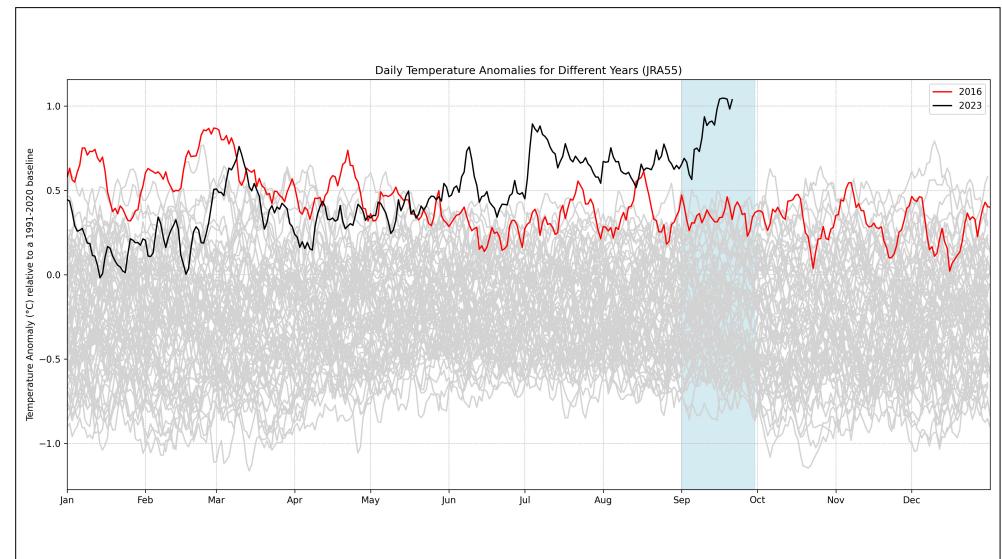




Design 101

Michele Lanza



Lecture 03

Universal Principles of Design II

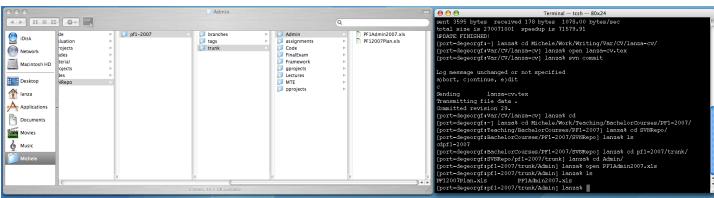
Universal Principles of Design II

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

Control

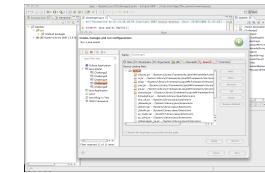
The level of control provided by a system should be related to the proficiency and experience levels of the people using the system

- ▶ Beginners do best with a limited amount of control, experts want no limits



Guidelines on Control

- ▶ When possible, use a method that is equally simple and efficient for beginners and experts
- ▶ Otherwise, provide methods specialized for each of them
- ▶ Conceal expert methods to the extent possible to minimize complexity for beginners
- ▶ When systems are complex and frequently used, consider designs that can be customized to conform to individual preference and level of expertise



Convergence

A process in which similar characteristics evolve independently in multiple systems

- ▶ Systems that best approximate optimal strategies afforded by the environment tend to survive, while the others tend to extinguish themselves
- ▶ Usually a very slow process strongly related to Darwinian laws ("survival of the fittest")



Reflections on Convergence

- ▶ Consider the level of stability and convergence in an environment prior to design
- ▶ Stable, convergent systems are receptive to minor innovations and refinements, but resist radical changes
- ▶ Unstable environments with no convergent systems are receptive to major innovations and experimentation
- ▶ Humans can also be convergent or not, boiling down to being conservative or innovation-friendly



Cost-Benefit

An activity will be pursued only if its benefits are equal to or greater than the costs

- ▶ People always think "is it worth my time?" (and you know that time = money)
- ▶ This principle can be used to assess design quality
- ▶ Many manifestations:
 - ▶ Is it worth to switch operating system/mobile phone?
 - ▶ How much time do I have to spend to organise my pictures?
 - ▶ How many things do I have to do to find something?



