24 Anthropomorphic and Geometric Aesthetics

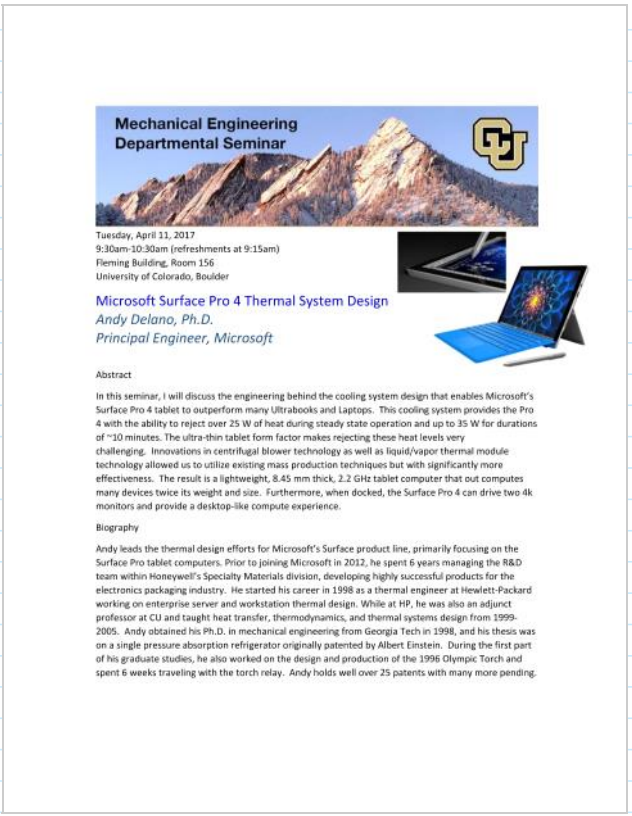
Wednesday, April 5, 2017

Today:

- Magic Factor of 7
- Sketching
- Anthropomorphic Effects
  - Uncanny Valley
  - Top down lighting bias
- Geometric Aesthetics (if there's time)
  - Symmetry
  - Area Alignment
  - Rule of Thirds
  - Fibonacci
  - Golden Ratio

Announcements

For blog this week, discuss your timeline for project completion. Do include a timeline graphic of some sort; Gantt chart or whatever.



Mechanical Engineering Departmental Seminar

Tuesday, April 11, 2017
9:30am-10:30am (refreshments at 9:15am)
Fleming Building, Room 156
University of Colorado, Boulder

Microsoft Surface Pro 4 Thermal System Design
Andy Delano, Ph.D.
Principal Engineer, Microsoft

Abstract

In this seminar, I will discuss the engineering behind the cooling system design that enables Microsoft's Surface Pro 4 tablet to outperform many Ultrabooks and Laptops. This cooling system provides the Pro 4 with the ability to reject over 25 W of heat during steady state operation and up to 35 W for durations of ~10 minutes. The ultra-thin tablet form factor makes rejecting these heat levels very challenging. Innovations in centrifugal blower technology as well as liquid/vapor thermal module technology allowed us to utilize existing mass production techniques but with significantly more effectiveness. The result is a lightweight, 8.45 mm thick, 2.2 GHz tablet computer that out computes many devices twice its weight and size. Furthermore, when docked, the Surface Pro 4 can drive two 4k monitors and provide a desktop-like compute experience.

Biography

Andy leads the thermal design efforts for Microsoft's Surface product line, primarily focusing on the Surface Pro tablet computers. Prior to joining Microsoft in 2012, he spent 6 years managing the R&D team within Honeywell's Specialty Materials division, developing highly successful products for the electronics packaging industry. He started his career in 1998 as a thermal engineer at Hewlett-Packard working on enterprise server and workstation thermal design. While at HP, he was also an adjunct professor at CU and taught heat transfer, thermodynamics, and thermal systems design from 1999-2005. Andy obtained his Ph.D. in mechanical engineering from Georgia Tech in 1998, and his thesis was on a single pressure absorption refrigerator originally patented by Albert Einstein. During the first part of his graduate studies, he also worked on the design and production of the 1996 Olympic Torch and spent 6 weeks traveling with the torch relay. Andy holds well over 25 patents with many more pending.

Magic Factor of 7

Here is some advice I got from Larry Talbot, my PhD advisor:

> "In research, tasks will take you 7 times longer than you think they should"

You may think that you are a reasonably good project planner, that things may take longer than you plan by a factor or 2 or 3, but a factor of 7? Really? Why?

