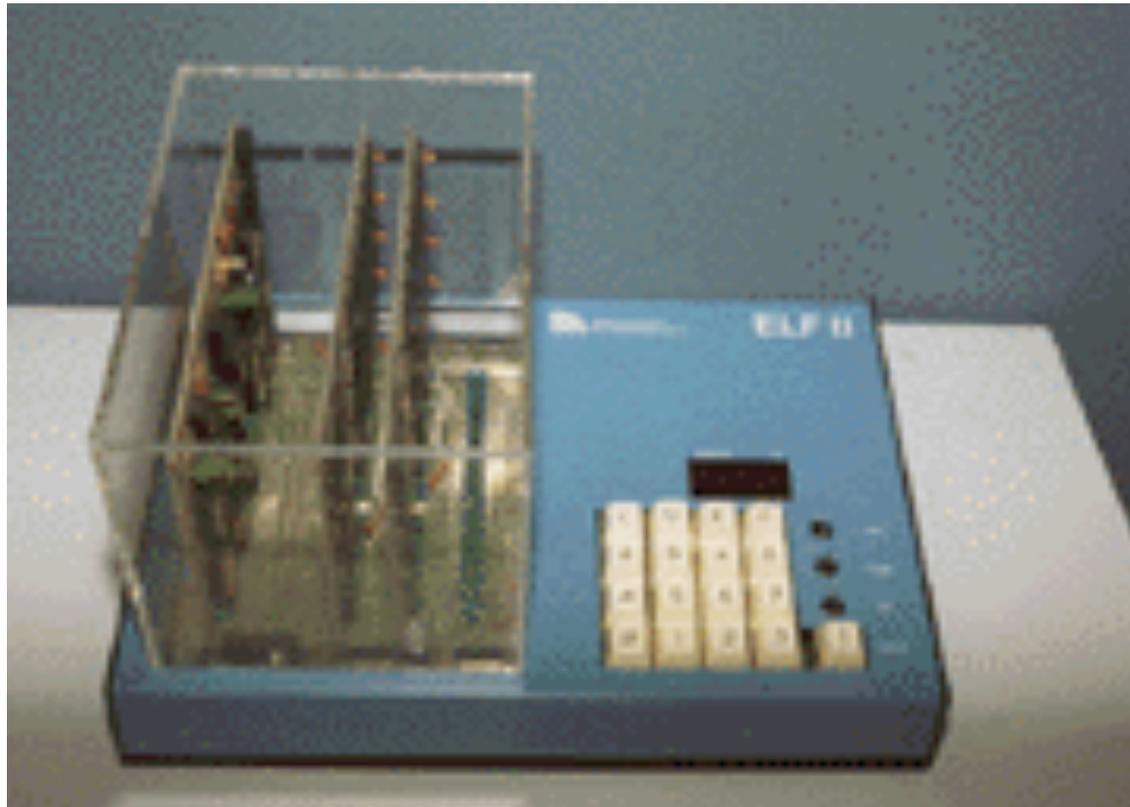
# Initial HCI-2



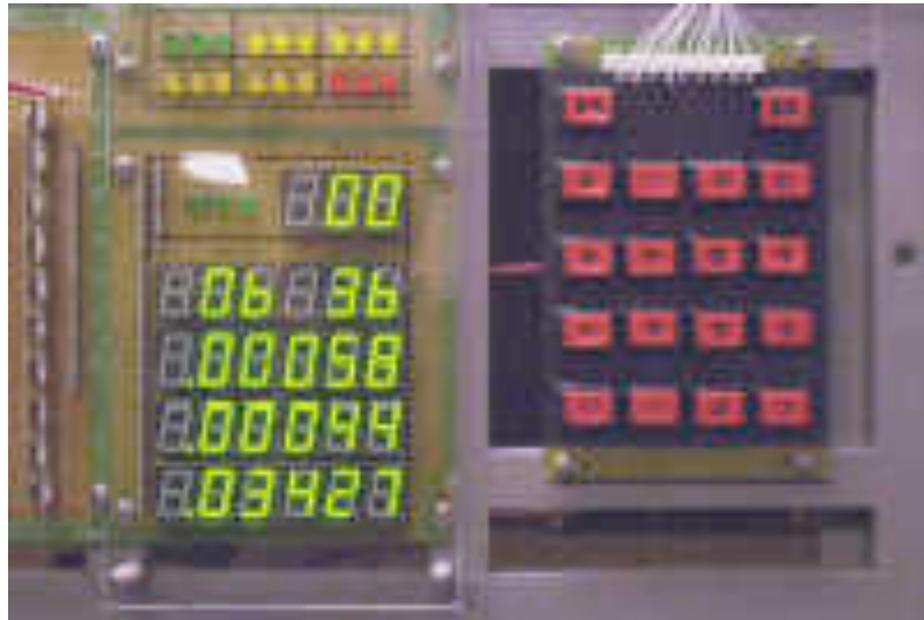
# Initial HCI-3



# Initial HCI-4



# Initial HCI-5



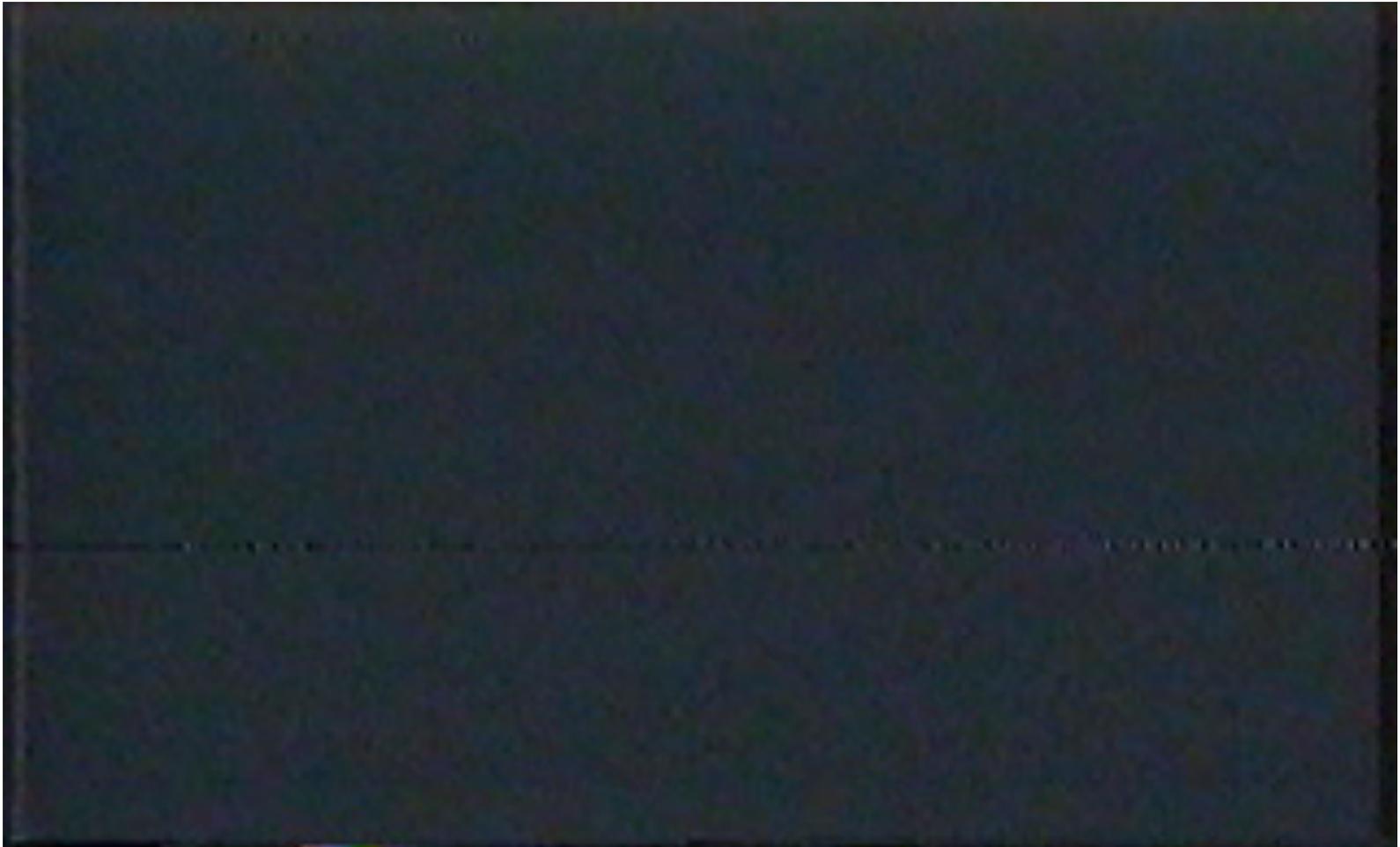
<http://starfish.osfn.org/AGCreplica/>

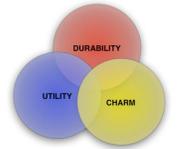
# Initial HCI-6



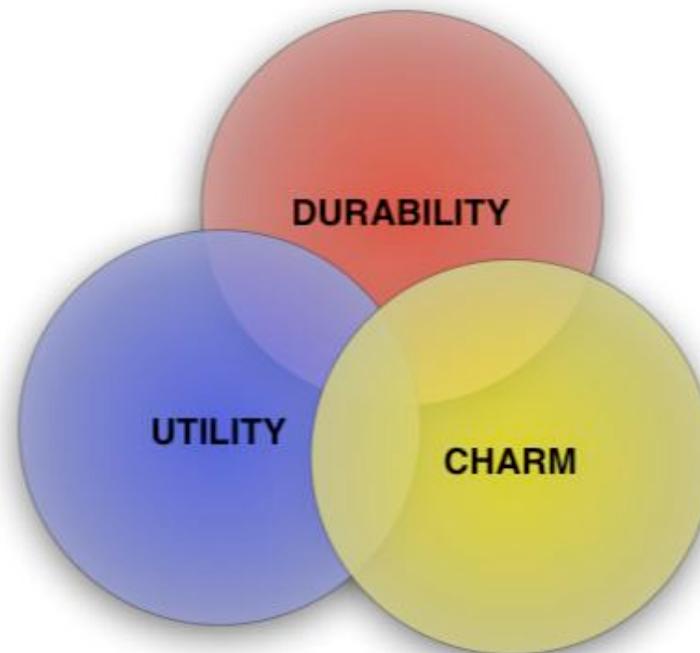
[http://klabs.org/history/history\\_docs/mit\\_docs/agc.htm](http://klabs.org/history/history_docs/mit_docs/agc.htm)

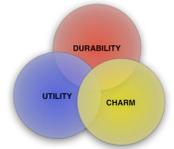
# Human Computer Interaction





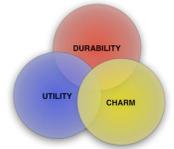
# Firmitas, Utilitas, Venustas





# HCI Overview

- Motivation for HCI the Benefits
- Definition of HCI
- Current view of Cognitive Science
- User Centered Design
- Evaluation
- Heuristics

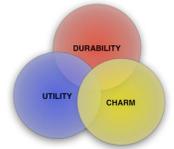


# Why Spend Effort on the UI?

- Increased efficiency
- Improved productivity
- Reduced errors
- Reduced training - strive for game like training
- Improved acceptance

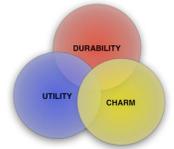
# Definition

- This definition emphasizes the benefits
- US Military Standard for Human Engineering Design Criteria (1999):
  - Achieve required **performance** by operator, control and maintenance personnel
  - **Minimize** skill and personnel requirements and training time
  - Achieve require **reliability** of personnel-equipment/software combinations
  - Foster **design standardization** w/in and among systems



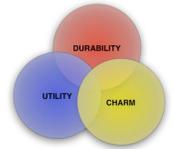
# Yet Another Definition

- But then there are other approaches and motivations
- **Raskin: An interface is humane if it is responsive to human needs and considerate of human frailties**
  - Boot up - that the user should not be kept waiting unnecessarily is an obvious and humane design principle
  - Users should set the pace of interaction
  - Windows - hitting start to shutdown
- Asimov paraphrase: "A computer shall not harm your work or, through inaction, allow your work to come to harm"
- A computer should not waste your time or require you to do more work than is strictly necessary



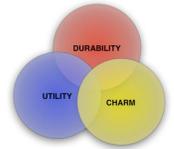
# YAD

- Stone, et.al.: "... how humans interact with computer systems."
  - Computer system is broadly defined
- Good user interfaces
  - Easy to use
  - Easy to understand
  - Meets users needs
  - Support users tasks
  - Encourages an easy, natural and engaging interaction
  - A safe system
- To users the interface is often the system



# Asimov's Laws of Robotics

- (A soon to be recurring motif that the best interface may be none, with precautions)
- 0. A robot may not injure a humanity or, through inaction, allow humanity to come to harm.
- 1. A robot may not injure a human being or, through inaction, allow a human being to come to harm, except where that would conflict with the Zeroth Law.
- (old 1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.)
- 2. A robot must obey orders given it by human beings except where such orders would conflict with the First Law.
- 3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