Reflections on Cost-Benefit

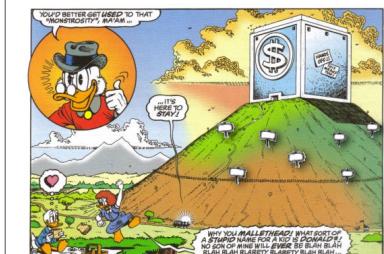
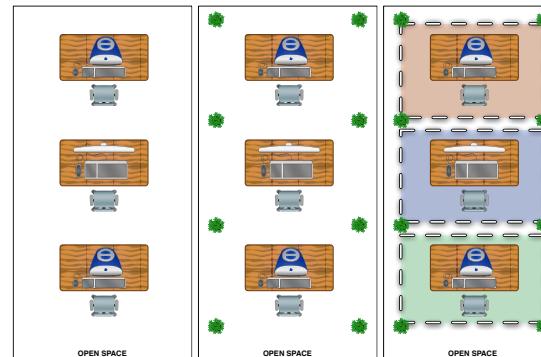
- ▶ It is not about the absolute quality of a design, but about the context in which a design resides
- ▶ Even the best website is worthless if its functionalities are hard to reach
- ▶ Even the best designed website is worthless if there are only poor contents
- ▶ "Form without content is meaningless, content without form goes unnoticed"
- ▶ Solution: Observe!
 - ▶ Observe people, collect statistics, constantly reflect on your design

Defensible Space

A space that has territorial markers, opportunities for surveillance, and clear indications of activity and ownership

- ▶ 3 key features of defensible space:
 - ▶ **Territoriality:** The establishment of clearly defined spaces of ownership
 - ▶ **Surveillance:** monitoring of the environment during normal daily activities
 - ▶ **Symbolic barriers:** Objects placed in the environment to create the perception that a person's space is cared for and worthy of defense

Exemplifying Defensible Space



Reflections on Defensible Space

- ▶ Incorporate it in the design of residences, offices, communities
- ▶ Clearly mark territories to indicate ownership and responsibility
- ▶ Increase opportunities for surveillance and reduce environmental elements that allow concealment
- ▶ Reduce unassigned open spaces and services
- ▶ Use typical symbolic barriers to indicate activity and use

Depth of Processing

A phenomenon of memory in which information that is analyzed deeply is better recalled than information that is analyzed superficially

- ▶ Information is processed in two ways
 - ▶ **Maintenance Rehearsal:** Superficially, like reading
 - ▶ **Elaborative Rehearsal:** Deeply, like reading and then answering questions about the reading material
- ▶ For example embedding pictures in text leads to elaborative rehearsal
- ▶ Tightly connected to how the brain works, and can be threatened by mental disorders (Alzheimer, Autism)

Reflections on Depth of Processing

- ▶ When designing information that has to be processed (text, a web page, etc.) keep this principle in mind
- ▶ Use unique presentation and interesting activities to engage people to deeply process information
- ▶ Can be overdone, leading to disrupted flow (for example when a text is full of tables and pictures that have to be processed separately)
- ▶ On a personal note: Scientific papers are largely affected by this problem

Development Cycle

Successful products typically follow 4 stages of creation: requirements, design, development, and testing

- ▶ **Requirements:** Gather them through controlled interactions
 - ▶ Do not just ask what the customer wants, (s)he doesn't know
- ▶ **Design:** Requirements are translated into specifications
 - ▶ Good design is obtained through careful research of analogous solutions, brainstorming, prototyping, and many iterations of trying.
 - ▶ If a design is the same at the beginning and the end of this stage, something is wrong..

Development Cycle Stages 3 & 4

- ▶ **Development:** Specs are transformed into an actual product in order to meet the specs
- ▶ Two basic control strategies:
 - ▶ Reduce variability of materials, create and assemble parts
 - ▶ This is/was the promise of component-based software engineering
 - ▶ Verify that specs are maintained all the time
- ▶ **Testing:** Ensure the design meets the requirements and the specs
 - ▶ Internal (you) and external testing (with the customer) is crucial

Software Development Life-Cycle

- ▶ The waterfall model a.k.a. linear model
- ▶ The spiral model a.k.a. iterative model

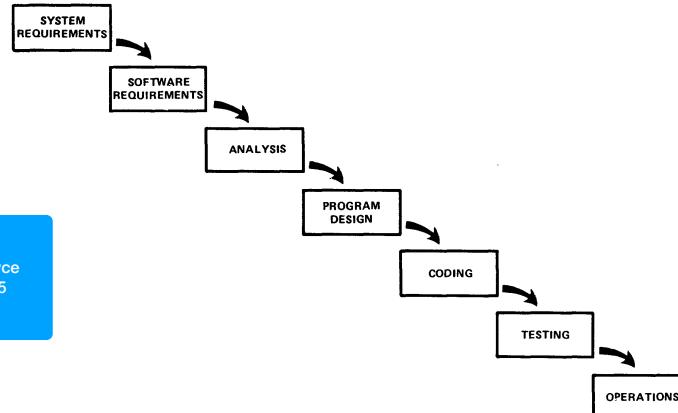
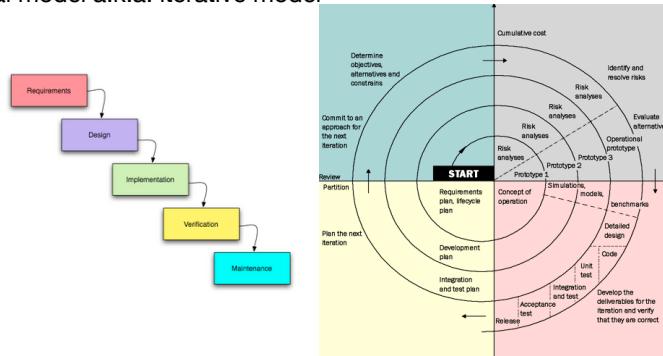