Everyone acknowledges the difficulty of planning when there are many unknowns. Used in project planning, risk assessment and chemical analyses. You must consider

- **Known known**s: things we know we know. You can make reasonable estimates of time regarding these issues. For example, how long it will take to order a material you need, or carry out an assembly step you have done before.
- **Known unknowns**: things we know that we don't know. For example you may know that you will need to learn to use a 3D printer for your projects. 'How to use a 3D printer' is a known unknown. (By the way, plan to do your printing this week; they will be all booked up by next week)

- **Unknown unknown**s. Things you have no way to predict for. A family emergency. A catastrophic laser cutter failure that will take months to repair. A nationwide shortage and backorder of a widget you need. Your friend who was going to help you with 3D printing falls in love and has no more time for you, and there are no more workshops offered this semester.

  This is a type of epistemology. "Epistemology is the investigation of what distinguishes justified belief from opinion." https://www.google.com/search?q=epistemology&ie=utf-8&oe=utf-8
  There is a fourth category sometimes added: **unknown knowns,** things we deny knowing.

  "Unknown unknowns" was made famous in 2002 by Donald Rumsfield during the Iraqi War w.r.t WMDs, but has been used by NASA and others since the 1950's.
  https://en.wikipedia.org/wiki/There_are_known_knowns

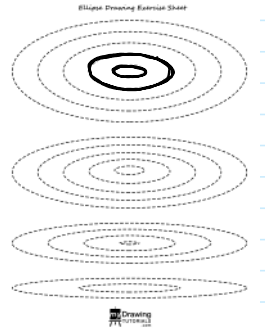
  For time management and planning, some use a time order-of-magnitude safety factor:
  if it should take 1 second, it will take 1 minute
  if it should take 1 minute, it will take 1 hour
  If it should take 1 hour, it will take 1 day
  and etc, for days, weeks, months, years.

  Factors of 60, 60, 24, 7, 30 etc. Perhaps excessive.

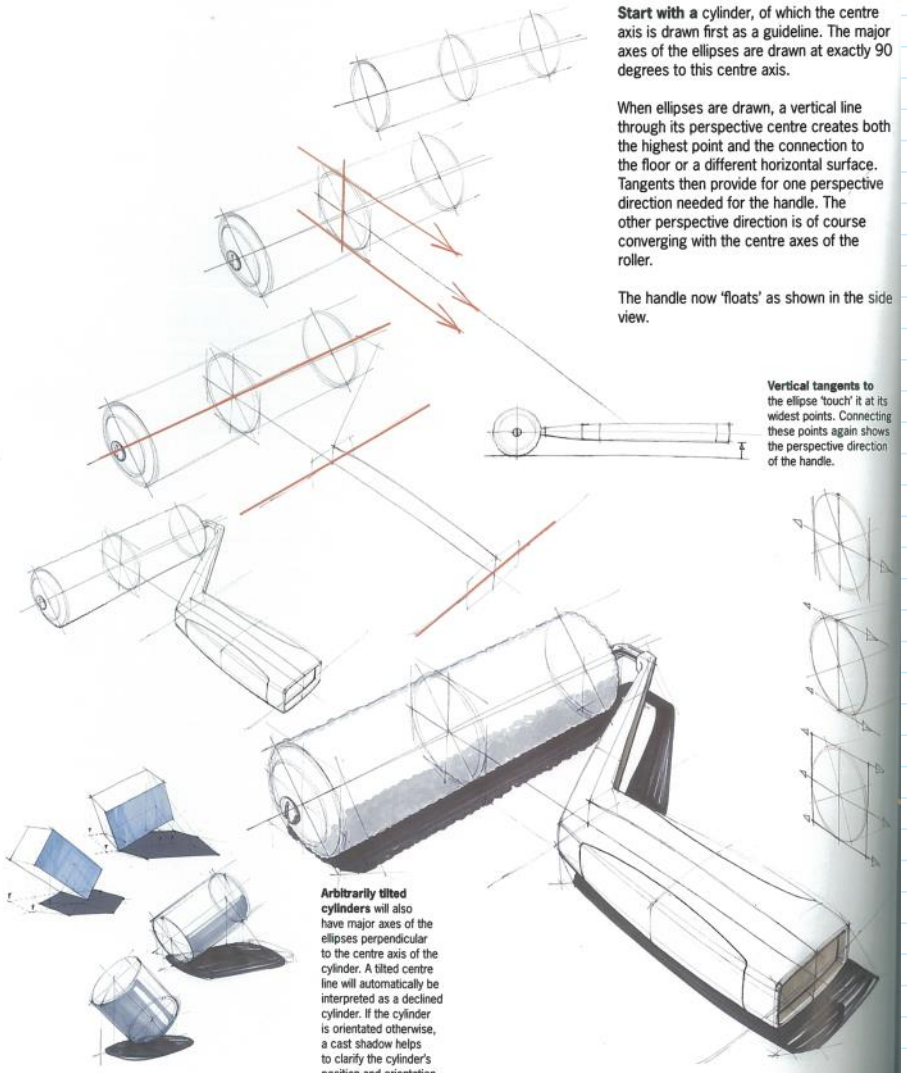
  This may work, but I have found the Magic Factor of 7 to be remarkably accurate for doing anything new, in research or design.

