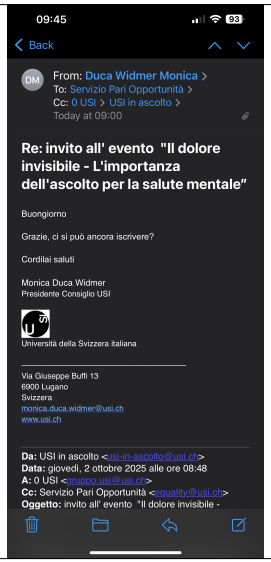
Design 101

Michele Lanza



Lecture 04

Universal Principles of Design III

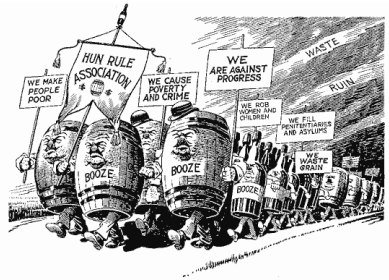
Universal Principles of Design III

80/20 Rule	Accessibility	Advance Organizer	Aesthetic-Usability Effect	Affordance	Alignment	Archetypes	Attractiveness Bias	Baby-Face Bias	Chunking
Classical Conditioning	Closure	Cognitive Dissonance	Color	Common Fate	Comparison	Confirmation	Consistency	Constancy	Constraint
Control	Convergence	Cost-Benefit	Defensible Space	Depth of Processing	Development Cycle	Entry Point	Errors	Expectation Effect	Exposure Effect
Face-ism Ratio	Factor of Safety	Feedback Loop	Fibonacci Sequence	Figure-Ground Relationship	Fitt's Law	Five Hat Racks	Flexibility-Usability Tradeoff	Forgiveness	Form Follows Function
Framing	**Garbage-In Garbage-Out**	**Golden Ratio**	**Good Continuation**	**Gutenberg Diagram**	**Hick's Law**	**Hierarchy**	**Hierarchy of Needs**	**Highlighting**	**Iconic Representation**
Immersion	**Interference Effects**	**Inverted Pyramid**	**Iteration**	**Law of Prägnanz**	**Layering**	**Legibility**	**Life Cycle**	**Mapping**	**Mental Model**

Framing

A technique that influences decision making and judgment by manipulating the way information is presented

- The use of images, words, and context to manipulate people



We're in a permanently framed world

Reflections on Framing

- A widely used technique for political debates (abortion, legalization of drugs, anti-terror, ..)
- A positive frame elicits positive feelings, resulting in pro-active and risk-seeking behavior
- A negative frame elicits negative feelings, resulting in reactive, risk-avoiding behavior
- Opposite frames eliminate each other, making people think for themselves
- Use positive frames to make people do things
- Use negative frames to reach the opposite

Garbage In - Garbage Out

The quality of system output is dependent on the quality of system input

- Refers to two kinds of input problems
  - **Problems of type** occur when the data is of the wrong type (a phone number instead of a credit card number)
    - Easy to detect, primary strategies to prevent this are "Affordance" and "Constraint"
  - **Problems of quality** occurs when defective data of the right type is entered (a phone number, but the wrong one)
    - Difficult to detect, mostly due to "slips" (see "Error" principle)

Reflections on Garbage In - Garbage Out

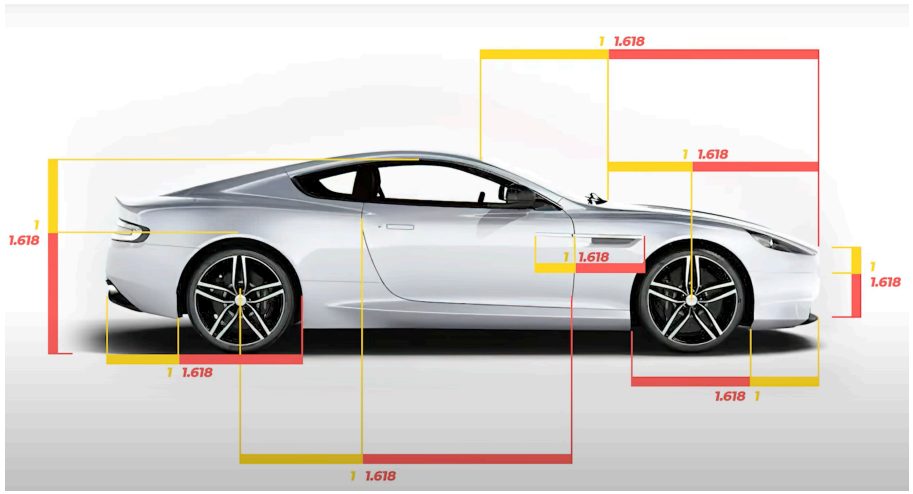
- The best way to prevent garbage out is to prevent garbage in ;-)
  - Use constraints and affordances to minimize problems of type
  - Use previews and confirmations to minimize problems of quality
  - When input quality is critical, use validation tests to check integrity prior to input
- IMO an obvious design principles, but one with many, many facets and manifestations in the real world!
- Software and Data Engineering
  - Data quality is an unsolved problem and there is no main approach to it
  - Future society will largely depend on good quality data: Digital society