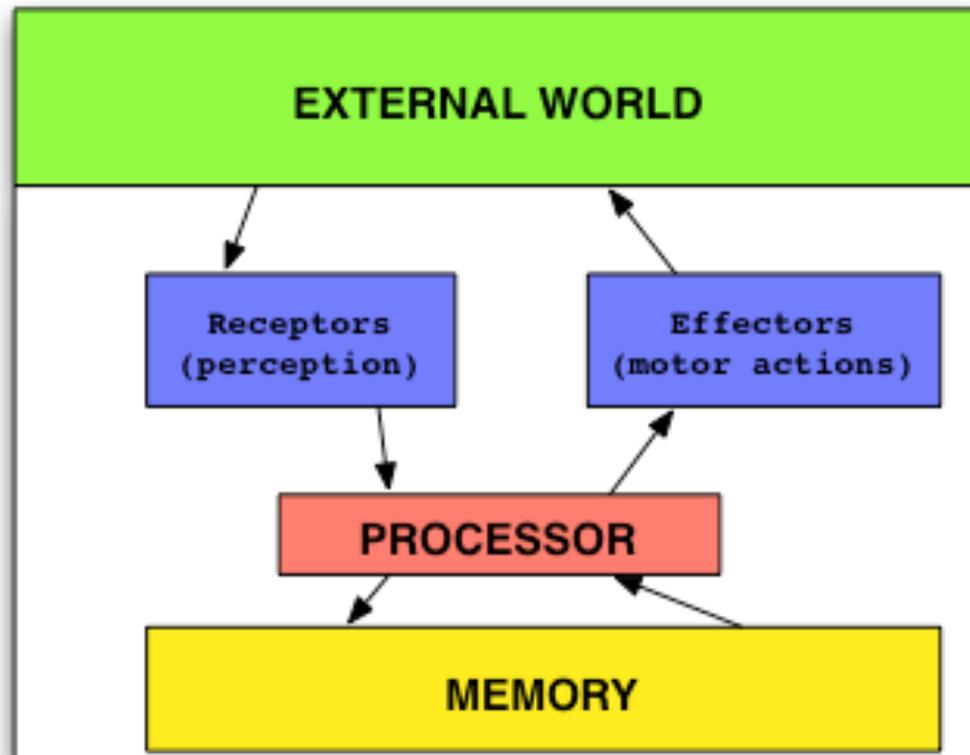


# Approach to UI

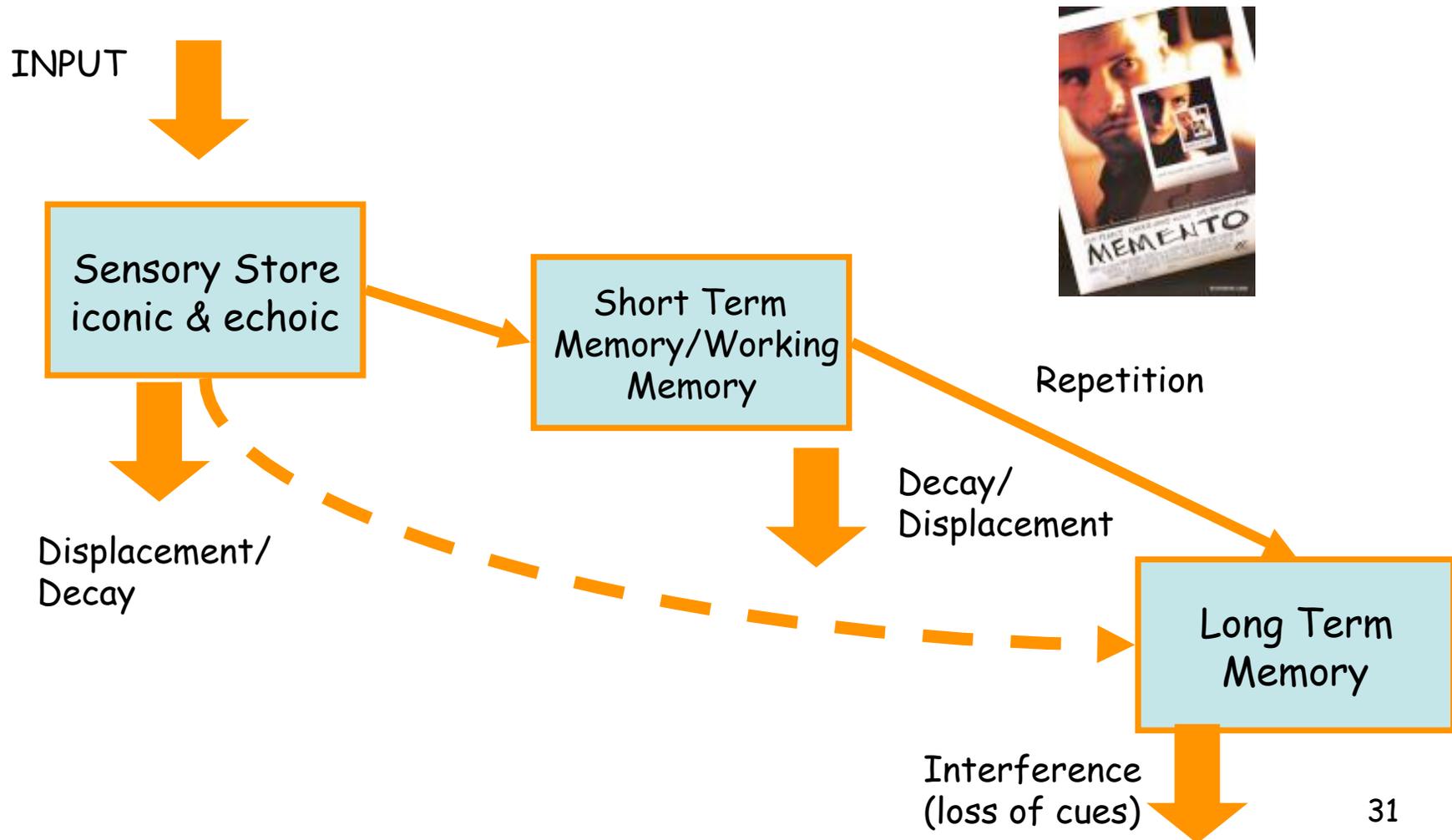
- So how do we get there?
- The user interface is **the system** to the user- not a novel approach, also known as User Centered Design
  - **Cognitive sciences (including "humanities") \***
  - **Artistic Design**
  - **Ergonomics \***
- User Interface is the point of view of the user! Includes hardware and software
- Do not separate design of functionality from design of interface - remember "**User manual first**" (combines functionality and interface) attitude to interface development
- Overlearning is powerful - sometimes RPN is the right thing!
- Mental model (desktop) vs. conceptual model/design model - have to be closely related
- **First a bit about ourselves**

# Human Information Processor

AI agent  
view



# The Human Information Processing System - Atkinson and Shiffrin+



# Human Information Processing System

- Maintenance rehearsal vs. elaborative rehearsal -- depth of processing improves memorability
- Forgetting
  - Repression - Freud
  - Interference
    - Proactive - previous memories
    - Retroactive - later learning
    - Forgetting same stimulus, two different responses > same stimulus, two similar responses > same stimulus, two different responses (minimal)
  - Retrieval based, encoding specificity, available but not accessible (recognition better than recall)
    - Cue dependent
    - Mood state dependent