Sketching

Have you been practicing ellipses? Here is a link to a good practice template:
http://mydrawingtutorials.com/a-drawing-exercise-every-beginner-artists-should-do/



2.5 HORIZONTAL CYLINDERS



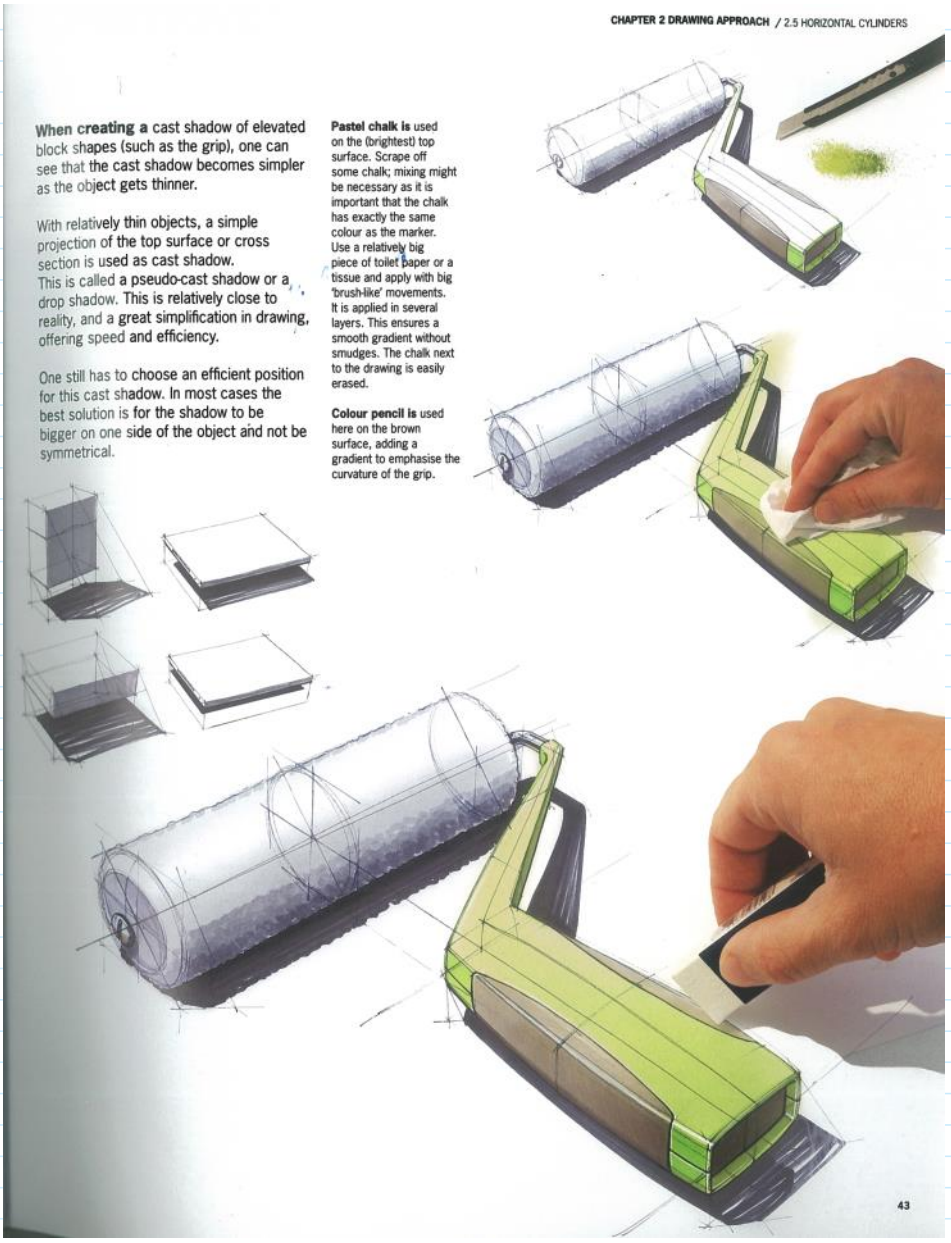
Start with a cylinder, of which the centre axis is drawn first as a guideline. The major axes of the ellipses are drawn at exactly 90 degrees to this centre axis.