Golden Ratio

A ratio within the elements of a form, such as heigh to width, approximating 1.618

- The golden ratio is found throughout nature, art, architecture
- Mondrian, Da Vinci, Le Corbusier, Stradivari, etc. used it extensively





Reflections on the Golden Ratio

- Whether the golden ratio has some inherent aesthetics or is simply an early design technique that became tradition is unclear
- There is no question that it has an important influence on design
- Consider it when it's not at the expense of other design objectives
- Geometries of a design should not be forced to correspond to the golden ratio

Good Continuation

Elements arranged in a straight line or a smooth curve are perceived as a group, and are interpreted as being more related than elements not on the line or curve

- A *Gestalt* Principle asserting that aligned elements are perceived as a single group or chunk
- When sections of a line or shape are hidden from view, good continuation leads the eye to continue along the visible elements
- Related to the “Closure” principle

Reflections on Good Continuation

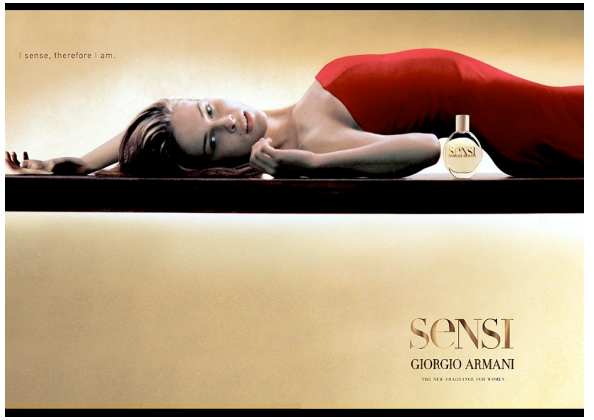
- Heavily used in nature
- Use good continuation to indicate relatedness between elements of a design
- Locate elements such that their alignment corresponds to their relatedness

Gutenberg Diagram

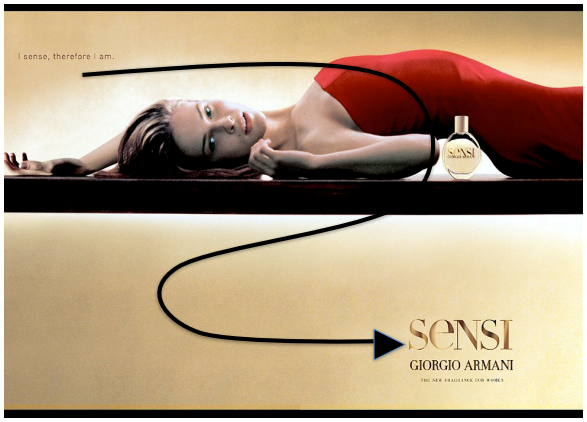
A diagram that describes the general pattern followed by the eyes when looking at evenly distributed, homogeneous information

- Divides the reading area into 4 areas
- Western readers naturally begin top-left and move to bottom-right according to “reading gravity”
- The fallow areas are ignored unless emphasized
- Consider this when doing document layouts

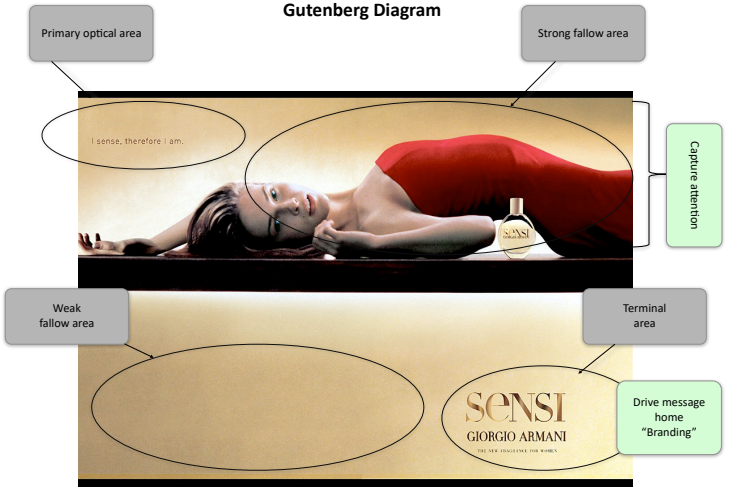
primary optical area	strong fallow area
weak fallow area	terminal area



Eye movement



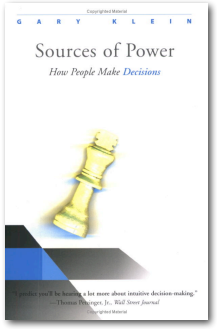
Gutenberg Diagram



Hick's Law

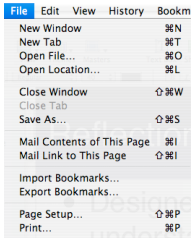
The time it takes to make a decision increases as the number of alternatives increases

- cf. "Sources of Power" by Klein
- Important design principle, especially in cases where people must decide quickly
- All tasks consist of 4 basic steps
  - identify a problem or goal
  - assess the available options
  - decide on an option
  - implement the option



Reflections on Hick's Law

- Designers can improve the efficiency of a design by understanding the implications of Hick's Law
- When designing for time-critical tasks, minimize the number of options!