# HIPS - Forgetting

- Consolidation Theory
  - (Neurologists)
  - Recently formed memories are still being consolidated over hours or days
    - Vulnerable during that time to interference and forgetting
  - New memories clear and fragile, old memories faded and robust
  - Training/studying implications (less interference)
- Support mechanisms

# Conscious vs. Unconscious

(from Raskin, 2000)

PROPERTY	CONSCIOUS	UNCONSCIOUS
Engaged by	Novelty, Emergencies, Danger	Repetition, Expected events, Safety
Used in	New circumstances	Routine situations
Can handle	Decisions	Non-branching tasks
Accepts	Logical propositions	Logic or inconsistencies
Operates	Sequentially	Simultaneously
Controls	Volition ( <i>free will</i> )	Habits
Capacity	Tiny	Huge
Persists for	10ths of seconds	Decades (lifelong?)

Conscious  $\approx$  STM, Unconscious  $\approx$  LTM

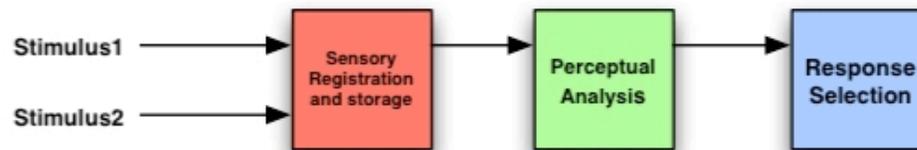
# Stroop Test

<b>BLUE</b>	<b>GREEN</b>	<b>YELLOW</b>
<b>PINK</b>	<b>RED</b>	<b>ORANGE</b>
<b>GREY</b>	<b>BLACK</b>	<b>PURPLE</b>
<b>TAN</b>	<b>WHITE</b>	<b>BROWN</b>

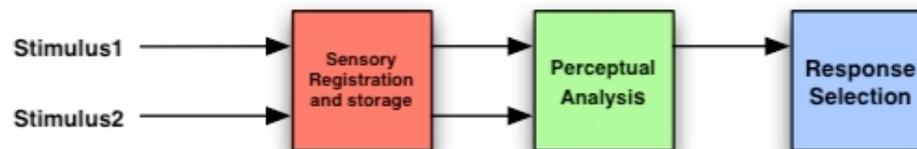
Interference between the memory systems  
What color are the words?

# Your Attention Please!

## Models of Selective Attention Kahneman(1973)

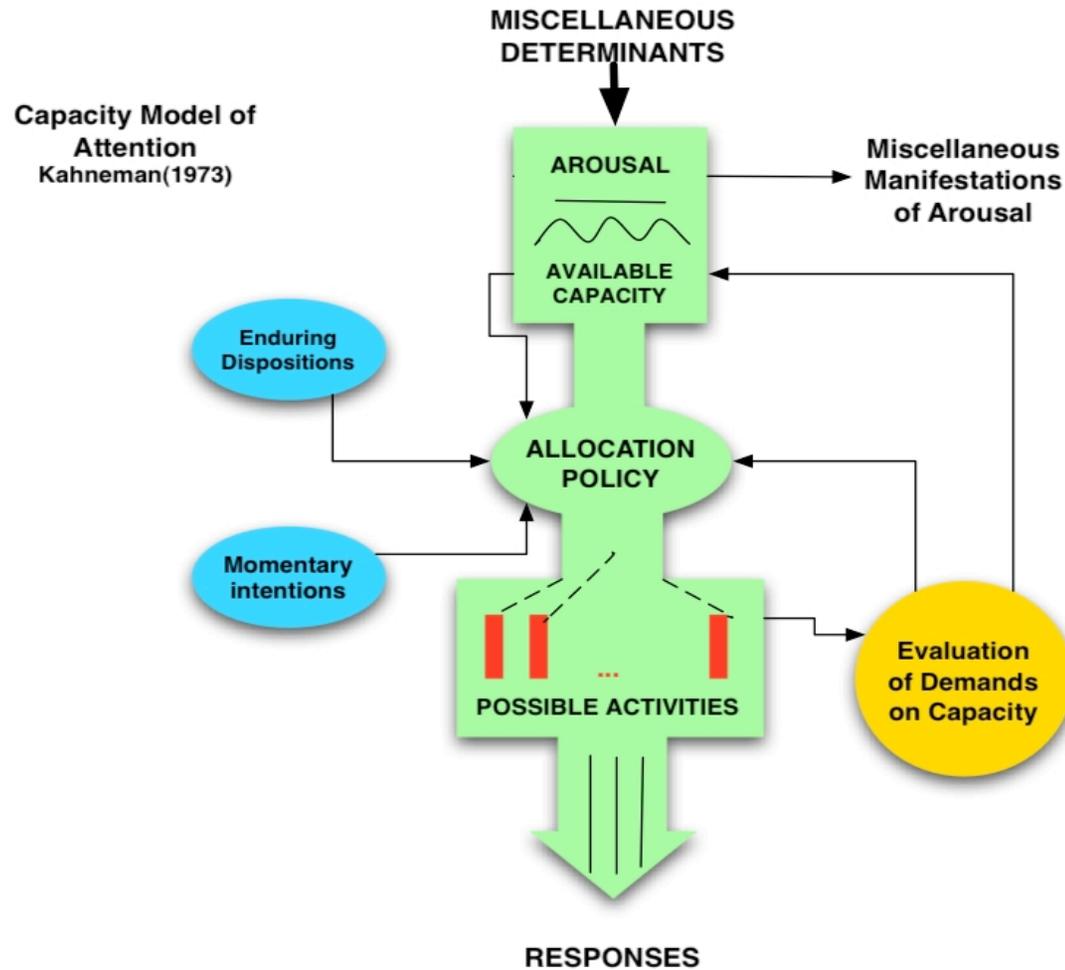


**Filter Theory  
Broadbent**



**Deutsch & Deutsch**

# Saturated Yet?





## In Summary - 1

- Is your experience up to **PAR**?
- Perception
- Attention
- Retention(Recall/Recognition)