When ellipses are drawn, a vertical line through its perspective centre creates both the highest point and the connection to the floor or a different horizontal surface. Tangents then provide for one perspective direction needed for the handle. The other perspective direction is of course converging with the centre axes of the roller.

The handle now 'floats' as shown in the side view.

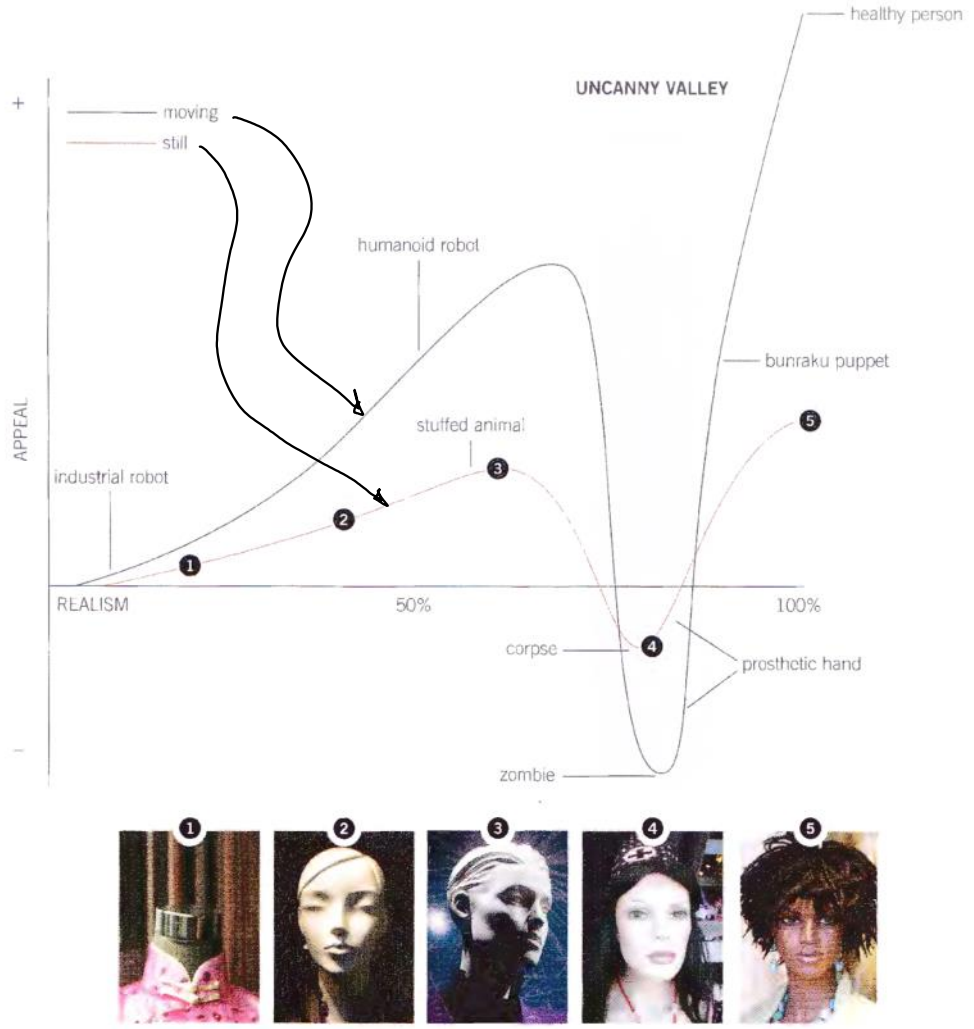
Vertical tangents to the ellipse 'touch' it at its widest points. Connecting these points again shows the perspective direction of the handle.