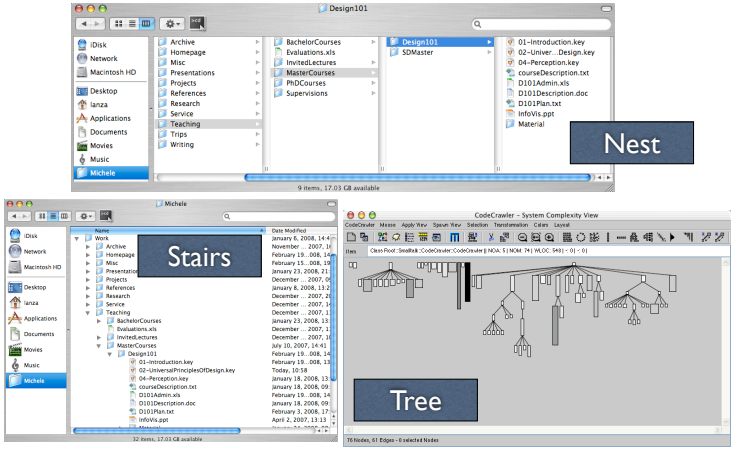


Hierarchy

Hierarchical organization is the simplest structure for visualizing and understanding complexity

- One of the most effective ways to increase knowledge about a system, related to "divide & conquer"
- Perception of hierarchical relationships among elements is a function of their relative top-down and left-right positions
  - also influenced by size, proximity, and the presence of connecting lines
- 3 basic ways to represent hierarchy: *trees*, *nests*, and *stairs*

Exemplifying Hierarchy



Detailing Hierarchy

- Superordinate elements are commonly referred to as *parent* elements, subordinate elements as *child* elements
- **Trees** illustrate hierarchical relationships by locating child elements below or to the right of parents or through the use of connecting lines. Effective for moderate complexity
- **Nests** use containment metaphors. Effective for low complexity
- **Stairs** stack children below and to the right of parent elements. Effective for high complexity, but cumbersome to browse

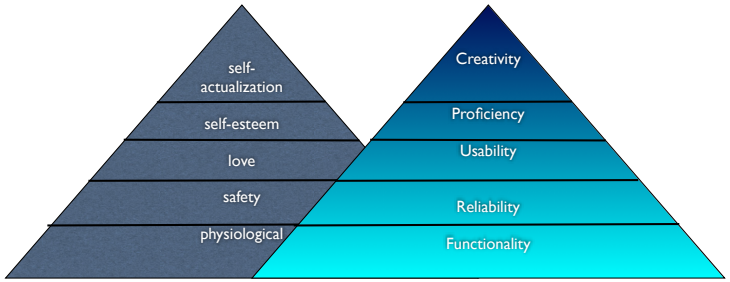
Hierarchy of Needs

In order for a design to be successful, it must meet people's basic needs before it can attempt to satisfy higher-level needs

- A design must serve the low-level needs (e.g., it must function) before the higher-level needs (e.g., it's fun to use) can begin to be addressed

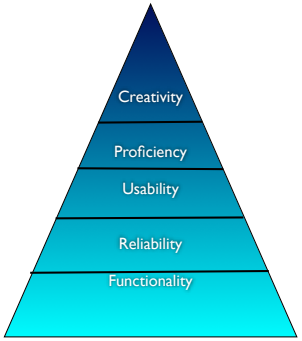
Detailing Hierarchy of Needs

- Inspired from Maslow's hierarchy of (human) needs
- Good designs follow this principle, poor designs attempt to satisfy needs at several levels without building on the lower levels first



The 5 Key Levels of Hierarchy of Needs

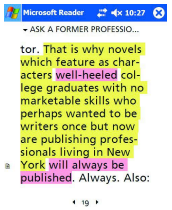
- **Functionality** needs must meet the most basic design requirements (a mobile phone should allow phone calls..)
- **Reliability** needs are to establish stable and consistent performance (battery lifetime, shock absorption)
- **Usability** needs are about how easy and forgiving a design is (quick access of agenda, calendar, etc.)
- **Proficiency** needs empower people to do things they could not do before
- **Creativity** needs come into play when everything else is given: one starts to use a design in unanticipated ways