Figure 2. Implementation steps to develop a large computer program for delivery to a customer.

I believe in this concept, but the implementation described above is risky and invites failure. The problem is illustrated in Figure 4. The testing phase which occurs at the end of the development cycle is the first event for which timing, storage, input/output transfers, etc., are experienced as distinguished from

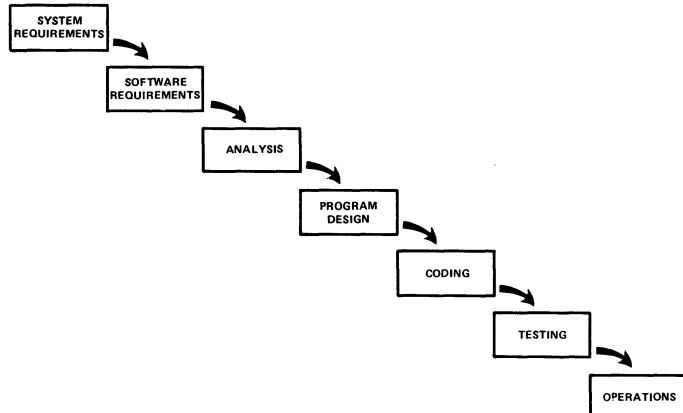


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Guidelines on Development Cycle

- ▶ Gather requirements through controlled interactions with target audiences (not speculation)
- ▶ Use research, brainstorming, prototyping and iterative design to achieve optimal designs
- ▶ Minimize variability in products and processes to improve quality
- ▶ Test all aspects of the design to the degree possible
- ▶ These rules are not only pertinent to software, but to everything!
 - ▶ Do you think the architects tested this building or asked us whether it was what we wanted?

Entry Point

A point of physical or attentional entry into a design

- ▶ People *do* judge books by their covers
- ▶ “First impressions are lasting impressions”
- ▶ The initial impression of a system or environment greatly influences subsequent perceptions and attitudes, which then affects the quality of subsequent interactions
- ▶ Think of this when you enter a website, a shop, a disco, a bar, a restaurant, etc...

Key points of the Entry Point Principle

- ▶ **Minimal Barriers:** Nothing should encumber entry points, such as long loading times for a web page, sales-people standing at the entrance of a shop, etc.
- ▶ **Points of Prospect:** Allow people to quickly become oriented at the entry point, do not hurry them
- ▶ **Progressive Lures:** Attract and pull people through the entry point, put “popular” things right after the entry point, such as toilets, candies, or “downloads”
- ▶ To see an impressive physical example go to an Apple retail store



Errors

An action or omission of action yielding an unintended result

- ▶ Human error is often a design error inducing a human to perform poorly or dangerously
- ▶ There are 2 basic types of errors, *slips* and *mistakes*
 - ▶ **Slips** (= errors of action/execution) are automatic, based on unconscious processes
 - ▶ **Mistakes** (= errors of intention/planning) are based on conscious processes and frequently result from stress or decision-making biases

Guidelines on Errors

- ▶ Minimize slips by providing clear feedback on actions
- ▶ Minimize mistakes by increasing situational awareness and reducing environmental noise
- ▶ Incorporate the principle of forgiveness into a design
 - ▶ Forgiveness refers to the use of design elements to reduce the frequency and severity of errors when they occur, enhancing the design's safety and usability



Expectation Effect

A phenomenon in which perceptions and behavior changes as a result of personal expectations or the expectations of others

- ▶ When people are aware of a probable or desired outcome, their perceptions and behavior are affected



Expectation Effect Examples

Effect	Description
Halo Effect	Employers rate the performance of certain employees more highly than others based on an overall positive impression of those employees
Hawthorne effect	Employees are more productive based on the belief that changes made to the environment will increase productivity
Pygmalion effect	Students perform better or worse based on the expectations of their teacher
Placebo effect	Patients experience treatment effects based on their belief that a treatment will work
Rosenthal effect	Teachers treat students based on their expectations of how students will perform
Demand characteristics	When questioned in a formal setting (interview, poll, etc.) people tend to give answers that they think are expected by the person asking