Arbitrarily tilted cylinders will also have major axes of the ellipses perpendicular to the centre axis of the cylinder. A tilted centre line will automatically be interpreted as a declined cylinder. If the cylinder is orientated otherwise, a cast shadow helps to clarify the cylinder's position and orientation.



Anthropomorphic Aesthetics

26 Anthropomorphic Form] last time
34 Baby-Face Bias (video)]
242 Uncanny Valley
240 Top-Down Lighting Bias (video)



Masahiro Mori's classic graph plots familiarity or appeal of an anthropomorphic form against its degree of realism. The uncanny valley resides to the right of the continuum, dipping sharply just before the likeness of a genuine healthy person. The mannequin images illustrate the benefits of abstraction and total realism in depicting human likenesses, as well as the perils of the uncanny valley.

Uncanny Valley

Anthropomorphic forms are appealing when they are dissimilar or identical to humans, but unappealing when they are very similar to humans.

Applies to other natural forms; flowers, plants etc.

Anthropomorphic forms are generally appealing to humans. However, when a form is very close but not identical to a healthy human—as with a mannequin or computer-generated renderings of people—the form tends to become distinctly unappealing. This sharp decline in appeal is called the "uncanny valley," a reference to the large valley or dip in the now classic graph presented by Masahiro Mori in 1970.[1] Though some have disputed the existence of the effect altogether, attributing any negative affective response to a simple lack of familiarity with artificial and rendered likenesses, more recent empirical research suggests the uncanny valley is a real phenomenon. The cause likely regards innate, subconscious mechanisms evolved for pathogen avoidance—that is, detecting and avoiding people who are sick or dead.[2]

Although a full understanding of the variables required to take an anthropomorphic likeness into the uncanny valley has not yet been realized, some conditions have been identified. The strength of the negative reaction seems to correspond to the fidelity of the likeness—a highly realistic likeness that is identifiable as artificial will evoke a stronger negative reaction than a less realistic likeness. Abnormally proportioned or positioned facial features, asymmetry of facial features, subtleties of eye movement, and unnatural skin complexions are all sufficient conditions to trigger uncanny valley effects.

Although the uncanny valley is generally observed by animators and roboticists, there are plenty of examples where the caveats of the principle are not abided. For example, director Robert Zemeckis decided to depict computer-generated characters with a high degree of realism for the movie *The Polar Express*. The resulting effect was both impressively realistic and eerie. The movie raised awareness of what is called "dead eye syndrome," where the lack of eye movements called *saccades* made the characters look zombielike, taking the Polar Express straight through the uncanny valley. Another example is found in retail contexts. There is a general perception among retailers that the effectiveness of mannequins is a function of their realism. However, barring a mannequin that is indistinguishable from a real person, the uncanny valley suggests that retailers would be better served by more abstract versus highly realistic mannequins.

Consider the uncanny valley when representing and animating anthropomorphic forms. Opt for more abstract versus realistic anthropomorphic forms to achieve maximum acceptance. Negative reaction is more sensitive to motion than appearance, so be particularly cognizant of jerky or unnatural movements when animating anthropomorphic bodies and faces.

See also Anthropomorphic Form, Threat Detection, and Top-Down Lighting Bias.

[1] The seminal work on the uncanny valley is "Bukimi No Tani [The Uncanny Valley]" by Masahiro Mori, *Energy*, 1970, vol. 7(4), p. 33–35.

[2] See, for example, "Too Real for Comfort? Uncanny Responses to Computer Generated Faces" by Karl MacDorman, Robert Green, Chin-Chang Hoa, et al., *Computers in Human Behavior*, May 2009, vol. 25(3), p. 695–710; and "The Uncanny Valley: Effect of Realism on the Impression of Artificial Human Faces" by Jun'ichiro Seyama and Ruth Nagayama, *Presence*, Aug. 2007, vol. 16(4), p. 337–351.