Highlighting

A technique for bringing attention to an area of text or image

- If used improperly, not only ineffective, but even reduces performance
- General principle: highlight no more than 10% of the visible design; highlighting effects are diluted as the percentage increases
- Use a small number of techniques applied consistently throughout a design



Highlighting Techniques

- **Bold**, *Italics*, <u>Underlining</u>
  - Bolding generally better because it adds minimal noise and clearly highlights target elements
  - Italics add minimal noise, but are harder to detect
  - Underlining adds lots of noise and should be used sparingly or not at all

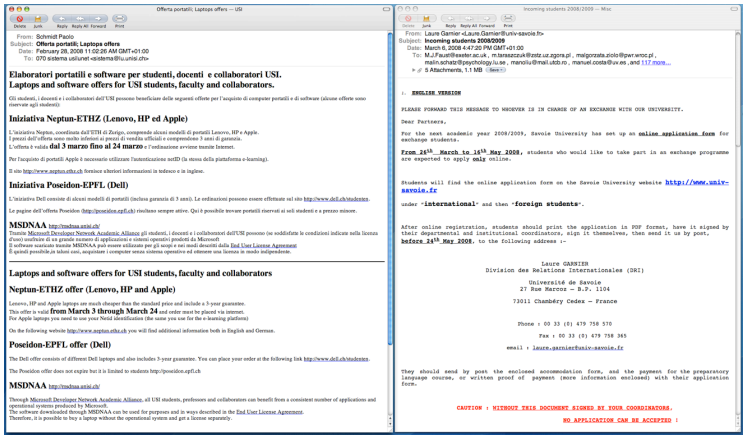
"You mean you can't take **less**" said the Hatter, "it's very easy to take **more** than nothing" "Nobody asked **your** opinion" said Alice	"You mean you can't take *less*" said the Hatter, "it's very easy to take *more* than nothing" "Nobody asked *your* opinion" said Alice	"You mean you can't take <u>less</u>" said the Hatter, "it's very easy to take <u>more</u> than nothing" "Nobody asked <u>your</u> opinion" said Alice

Highlighting Techniques 2

- **Typeface**: Uppercase is easy to detect. Avoid changing fonts
- **Color**: Potentially effective, but should be used sparingly and only together with other techniques
- **Inversing**: Works well with text, less with pictures. Very effective, but disrupts a design. Use sparingly
- **Blinking** (flashing) elements are easy to detect and attract attention, but disturb in the long run

"You mean you can't take LESS" said the Hatter, "it's very easy to take MORE than nothing" "Nobody asked YOUR opinion" said Alice	"You mean you can't take less" said the Hatter, "it's very easy to take more than nothing" "Nobody asked your opinion" said Alice	"You mean you can't take less" said the Hatter, "it's very easy to take more than nothing" "Nobody asked your opinion" said Alice
Hello World		

Sidestep: E-Mails & Highlighting @ USI



Iconic Representation

The use of pictorial images to improve the recognition and recall of signs and controls

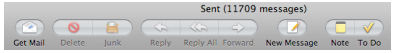
- Used in signage, computer displays, control panels,..
- Can be used for identification, serve as space-efficient alternative to text, or to draw attention
- Four types of iconic representation
  - Similar
  - Example
  - Symbolic
  - Arbitrary

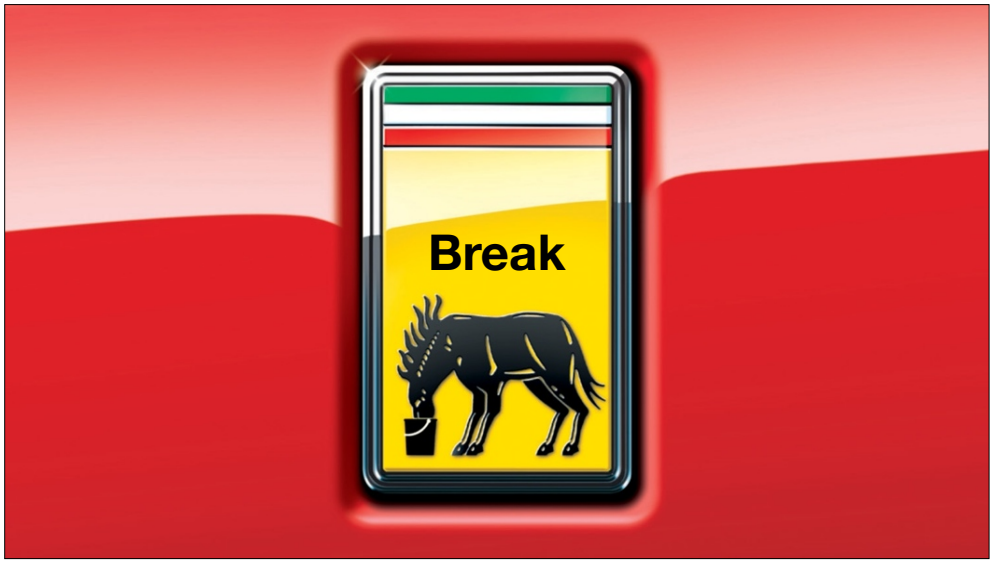
Detailing Icon Representation

- **Similar** icons use images analogous to an object, concept, or action
- **Example** icons use images commonly associated to an action, object, or concept
- **Symbolic** icons use images at a higher level of abstraction
- **Arbitrary** icons use images with little or no relationship to an action, object, or concept. They have to be learned