Guidelines on Expectation

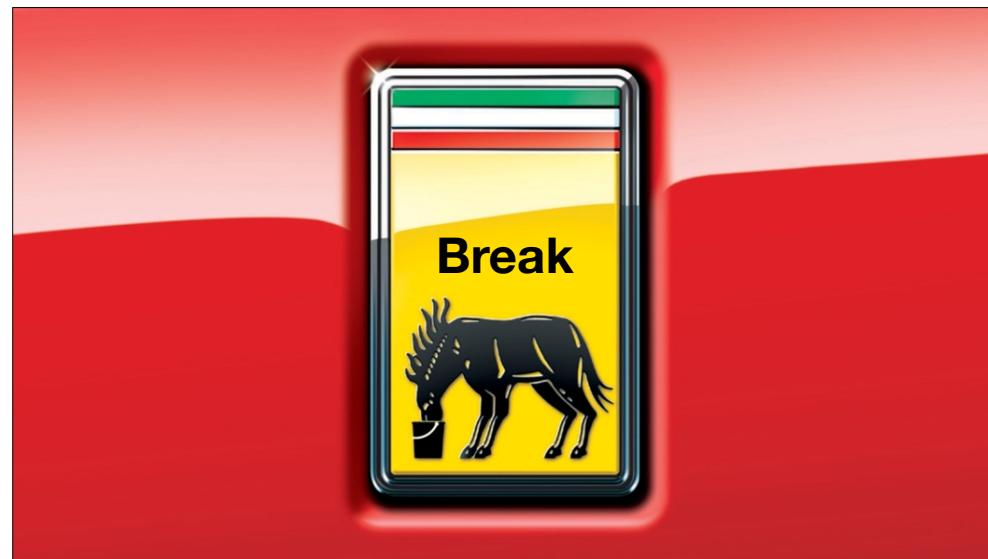
- ▶ Keep expectation in mind when introducing a new design
- ▶ When trying to persuade, leverage it to guide a target audience to a desired conclusion, rather than letting them form their own
- ▶ Morally and ethically a hairy concept..



Exposure Effect

Repeated exposures to stimuli for which people have neutral feelings will increase the likeability of the stimuli

- ▶ Heavily exploited by television and music companies
- ▶ Strongest exposure seen with photos, words, names, and simple shapes
- ▶ The effect gradually weakens as the number of presentations increases
- ▶ Works best at a subconscious level (only show briefly, if possible)
- ▶ Used for propaganda (communists, for example)



Face-ism Ratio

The ratio of face to body in an image that influences the way the person in the image is perceived

- ▶ Face-ism measures how much of a picture is taken up by the face of a person
- ▶ High face-ism: Focus attention on the person's intellectual and personality attributes
- ▶ Low face-ism: Focus attention on the physical and sensual attributes
- ▶ Irrespective of gender, people rate individuals in high face-ism images as being more intelligent, dominant, and ambitious than with a low face-ism



Face-ism Examples

The collage illustrates various examples of face-ism. It shows a woman in a red dress (high face-ism), a close-up of a woman's face (very high face-ism), a silhouette of a person holding an iPod (low face-ism), and screenshots of the Greenpeace International and UNICEF websites, which feature large images of people's faces.

Greenpeace International

Welcome to Greenpeace International

We are delighted that Philip Morris has announced a commitment to invest \$1 billion over five years in recycling products. During this week Philip Morris confirmed that it would invest \$1 billion over five years in recycling products. This investment comes closer to being part of the overall