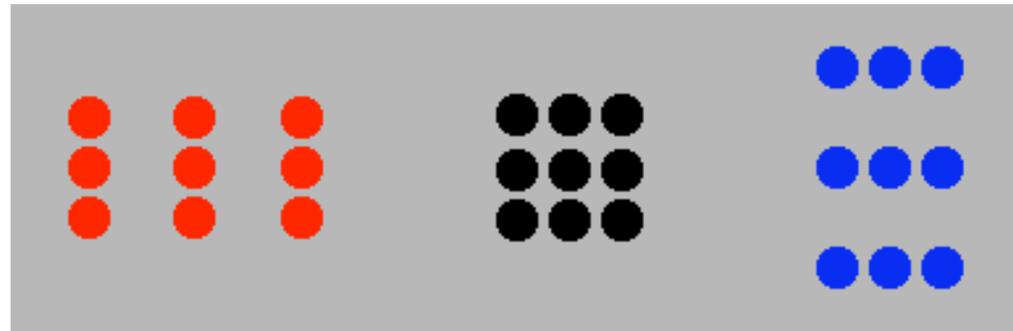
# Psychological Principles

- Working memory (STM) is only around 5 - auditory tasks depend on working memory
- Long Term Memory is slow and things may be available but not accessible - multiple coherent cues make it easier
- Attention can be overloaded and depends on the state of the individual
- Recognition is easier than recall
- Remember issues of Just Noticeable Differences, JNDs
- Expert Novice distinctions are a factor in enjoyment of the system

# More Principles

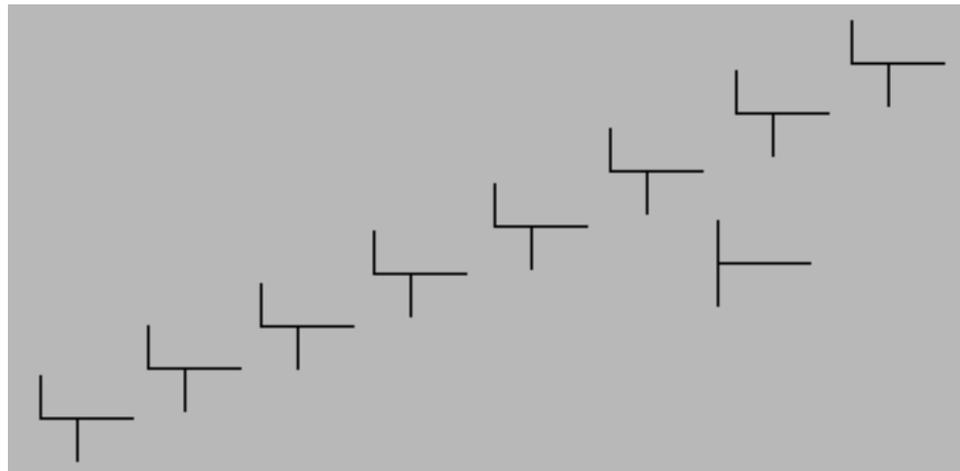
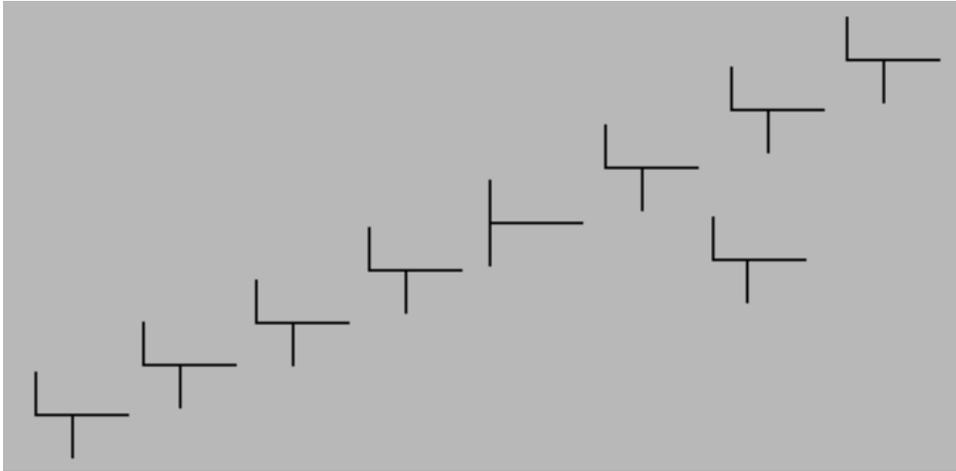
- Humans receive more information through visual system and store it spatially -- mental rotation studies, the more rotation, the longer to respond
- Humans tend to structure what they see to form cohesive patterns -- 5 Gestalt laws
  - **Proximity** - we tend to group things together that are close together in space
  - **Similarity** - we tend to group things together that are similar
  - **Continuation** - we tend to perceive things in good form
  - **Closure** - we tend to make our experience as complete as possible
  - **Figure and ground** - we tend to organize our perception by distinguishing between a figure and a background

# Proximity



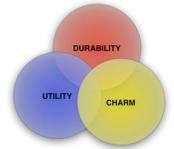
Thanks to Psy280 notes from Toronto!

# Continuation



# Figure - Ground





# Still More Principles

- **Multimodal information** is easier to use than single mode (text + image + sound) increasing the richness of memory -- similar to mnemonic tricks such as the method of loci -- depth of processing!

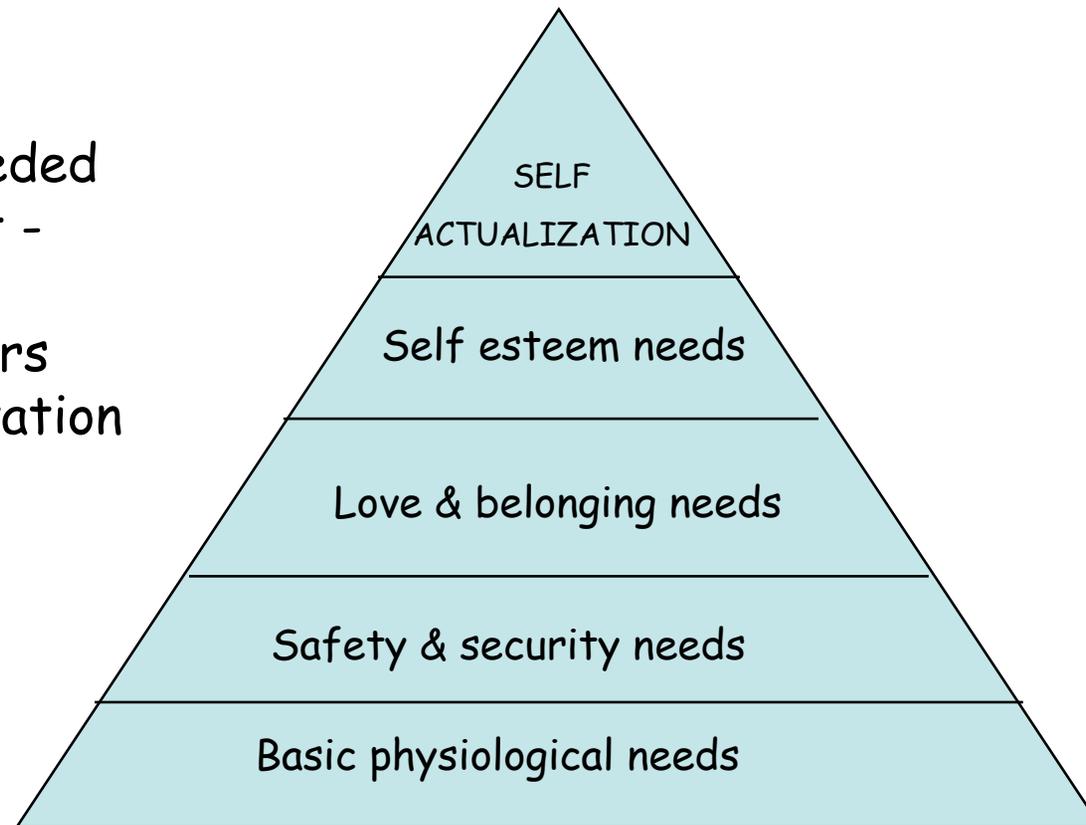
# Cognitive and Perceptual Abilities

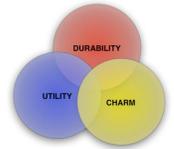
(we just scratched the surface in our discussion and will cover more as appropriate)