Reflections on Iconic Representation

- Icons reduce performance load, conserve display and control area, and make signs and controls understandable across cultures
- Use..
  - similar icons when representations are simple and concrete
  - example icons when representations are complex
  - symbolic icons when representations involve well-established and recognizable symbols
  - arbitrary icons to set new standards
- Label icons and make them share a common visual motif (style and color) for optimal performance





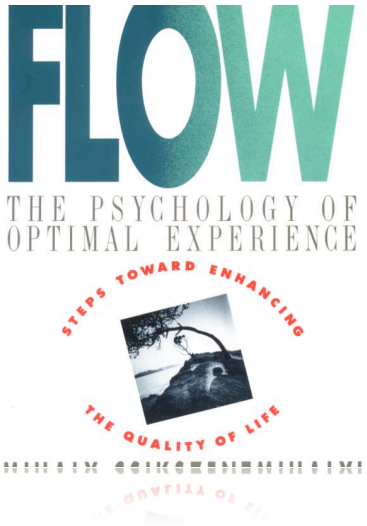
Immersion

A state of mental focus so intense that awareness of the "real" world is lost, generally resulting in a feeling of joy and satisfaction

- Apathy and boredom is a consequence of under-taxed cognitive and perceptual systems
- Stress is a consequence of over-taxation
- Immersion occurs when a person's cognitive system is challenged at near capacity
- This is also called "flow", a state of mind where everything else becomes less relevant and one is fully concentrated on a task, leading to joy and satisfaction

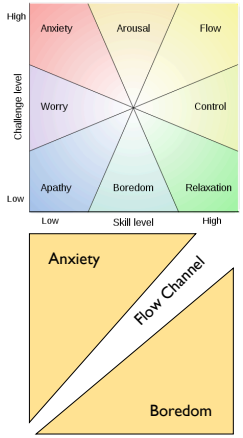
Mihály Csíkszentmihályi, 1975

"The holistic experience
that people feel when
they act with total involvement"



Detailing Immersion

- Challenges that *can* be overcome
- Contexts where one can focus without distraction
- Clearly defined goals
- Immediate feedback regarding actions and performance
- Loss of awareness of problems of everyday's life
- Feeling of control over actions and the environment
- Loss of concern regarding the self (hunger, thirst, ..)
- A modified sense of time (time goes by very quickly)



Guidelines on Immersion

- Incorporate elements of immersion in activities and environments that seek to engage people over time (entertainment, instruction, games, exhibits, etc.)
- Provide clearly defined goals and challenges
- Design environments that minimize distractions, but promote a feeling of control, and provide feedback
- Distract people from the "real" world
- All of this is more art than science, it requires time to develop a sense for how to support immersion
- Question: Does this building support immersion?

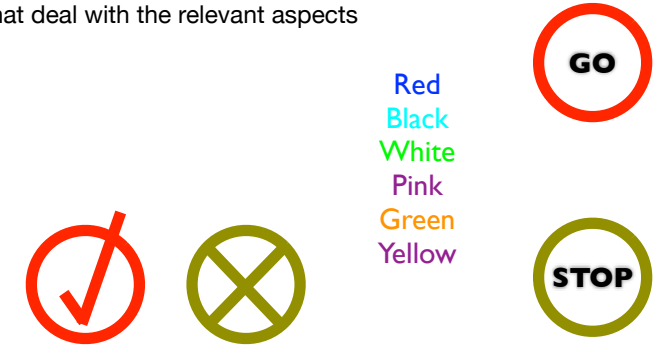
Interference Effects

A phenomenon in which mental processing is made slower and less accurate by competing mental processes

- Occurs when two or more perceptual or cognitive processes are in conflict
- Human cognition is fed by parallel inputs (visual, aural, memory, etc.)
  - When they conflict, processing time is increased and performance reduced
- Example interferences:
  - Stroop, Garner, Proactive, Retroactive

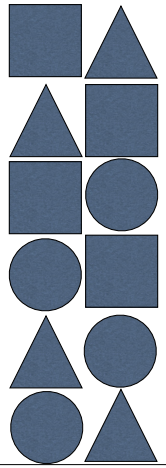
Stroop Interference

- An irrelevant aspect of a stimulus triggers a mental process that interferes with the processes that deal with the relevant aspects