UNICEF

National Committees for UNICEF

West Africa fights polio

A message from the UNICEF Executive Board

UNICEF Special Reports

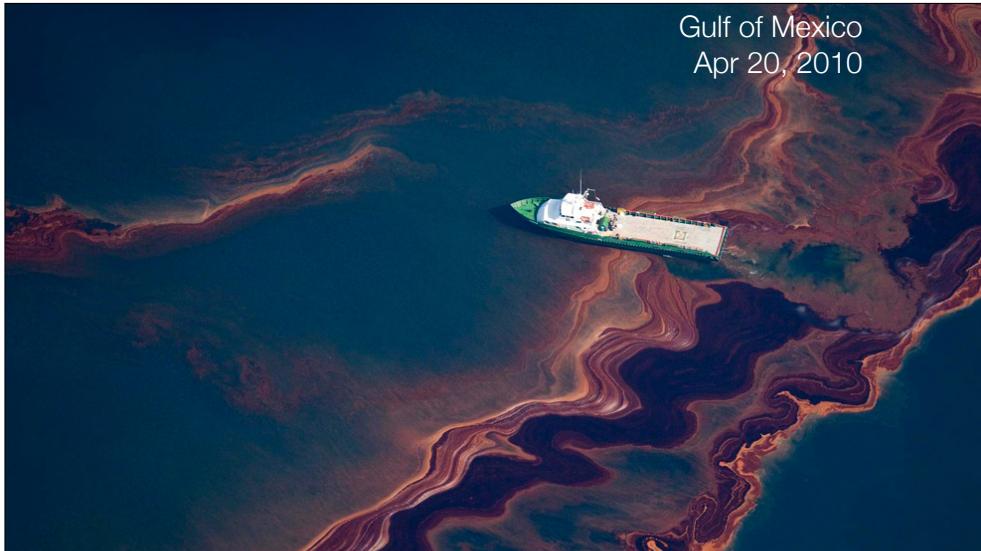
Reflections on Face-ism

- ▶ There's a gender bias
- ▶ In magazines men are always shown with high face-ism, women with low face-ism
 - ▶ May have changed a bit since the whole body-worship started
 - ▶ True across cultures, seems to be deeply rooted
- ▶ Consider face-ism when making your CV and when you look at media in general (e.g., elections)
- ▶ Rule of thumb:
 - ▶ When a design requires thoughtful interpretations or associations, then use high face-ism
 - ▶ When a design is mostly aesthetic, then use low face-ism

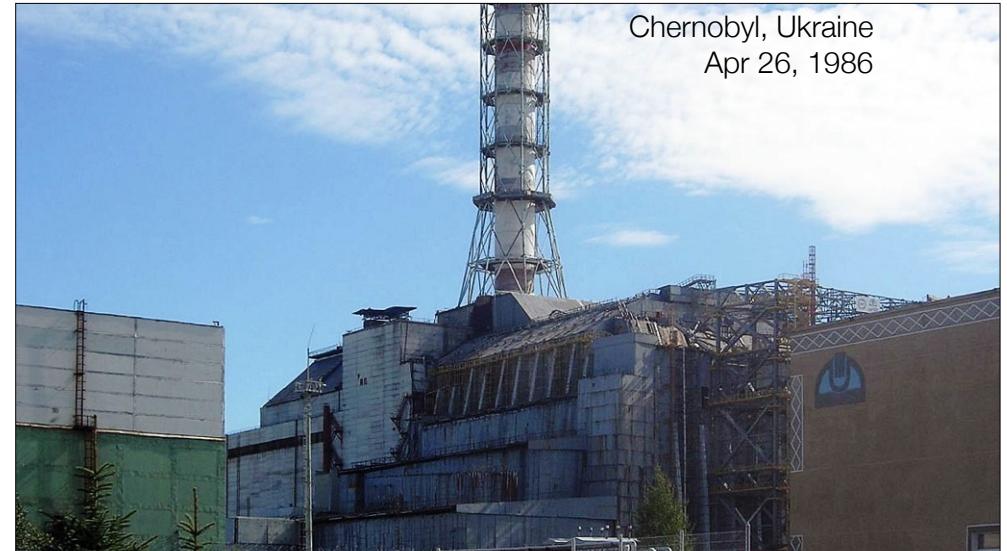
Factor of Safety

The use of more elements than is thought to be necessary to offset the effects of unknown variables and prevent system failure

- ▶ Design requires dealing with unknowns
 - ▶ Even in the case of full specs, you always make assumptions about things
 - ▶ The safety factor models such assumptions
 - ▶ For example: when constructing a house, you assume certain static properties
 - ▶ What happens in the case of an earthquake?
 - ▶ A sad truth is that construction is always at the borderline of legality to save costs!



Gulf of Mexico
Apr 20, 2010

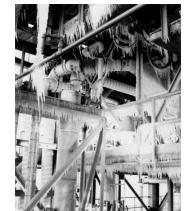


Chernobyl, Ukraine
Apr 26, 1986



Reflections on Factor of Safety

- ▶ A high factor safety makes worst-case assumptions
 - ▶ Your server can handle 1000 connections an hour
 - ▶ Can it handle 10,000? 100,000? 1,000,000?
- ▶ This principle is tied to problems of scale as well
- ▶ Sad example: the challenger mission
- ▶ The coldest launch ever



Feedback Loop

A relationship between variables in a system where the consequences of an event feed back into the system as input, modifying the event in the future

- ▶ Every action creates an equal and opposite reaction
- ▶ When reactions loop back to affect themselves, a feedback loop is created. There are two kinds of feedback loops
 - ▶ **Positive feedback loops:** Effective to create change, but result in negative consequences if not moderated by negative feedback loops
 - ▶ **Negative feedback loops:** Effective for resisting change and stabilizing systems
- ▶ Example: people drive too fast, dying in accidents. Positive feedback: make cars safer. Result: people drive faster, dying even more..