- Human cognitive processes
  - Short term memory
  - Long term memory and learning
  - Problem solving
  - Decision making
  - Attention and set (scope of concerns)
  - Search and scanning
  - Time perception
- Factors affecting perceptual and motor performance:
  - Arousal and vigilance
  - Fatigue
  - Perceptual (mental) load
  - Knowledge of results
  - Boredom and monotony
  - Sensory deprivation
  - Sleep deprivation
  - Anxiety and fear
  - Isolation
  - Aging
  - Drugs and alcohol
  - Circadian rhythms

# Maslow's PYRAMID

Needs needed  
to be met -  
ideas for  
reinforcers  
and motivation





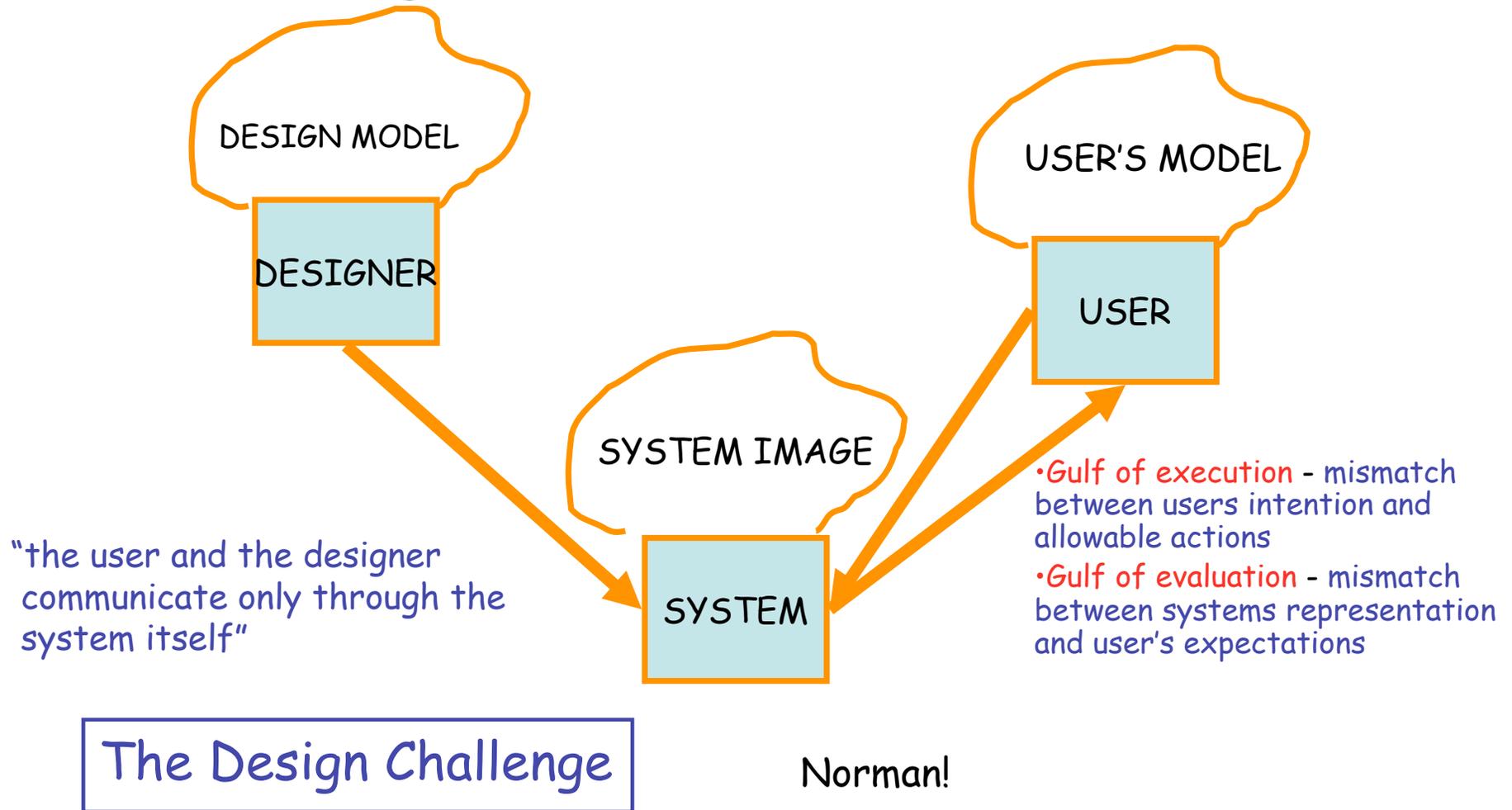
# Other Psychological Differences

- Personality differences, gender, cultural -- be sensitive to names: Kill, abort, master, slave
- Myers-Briggs Type Indicator no wrong answer (example of personality tests):
  - Extroversion-introversion
  - Sensing vs Intuition
  - Perceptive vs Judging
  - Feeling vs thinking
  - Matching personality types to professions, **example of psychological scales**, there are many of them!

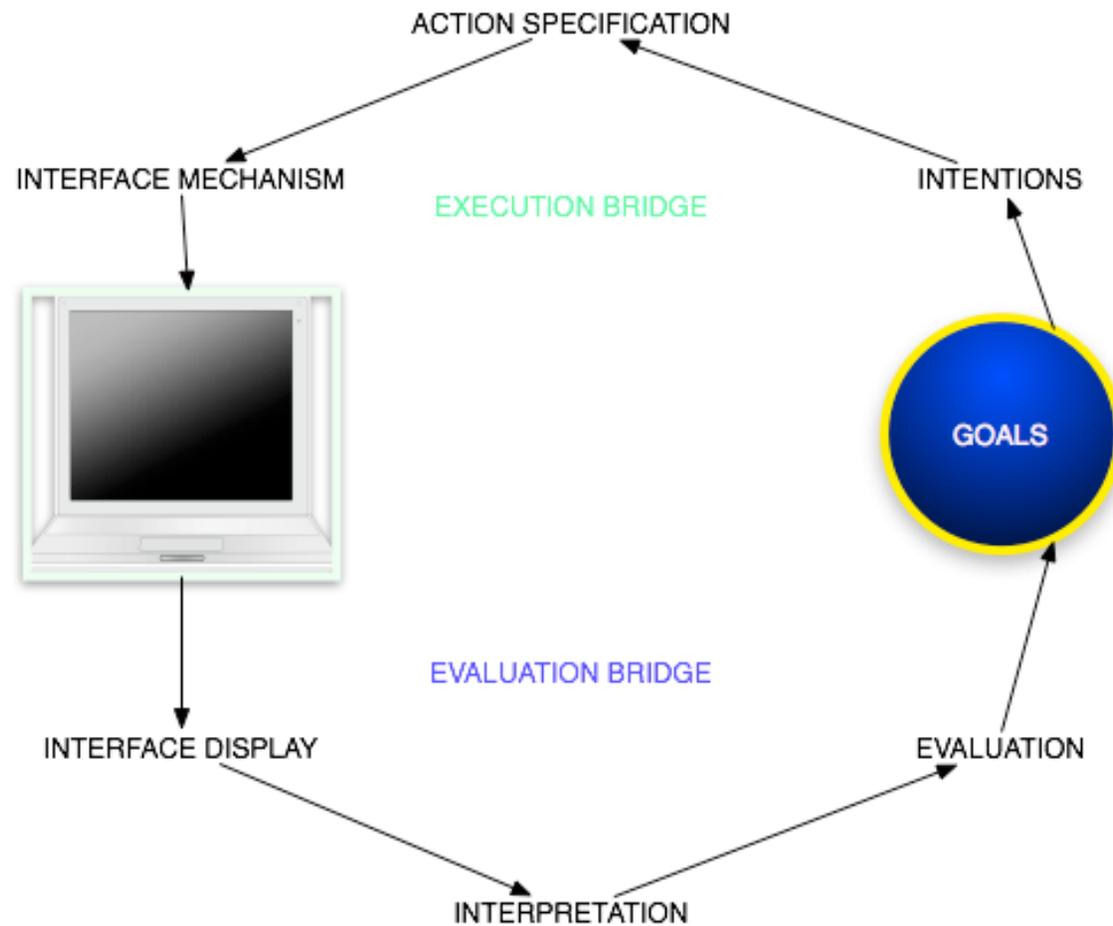
# OPD-2

- Cultural and International Diversity
  - Still largely unexplored but important in international market
  - **Respect for tradition vs novelty**
  - Japanese, Chinese may scan screen in different order
  - Sampling of other international issues:
    - Numeric (.,) and currency formats
    - Weights and measure
    - Names and titles
    - National identification
    - Etiquette, policies, tone, formality
    - Government regulations
    - Surfaces in out sourcing too
  - On to design