Garner Interference

- An irrelevant variation of the stimulus triggers a mental process that interferes with processes involving a relevant aspect of the stimulus



Proactive & Retroactive Interference

- Proactive Interference
  - Existing memories interfere with learning
    - For example when learning a new language, errors are made because one tries to map the concepts to already known concepts from other languages
- Retroactive Interference
  - Learning interferes with existing memories
    - Learning a new phone number can interfere with phone numbers already in memory

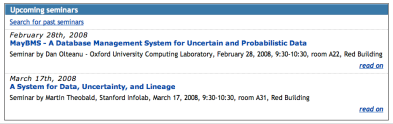
Guidelines on Interference

- Avoid designs that create conflicting mental processes
  - Perception interference (Stroop, Garner) usually occurs because of conflicting coding combinations or from elements too closely positioned
  - Minimize learning interference (pro- and retroactive) by mixing presentation modes of instruction (e.g., lectures, videos, activities, etc.).
    - Also incorporate periods of rest (performance generally degrades over time).

Inverted Pyramid

A method of information presentation in which information is presented in descending order of importance

- In a normal pyramid, first the foundation is laid out (giving the context), then come the details
- The inverted pyramid first summarizes the “what”, “where”, “when”, “who”, “why”, and “how”
- The body then elaborates facts and details in descending order of importance

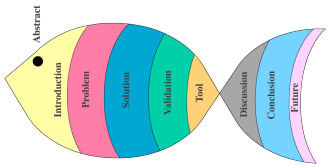


Reflections on Inverted Pyramid

- It has a number of benefits over traditional methods of information presentation
  - Important stuff first (more likely to be remembered)
  - Establishes a context (to interpret subsequent facts)
  - Permits efficient scanning and searching of information
  - Allows information to be edited for length (the less important things are at the end)
- The major drawback is that it does not allow the flexibility of building suspense and is thus boring

Guidelines on Inverted Pyramid

- Use it when presentation efficiency is important
- If interestingness is important and has been compromised, include multimedia, interesting layouts, and interactivity to complement the information and actively engage the audience
- When it is not possible to use it (for example scientific writing), go for a compromise (such as an abstract, and introduction section, etc.)



Iteration

A process of repeating a set of operations until a specific result is achieved

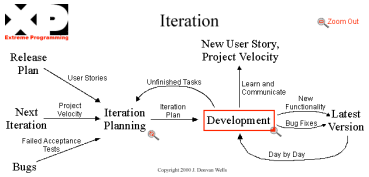
- Ordered complexity does not occur without iteration
- Nature is a good example of that
- The emergence of ordered complexity results from an accumulation of knowledge and experience that is then applied to a design
- For example user interfaces evolve as the users' needs become clear and/or change
- Iteration occurs in all development cycles in two basic forms: **design** iteration and **development** iteration

Design & Development Iteration

- Design iteration occurs when exploring, testing, and refining design concepts
  - Each cycle narrows the range of possibilities until the design conforms to the design requirements
  - The target audience should always be involved in this!
  - Success or failure is irrelevant, the point is the information about what works and what doesn't
    - Actually, learning from mistakes is usually easier ;-)
- Development iteration in the unexpected/unpleasing additional work when building a product
  - Costly and undesirable, should be eliminated during the design stage

Guidelines on Iteration

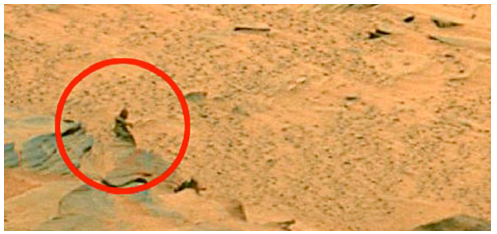
- Plan for design iteration
- Establish clear criteria for when a design fulfills its requirements
- Ensure that all development members have the same, clear vision of the end goal (the final product)
  - This is often accomplished through well-written specs and high-fidelity models & prototypes
- In software engineering prepare for development iteration, by embracing change



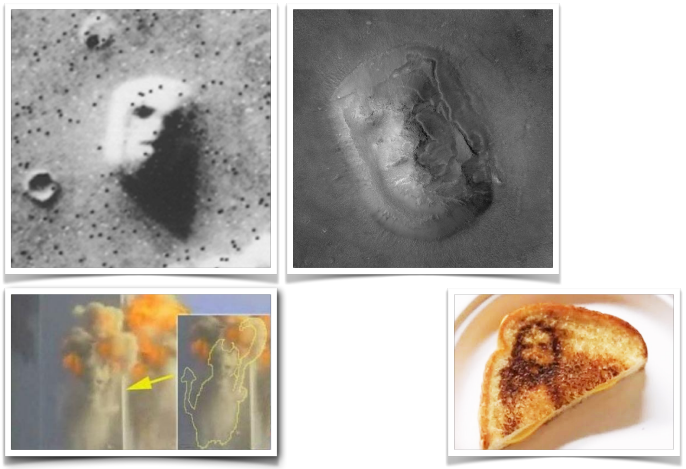
Law of Prägnanz

A tendency to interpret ambiguous images as simple and complete, versus complex and incomplete

- A *Gestalt* principle asserting that people interpret information in the simplest way possible
  - "Simple"refers to fewer elements, symmetry, or known concepts



Mars Attacks?