Reflections on Feedback Loop

- ▶ Key lesson: Things are connected!
- ▶ Modifying a variable in a system affects all the other variables in one way or another
- ▶ Therefore: consider a design in its global context
- ▶ Use positive feedback loops to perturb systems and spark change
- ▶ Use negative feedback loops to stabilize systems, at the risk of stagnation
- ▶ The history of war also provides some good examples of this principle

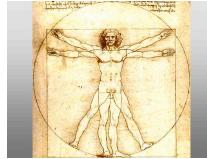


Fibonacci Sequence

A sequence of numbers in which each number is the sum of the preceding two

► 0 1 1 2 3 5 8 13 21 34 55 89 144 233 377...

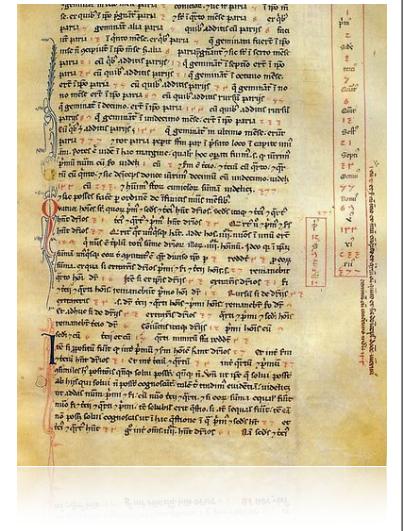
- Patterns exhibiting this sequence are found in natural forms, such as the petals of a flower, spirals of galaxies, bones in the human hand, etc.
- Also present in works of art (music, poems, etc.)



Leonardo da Pisa

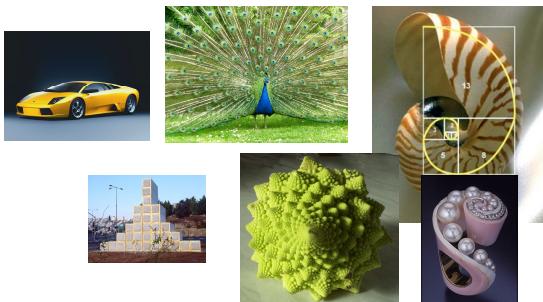
a.k.a. "filius bonacio"
(1170-1250)

Author of the "Liber Abaci", an arithmetics book that brought Arabic numbers to Europe (not the first book, but the most successful because it was targeted at merchants)



Fibonacci Numbers Everywhere..

- Petals
 - 3 (lily, iris), 5 (buttercup, wild rose, larkspur, columbine), 8 (delphiniums), 1 (ragwort, corn marigold, cineraria), 21 (aster, chicory), 34 (plantain), etc.
- Shells
- Vegetables
- Animals
- Cars
- Jewelry
- Art



Reflections on Fibonacci Sequence

- Generally used in concert with the Golden Ratio
- Are Fibonacci patterns aesthetic because we find them so, or because we are told so? Hmm...
- Still, one of the most influential patterns in mathematics and design
- Consider using Fibonacci sequences when
 - developing interesting compositions, geometric patterns, organic motifs and contexts, especially when they involve rhythms and harmonies among multiple elements
- Do not contrive designs, but do not forgo opportunities

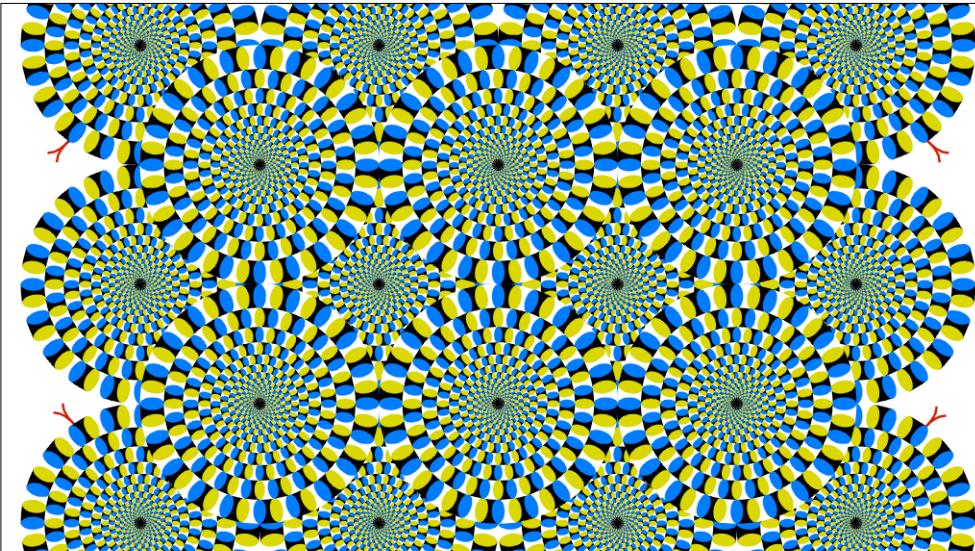
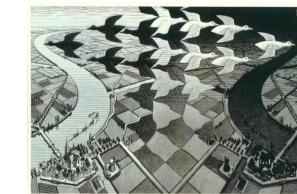
Figure-Ground Relationship