# Knowledge in the World and in the Head



# Bridge the Gulfs



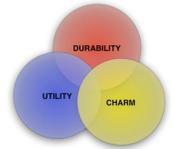
# Task Analysis

- Analyze task within context of use:
  - The users
  - The tasks
  - The equipment (hardware, software, materials)
  - The social environment
  - The physical environment
- Often Hierarchical Task Analysis (think outline) is used - A modern refinement is Goals, Tasks and Actions



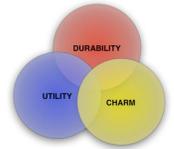
# Applying it

- Population
- Tasks
- Methods
- Techniques
- Evaluation
- Heuristics



# The Users: Groupings -1

- Pre school
- Grade school
- Middle/High School
- College to Post Grad
- Adult - business use
- Adult - home use
- Elderly
- Special needs

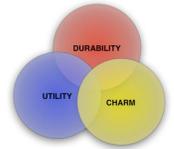


## Groupings-2

- Computer professionals
- Technical professionals and industrial workers
- Business professionals and clerical folks
- Professionals (doctors, lawyers, architects,...)
- Public administrators, police
- Instructor, teachers
- Research scientists
- (loosely adapted from Endres and Rombach, 2003)

# Users and Disabilities

- 1998 amendment to Rehabilitation Act requires Federal Agencies to assure access to Information Technology, including computers and web sites by employees and the public
  - Keyboard mods
  - Supporting vision and hearing impaired
  - Color coding issues
  - Font size settings
  - Conversion to Braille and text to speech including description of figures
- Plan early .. Computer curb cuts, e.g., in design move on/off switch to front
- Packages for learning disabled, e.g., game-like interfaces

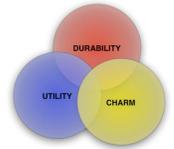


# Applying It

- Population
- **Tasks**
- Methods
- Techniques
- Evaluation
- Heuristics

# Classes of Systems

- Life critical systems - lengthy training periods for **error free performance, even under stress**
  - Practice sessions for emergencies
  - Subjective satisfaction less of an issue
- Industrial and commercial uses - issues of reliability may be eased due to cost concerns
- Office and Home Entertainment - subjective satisfaction
- Exploratory, creative and cooperative systems
- **Sociotechnical systems: voting, identity verification, crime reporting, ...**



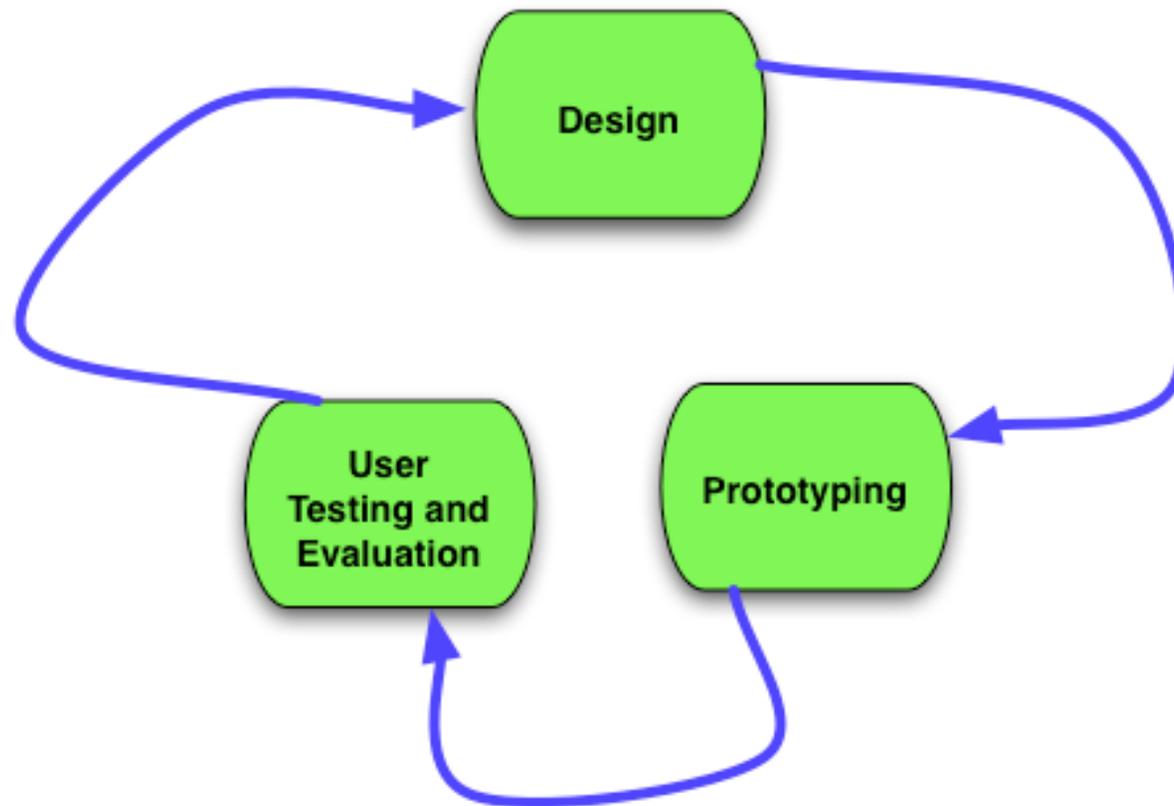
# Applying It

- Population
- Tasks
- **Methods**
- Techniques
- Evaluation
- Heuristics

# User Centered Design

- 4 main principles:
  - Active involvement of users
  - Appropriate allocation of function between user and system
  - Iteration of design solutions
  - Multidisciplinary design teams
- 4 main activities
  - Understand context of use
  - Specify users organizational requirements
  - Produce design solutions (prototype)
  - Evaluate designs with users against requirements

# UI Design and Development Process



# Experimentation

- Understand the task, understand potential solutions
- Try to approximate the task(s) under controlled circumstances
- If new techniques use a control and experimental group(s)
- Measure everything that may be relevant: error rate, time for various stages, keystrokes, ...
- Observe, perhaps video tape or think aloud with permission - very time intensive

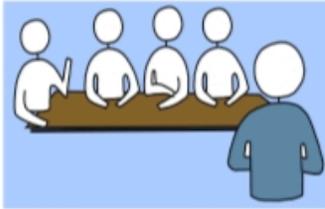
# Situated Action and Distributed Cognition

- A simple experiment may not always be diagnostic because:
  - Complex interactions between people, electronic devices and paper resources
  - Physical and social resources are intertwined with use of computer and information technologies
  - Design cannot be separated from patterns of use
  - Users change plans in response to circumstances
- **Distributed cognition - knowledge not only in the minds but also distributed in the environment**
- Therefore users have to be participants in the design process not just experimental subjects (rigid definition): ethnography, longitudinal studies

# More on Task Analysis

- Agents, work and situation
- User interface details:
  - What can the user do with the system? System capabilities
  - What is dialog and presentation interface
- On dialog
  - Command language, interaction according to a grammar, user has to understand what's possible - persuades system to do it - UNIX
  - Menu, complete form, respond to interface - eases memory load, user may not feel in control - MS Windows
  - Direct manipulation in a space - 3D environments - MATRIX
- On representation
  - Perceptible aspects, includes artist and designer, story boards are helpful