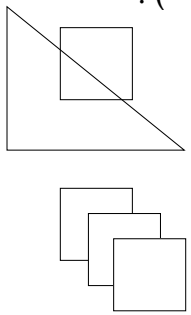


Reflections on Law of Prägnanz

- It indicates that our brain tries to simplify inputs to increase performance
- Guidelines
  - Minimize the number of elements in a design ("simple is beautiful")
  - Symmetrical compositions are preferred over asymmetrical ones, but they are less interesting
  - Favor symmetrical compositions when efficiency is paramount, favor asymmetrical ones when interestingness is crucial

;-)

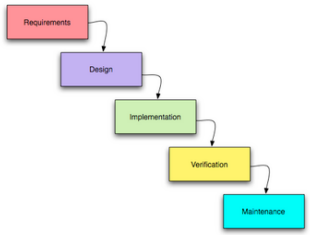
:-(

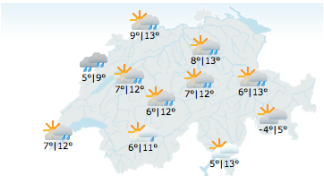


Layering

The process of organizing information into related groupings in order to manage complexity and reinforce relationships in the information

- Two basic kinds: 2D- and 3D-layering





2D Layering

- 2D Layering separates information into layers such that only one layer is visible at a time
  - Can be done in a linear or non-linear fashion
  - Useful when information has a clear beginning and end
  - Non-linear can be *hierarchical*, *parallel*, or *web*
    - **Hierarchical**: useful when information contains super-ordinate and subordinate relationships
    - **Parallel**: useful when information is based on the organization of other information (think: Dictionary)
    - **Web**: useful when information has many different kinds of relationships within itself

3D Layering

- Involves separating information into layers such that multiple layers can be viewed at one time
  - Revealed as either opaque or transparent planes that sit atop one another (hence the 3rd dimension)
  - Opaque layers are useful when additional information has to be transmitted in a given context (e.g., a pop-up window)
  - Transparent layers are useful when overlays of information combine to illustrate concepts or highlight relationships

Legibility

The visual clarity of text, generally based on the size, typeface, contrast, text block, and spacing of the characters used

- **Not** readability
- A controversial domain, and the rise of computers has complicated the discussion (everybody can be a publisher ;-)
- Still, there's a number of fundamental guidelines concerning
  - Size
  - Typeface
  - Contrast
  - Text Blocks
  - Spacing

Exemplifying Legibility

Size

9pt Times New Roman 10pt Times New Roman 12pt Times New Roman 14pt Times New Roman 18pt Times New Roman

Typeface

"Sans Gill" Sans-Serif

"Bookman Old Style" with Serif

Text Blocks

Ragged Right	Justified	Ragged Left
Established in October 2004, the faculty of informatics is dedicated to high quality teaching and research in informatics and computer science.	Established in October 2004, the faculty of informatics is dedicated to high quality teaching and research in informatics and computer science.	Established in October 2004, the faculty of informatics is dedicated to high quality teaching and research in informatics and computer science.

Spacing

Proportionally spaced: Established in October 2004, the faculty of informatics is dedicated to high quality teaching and research in informatics and computer science.

Monospaced: `Established in October 2004, the faculty of informatics is dedicated to high quality teaching and research in informatics and computer science.`

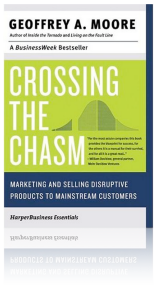
Guidelines on Legibility

- **Size**: for printed text 9-12 point type is optimal
  - Smaller sizes ok for captions and notes. Use larger type for low-resolution displays and senior audiences
- **Typeface**: no performance difference between serif and sans-serif
- **Contrast**: dark text on light background or vice-versa
  - Performance is best when contrast > 70%, if this is given any color combination works. Patterned or textured backgrounds reduce legibility and should be avoided
- **Text Blocks**: No performance difference between justified or unjustified text. For 9-12 pt fonts a line length of 8-13 cm is best (= 10-12 words or 35-55 characters each line)
- **Spacing**: For 9-12 pt font set leading (spacing between lines from baseline to baseline) to type size + 1-4 points
  - Proportionally spaced typefaces work better than monospaced

Life Cycle

All products progress sequentially through four stages of existence: introduction, growth, maturity, and decline