Elements are perceived as either figures (objects of focus) or ground (the rest of the perceptual field)

- ▶ A *Gestalt* principle asserting that humans divide stimuli into either figure elements or ground elements
- ▶ Can be demonstrated by pictures
- ▶ When figure and ground are clear, the figure receives more attention
- ▶ In unstable figure-ground relationships the interpretation of elements alternates between figure and ground



Unstable Figure-Ground Relationships



Reflections on Figure-Ground

- ▶ Cues determining which elements are perceived as figures or not
 - ▶ The figure has a definite shape, the ground is shapeless
 - ▶ The ground continues behind the figure
 - ▶ The figure seems closer with a clear location in space, the ground seems farther away with no clear location in space
 - ▶ Elements below a horizon line are more likely to be perceived as figures
 - ▶ Elements in the lower regions of a design are more likely to be perceived as figures
- ▶ Guidelines
 - ▶ Clearly differentiate between figure and ground in order to focus attention and minimize perceptual confusion
 - ▶ Ensure that designs have stable figure-ground relationships

Fitt's Law

The time required to move to a target is a function of the target size and distance to the target

- ▶ MT = movement time
- ▶ a = 0.23 seconds
- ▶ b = 0.166 seconds
- ▶ d = distance between pointing device and target
- ▶ s = size of target
- ▶ To hit a 1 inch icon 3 inches away => 0.7 seconds

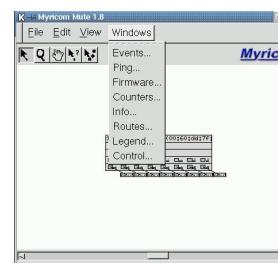
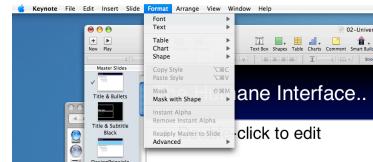
$$MT = a + b * \log^2\left(\frac{d}{s} + 1\right)$$

Detailing Fitt's Law

- ▶ In simple words: “the smaller and more distant a target, the longer it takes to come to a resting position over the target”
- ▶ “The faster the required movement and the smaller the target, the greater the error rate due to a speed-accuracy trade-off”
- ▶ Only applicable for rapid, pointing movements, not for writing or drawing
- ▶ Used to predict the efficiency of movements for assembly work
- ▶ A pointing movement consists of
 - ▶ one large quick “ballistic” movement toward a target
 - ▶ one fine-adjustment “homing” movement
 - ▶ one stop to “acquire” the target

The Humane Interface..

- ▶ Mac OS menus are easier to reach than those in Windows
- ▶ More information in “The Humane Interface” by Jef Raskin



Guidelines on Fitt's Law

- ▶ Make sure controls are near or large when rapid movements are required and accuracy is important
- ▶ Make controls more distant and smaller when they should not be frequently used or it's dangerous to use them
- ▶ Consider strategies to constrain movements to improve performance and reduce error (see “Constraint” design principle)

Five Hat Racks

There are 5 ways to organize information: category, time, location, alphabet, and continuum

- ▶ There are limits to the ways to organize information
- ▶ Organizing information is important as it is crucial for the way people actually think about the information
- ▶ **Alphabetical** examples are dictionaries and encyclopedias
 - ▶ Efficient when
 - ▶ information is referential
 - ▶ rapid non-linear access to specific items is required
 - ▶ no other organization strategy is appropriate