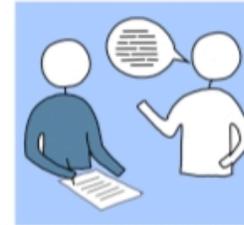
# HCI Techniques



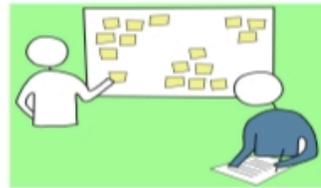
**Focus Group**



**Side by Side  
(Contextual Inquiry)**



**Interview**



**Card Sort**



**Participatory Design**



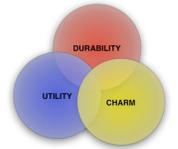
**Paper Prototyping**



**Usability Test**



**Data Analysis**



# Applying It

- Population
- Tasks
- Methods
- **Techniques**
- Evaluation
- Heuristics

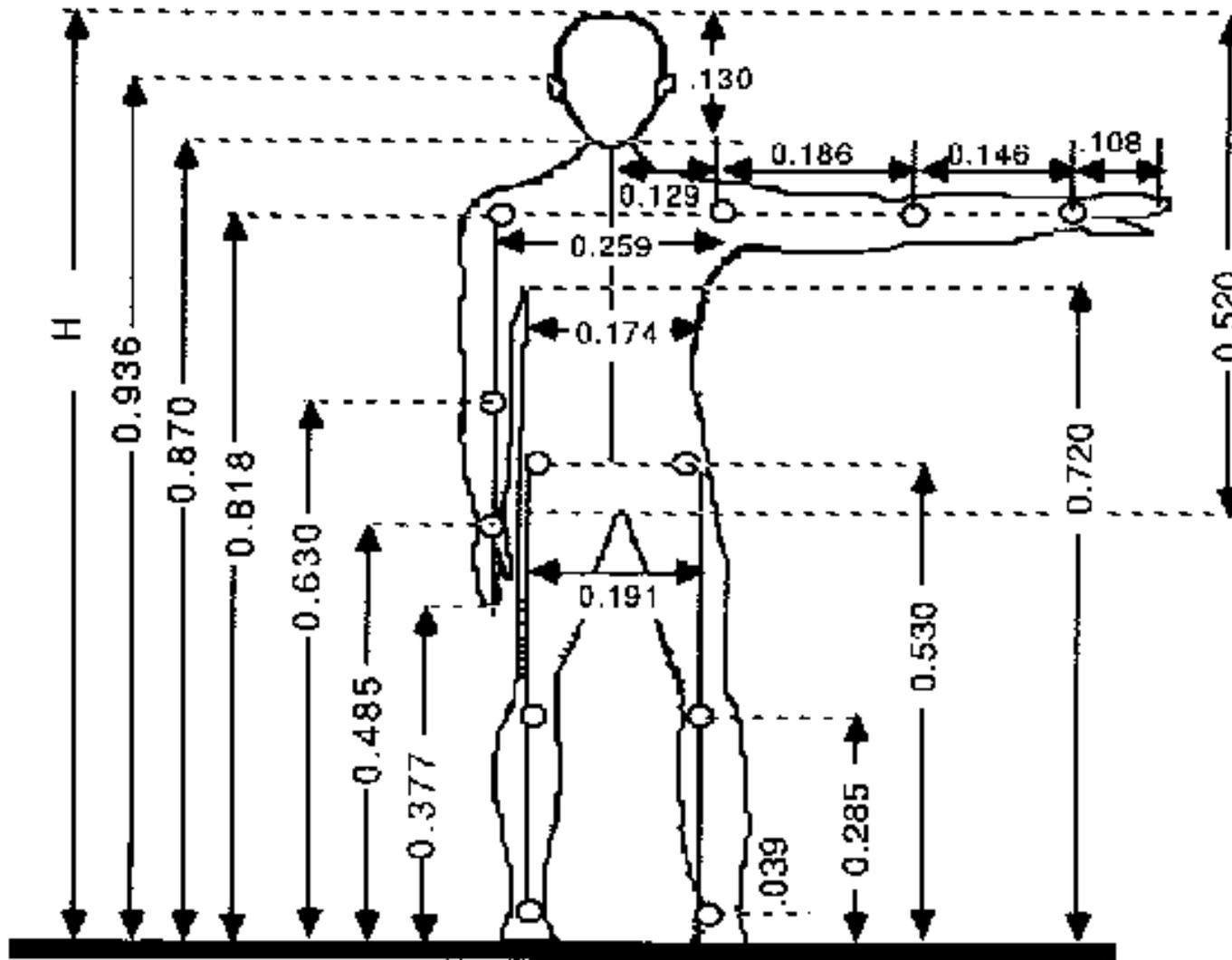
# Interaction Styles

Style	Advantages	Disadvantages
Direct Manipulation	Visually presents task concepts, easy learning, easy retention, avoids errors, encourages exploration, high subjective satisfaction	Hard to develop, requires graphics display & pointing device
Menu Selection	Shortens learning, reduces keystrokes, structures decision making, can use dialog management tools, easy support of error handling	Danger of many menus, slows frequent users, consumes screen space, requires rapid display rate
Form Completion	Simple data entry, modest training, convenient assistance, use of form management tools	Consumes screen space
Command Language	Flexible, power users, user initiative, creation of macros (customizing)	Poor error handling, long training, memorization
Natural Language	Relieves burden of learning syntax	Clarification dialog, more keystrokes, contest is hard, unpredictable

# Physical Abilities and Surroundings

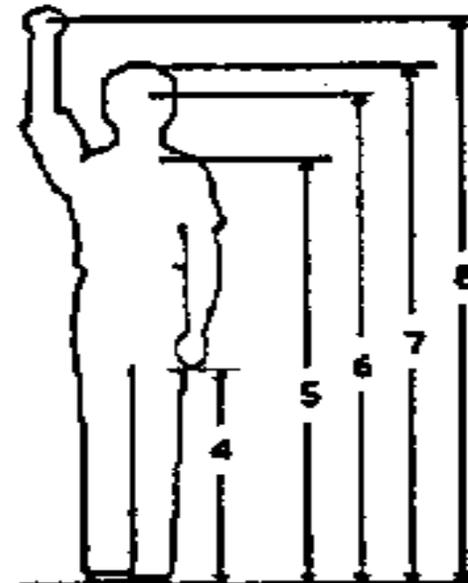
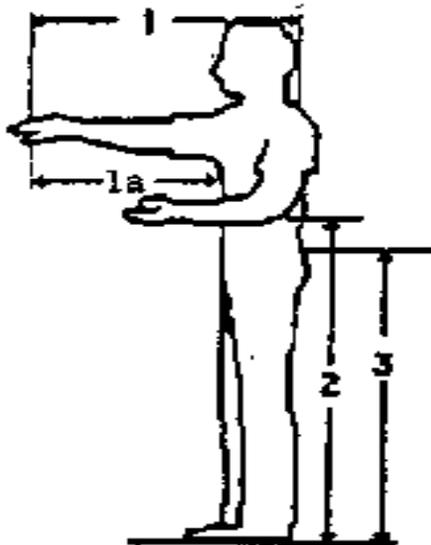
- **Anthropometry** - basic data about human dimensions (range of dimensions)
  - Not only static (size of hand) but also dynamic, reach distance while seated, speed of finger presses, strength of lifting, ...
- Human Factors engineering of computer work stations
  - Work surface and display support height
  - Clearance under work surface for legs
  - Work surface width and depth
  - Adjustability of heights and angles for chairs and work surfaces
  - Posture adjustments, arm rests, foot rests, chair coasters
  - Lumination levels, glare, flicker, noise, air temperature, movement and humidity

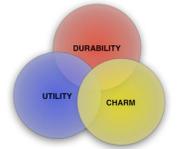
# Relative Dimensions of Average Human Body



## Standing Posture Data

Measurement (Inches)	Males			Females		
	95th	50th	5th	95th	50th	5th
1- Forward Grip Reach	33.3	30.9	28.5	30.1	28.0	25.8
1a- Bust to Grip Reach	21.9	20.9	19.8	18.3	18	17.5
2- Elbow Height	46.9	43.5	40.2	43.1	40.2	37.2
3- Hip Height	39.2	36.0	32.9	35.8	32.9	29.9
4- Fingertip Height	28.5	26.0	23.4	27.4	24.8	22.2
5- Shoulder Height	61.0	56.7	52.4	56.1	52.2	48.2
6- Eye Height	71.9	67.3	62.8	64.2	60.0	55.9
7- Stature	73.6	69.1	64.6	68.1	64.0	59.8
8- Vertical Grip Reach	87.0	81.9	76.8	80.5	75.8	71.1



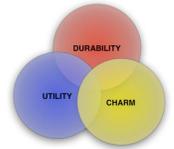


# Applying It

- Population
- Tasks
- Methods
- Techniques
- Evaluation
- Heuristics

# Relativity of Design

- Each user and each task should have precise objectives:
  - Average time to learn
  - Speed of performance
  - Error rate by users
  - Retention over time (frequency of use is a factor)
  - Subjective satisfaction - surveys satisfaction scale
- **Tradeoffs:**
  - lengthy learning -> better performance
  - Rate of errors vs. speed of performance

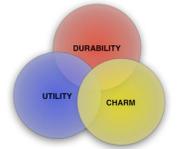


# Why spend effort on the UI? (redux)

- Increased efficiency
- Improved productivity
- Reduced errors
- Reduced training - strive for game like training
- Improved acceptance
- So evaluation determines how well we did

# Usability Characteristics Evaluation

ISO 9241	Schneiderman	Nielsen
Efficiency	Speed of performance	Efficiency
Effectiveness	Time to learn	Learnability
Satisfaction	Retention over time	Memorability
	Rate of errors by users	Errors/Safety
	Subjective satisfaction	Satisfaction