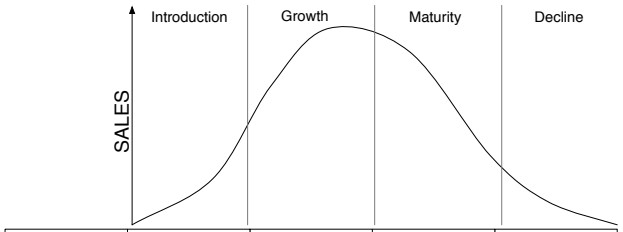
- All products progress through stages that roughly correspond to birth, adolescence, adulthood, death
- Understanding the implications of this allows designers to prepare for the unique and evolving requirements of a product over its lifetime
- cf. "Crossing the Chasm" by Geoffrey Moore



Detailing Life Cycle

- **Introduction**: The official birth of a product. Design is focused on usability and performance by interacting with early adopters
- **Growth**: The most difficult stage where most products fail. Focus on scaling and performance to keep user satisfaction. Next-generation requirements are already being collected
- **Maturity**: The peak. Sales start to flatten. Competition is strong. Design focus on retaining users. Next-generation development already started
- **Decline**: The end. Core market is closing down. Focus on minimizing costs and migrate customers to new products

Depicting the 4 stages



Audience	Early Adopters	Mainstream	Late Adopters	Laggards
Market	Small	Growing	Large	Contracting
Sales	Low	High	Flattening	Moderate
Competition	Low	Moderate	High	Moderate
Business Focus	Awareness	Market Share	Customer Retention	Transition
Design Focus	Tuning	Scaling	Support	Transition

Mapping

A relationship between controls and their movements or effects. Good mapping between controls and their effects results in greater ease of use

- Turn a wheel, flip a switch, push a button: you expect something to happen
- If this something meets your expectations, the mapping is good

Detailing Mapping

- Good mapping is primarily a function of similarity of layout, behavior, or meaning
  - Layout: e.g., when the layout of the stove buttons corresponds to the layout of the burners
  - Behavior: Turning a steering wheel left makes the car go left (not at trivial as you may think: consider an airplane wrt going up/down)
  - Meaning: a red “emergency” button
- Ease of use comes from a good mapping

Guidelines on Mapping

- Position controls so that their locations and behaviors correspond to the layout and behavior of the device
- Avoid using a single control for multiple functions
  - If not avoidable, use colors to indicate the state
- Watch out for existing conventions, as different populations may grow up differently
  - E.g., in the UK flipping a switch up turns it off, flipping it down turns it on. In the USA it’s the contrary!

Mental Model

People understand and interact with systems and environments based on mental representations developed from experience

- Whenever you interact with a system you expect it to behave according to a mental model you developed
  - If the imagined and real outcomes correspond, a mental model is accurate and complete
- There are two basic types of mental models
  - **System models**: how the system works
  - **Interaction models**: how people interact with systems
- Example: Anti-lock brakes do not help to reduce accidents. Why?

Reflections on Mental Model

- Designers usually have accurate system models, but weak interaction models
- Users on the hand quickly develop good interaction models but have incomplete system models
- Optimal designs only emerge if the designer on top of an accurate system model takes the pain to infer a complete interaction model
  - Again: observe the user, don't make assumptions
- When designing, if there's a standard interaction model, leverage it. If not, use common models (e.g., the desktop metaphor for computers)
  - Do not contrive designs to make them fit a common model, if the system is new, it's better to use a consistent new metaphor
- In Software Engineering having a mental model of a system is a pre-condition for implementing changes

Universal Principles of Design III

80/20 Rule	Accessibility	Advance Organizer	Aesthetic-Usability Effect	Affordance	Alignment	Archetypes	Attractiveness Bias	Baby-Face Bias	Chunking
Classical Conditioning	Closure	Cognitive Dissonance	Color	Common Fate	Comparison	Confirmation	Consistency	Constancy	Constraint
Control	Convergence	Cost-Benefit	Defensible Space	Depth of Processing	Development Cycle	Entry Point	Errors	Expectation Effect	Exposure Effect
Face-ism Ratio	Factor of Safety	Feedback Loop	Fibonacci Sequence	Figure-Ground Relationship	Fitt's Law	Five Hat Racks	Flexibility-Usability Tradeoff	Forgiveness	Form Follows Function
Framing	**Garbage-In Garbage-Out**	**Golden Ratio**	**Good Continuation**	**Gutenberg Diagram**	**Hick's Law**	**Hierarchy**	**Hierarchy of Needs**	**Highlighting**	**Iconic Representation**
Immersion	**Interference Effects**	**Inverted Pyramid**	**Iteration**	**Law of Prägnanz**	**Layering**	**Legibility**	**Life Cycle**	**Mapping**	**Mental Model**

Homework

- Install & make Pharo work: Mattia is in charge for tomorrow and next week
- Prepare a 180 seconds prez on one of the design principles presented so far, and deliver it on Oct 16