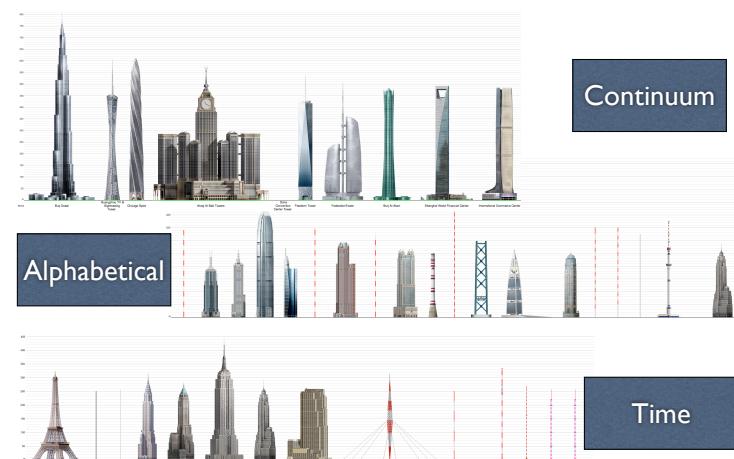
Time, Location

- ▶ **Time** refers to organization by chronological sequence such as TV guides, schedules, CVs
- ▶ Use time when presenting and comparing events over fixed durations, or when a time-based sequence is involved (e.g., a log-book)
- ▶ **Location** refers to organization by geographical or spatial reference, such as emergency exit maps or travel guides
- ▶ Use location when orientation and wayfinding are important or when information is meaningfully related to the geography of a place

Continuum, Category

- ▶ **Continuum** refers to organization by magnitude (lowest to highest, worst to best) such as rankings
- ▶ Use continuum when comparing things using a common measure
- ▶ **Category** refers to organization by similarity or relatedness such as a university course book or a web store
- ▶ Use category when clusters of similarity exist within the information, or when people naturally seek out information by category

Examples: Sky Scrapers (from <https://skyscraperpage.com/>)



Flexibility-Usability Tradeoff

As the flexibility of a system increases, its usability decreases

- ▶ “Jack of all trades, master of none”
- ▶ A common design mistake: designs should be as flexible as possible
- ▶ This makes them less usable!
- ▶ Flexibility has costs in terms of decreased efficiency, added complexity, increased time and money for development



Reflections on Flexibility-Usability Tradeoff

- ▶ PCs are universal tools, but difficult to use
- ▶ A Playstation concentrates on gaming!
- ▶ When an audience cannot clearly define its needs more flexible designs will be more successful
- ▶ The inverse is also true: when you know what you want, don't go for flexibility



Side-step into Software Engineering

- ▶ When designing a system don't go early for flexibility, but make the system do what it's supposed to do
- ▶ “Frameworks should only be created after three applications”
- ▶ In a waterfall model people try to anticipate everything, which is unrealistic
 - ▶ “build one to throw away”
- ▶ Agile development embraces change by always staying flexible but delivering constantly
- ▶ Requires mastery of a language and the tools

Forgiveness

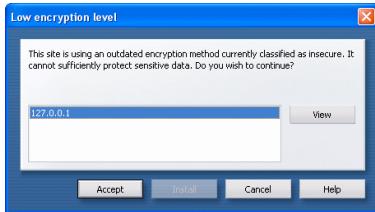
Designs should help people avoid errors and minimize the negative consequences of errors when they do occur

- ▶ “Errare humanum est”, get used to it
- ▶ Common strategies to incorporate forgiveness
 - ▶ *Good affordances*, physical characteristics of a design that influence its correct use
 - ▶ *Reversibility of actions*, such as an “undo” in a software
 - ▶ *Safety nets*, to minimize consequences, such as the pilot ejection seat
 - ▶ *Confirmation*, to verify the intent
 - ▶ *Warnings*, such as signs, prompts, alarms
 - ▶ *Help*, to assist basic operations and error recovery



Reflections on Forgiveness

- ▶ Create forgiving designs by using good affordances, reversibility of actions, and safety nets
- ▶ If not possible, include confirmations, warnings, and a good help system
- ▶ Be aware that the amount of help necessary to successfully interact with a design is inversely proportional to the quality of a design
 - ▶ If a lot of help is required..
 - ▶ ..the design is poor!



Form Follows Function

Beauty in design results from purity of function

- ▶ Origin of the concept: Carlo Lodoli (1690-1761)
- ▶ Two interpretations of this principle
 - ▶ A *description* of beauty: Beauty results from purity of function and the absence of ornamentation
 - ▶ A *prescription* for beauty: Aesthetic considerations in design should be secondary to functional considerations



Reflections on Form Follows Function

- ▶ Originated from the belief that form follows function in nature
- ▶ This is wrong, function follows form in nature, if at all
- ▶ There is no *intention* in evolution & nature (other than survival?)
- ▶ There's always a trade-off between form and function
 - ▶ Choose based on your goals..
 - ▶ Wanna make something functional? Do it, form will follow
 - ▶ Wanna make something beautiful? Do it, function will follow

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Homework



- ▶ Pharo!