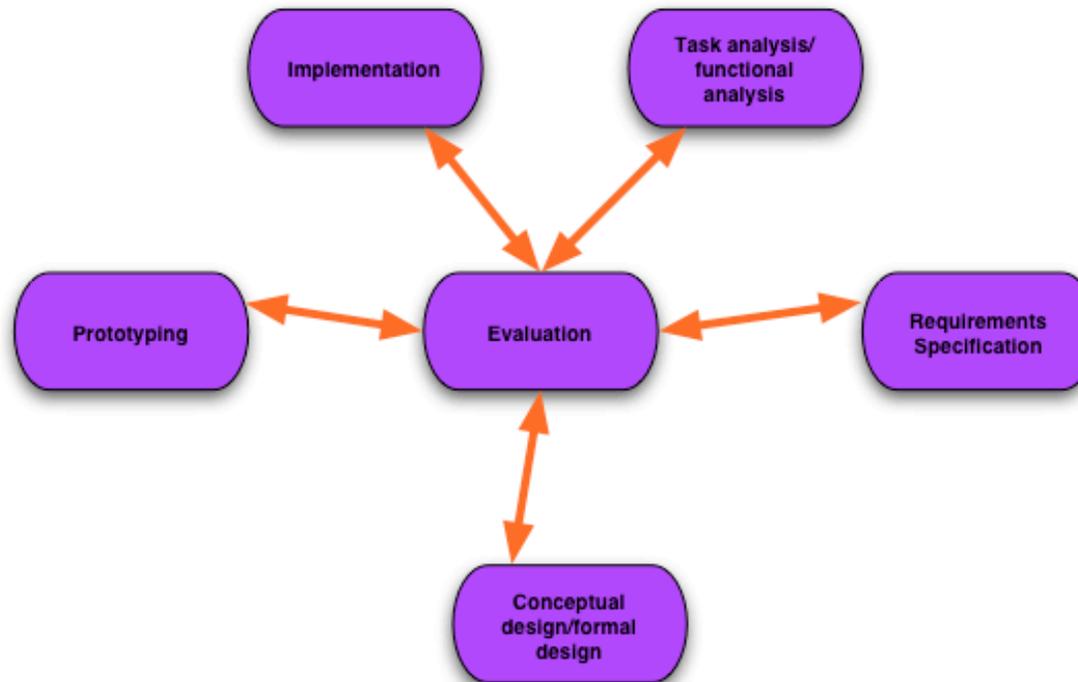
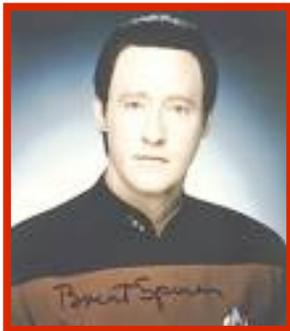
# Evaluation Keys

- Plan the evaluation and plan to evaluate frequently
- Evaluation early in the life cycle, mockups serve as feedback to requirements and design process
- Evaluation later - how well does it meet the users needs (sometimes defer)

# Star Life Cycle

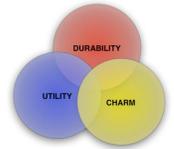
THE STAR LIFE CYCLE

DATA!



# Evaluation

- Not only in course of design process but as part of the system - throughout process, continually evaluate
- BEFORE: scenario based, manual based, story board based - evaluation as prototyping, experimentation
- AFTER: (have a prepared baseline of all tasks in previous environment) study and MEASURE how users are doing - in the beginning and at regular intervals
  - Casual interfaces - kiosks should go quickly: seconds to minutes
  - Week on task interfaces - telemarketing: minutes to hours
  - Month on task interfaces - help desk: days
- Observe the entire environment before and after for days
  - Include what is on their desk, tacked to wall and interactions
- **SATISFACTION AND JOY** - what follows are some heuristics to get there

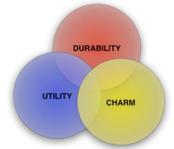


# Applying It

- Population
- Tasks
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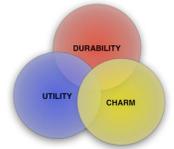
# Heuristics on the User Interface

- If there's a substantial UI component have full time UI person involved from beginning **plus artist/designer**
  - UI person is not converted developer
- **Avoid Natural Language interfaces**
- Understand the environment and the users and the types of users
  - Auditory interface in high noise or long dialog text is not recommended
- Test it and observe - prototypes, user manuals, storyboards
- Do not stray too far from current interfaces, unless ... revolution
- Do not be tempted by direct manipulation/"Matrix mode" unless ample time and software/hardware - but be inventive



# More on UI

- **Do automate!**
- Do not ignore the users needs
- Do talk to the users
- Do understand your user population
- Do be predictable
- Do use common examples in documentation - Unix Man pages
- Do use designers/artists
- **Do use paper, stickers, job aids, ...**
- Do consider Ergonomics
- Do consider special needs
- Joy is an important aspect



# Information Visualization

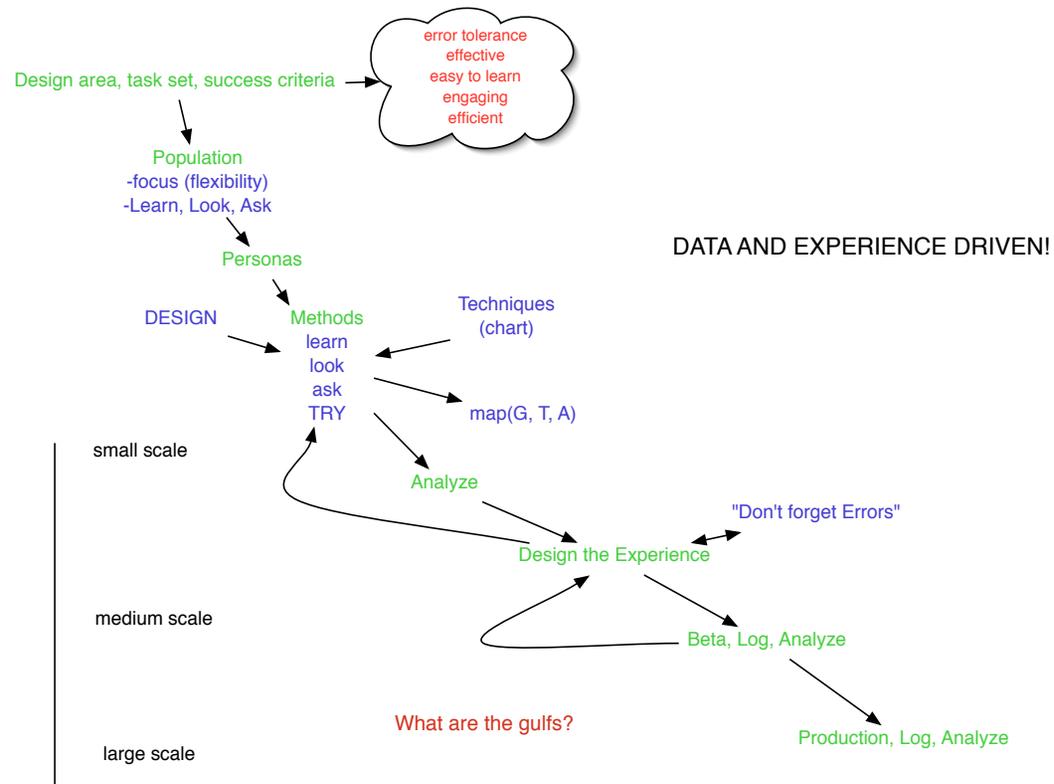
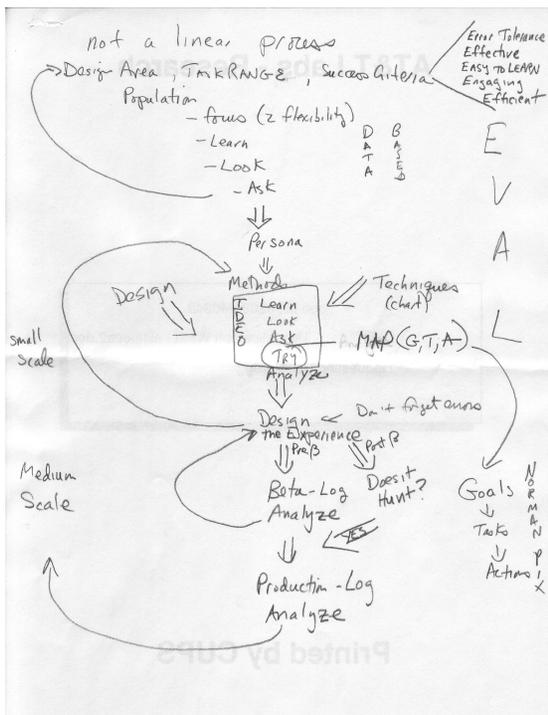
- Shneiderman and Plaisant
  - Overview
  - Zoom
  - Filter
  - Details on demand
  - Relate - among items
  - History
  - Extract

## And So Much More

- Psychology of computer programming
- More on ethnography
- Psychology of online communities - Mail vs IM generations
- Computer supported cooperative work
- Psychology of embedded device interfaces
- Challenges of every new leap in technology
- ...

# In Summary

- User Experience Design is neither linear nor rigid!



# References

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