Strandbeest

https://en.wikipedia.org/wiki/Janssen's_linkage

Geometric Aesthetics

Classical Composition

Much comes from classical painting composition, dating far back. These rules are made to be broken.
https://en.wikipedia.org/wiki/Composition_%28visual_arts%29

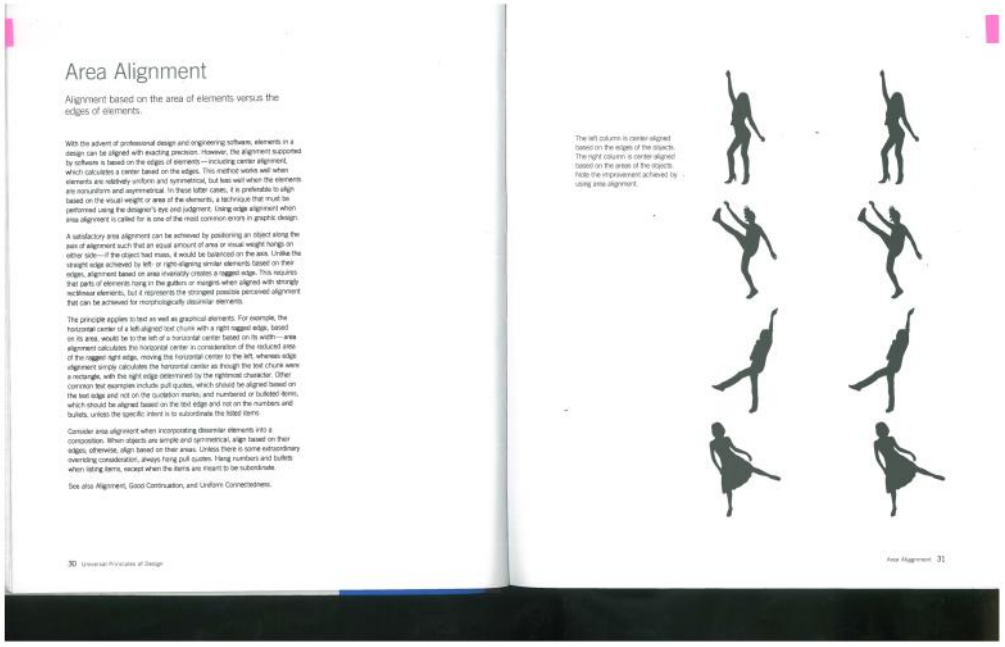
Contents [hide]

Leading the audience's attention;
what to touch first, what second?

Modern implementation in 2D graphic design, part of **Human-Computer Interface (HCI)** research
Ware, Colin. *Visual Thinking For Design*. Morgan Kaufmann, 2010. Whole pdf in our AesDes Zotero library
Table of contents: http://www.amazon.com/Visual-Thinking-Kaufmann-Interactive-Technologies/dp/0123708966#reader_0123708966

Universal Principles of Design topics

Good symmetry works. Asymmetry works. Broken symmetry is tricky.



Area Alignment

Alignment based on the area of elements versus the edges of elements.

With the advent of professional design and engineering software, elements in a design can be aligned with exacting precision. However, the alignment supported by software is based on the edges of elements — including center alignment, which calculates a center based on the edges. This method works well when elements are relatively uniform and symmetrical, but less well when the elements are nonuniform and asymmetrical. In these latter cases, it is preferable to align based on the visual weight or area of the elements, a technique that must be performed using the designer's eye and judgment. Using edge alignment when area alignment is called for is one of the most common errors in graphic design.

A satisfactory area alignment can be achieved by positioning an object along the axis of alignment such that an equal amount of area or visual weight hangs on either side—if the object had mass, it would be balanced on the axis. Unlike the straight edge achieved by left- or right-aligning similar elements based on their edges, alignment based on area invariably creates a ragged edge. This requires that parts of elements hang in the gutters or margins when aligned with strongly rectilinear elements, but it represents the strongest possible perceived alignment that can be achieved for morphologically dissimilar elements.

The principle applies to text as well as graphical elements. For example, the horizontal center of a left-aligned text chunk with a right ragged edge, based on its area, would be to the left of a horizontal center based on its width—area alignment calculates the horizontal center in consideration of the reduced area of the ragged right edge, moving the horizontal center to the left, whereas edge alignment simply calculates the horizontal center as though the text chunk were a rectangle, with the right edge determined by the rightmost character. Other common text examples include pull quotes, which should be aligned based on the text edge and not on the quotation marks, and numbered or bulleted items, which should be aligned based on the text edge and not on the numbers and bullets, unless the specific intent is to subordinate the listed items.

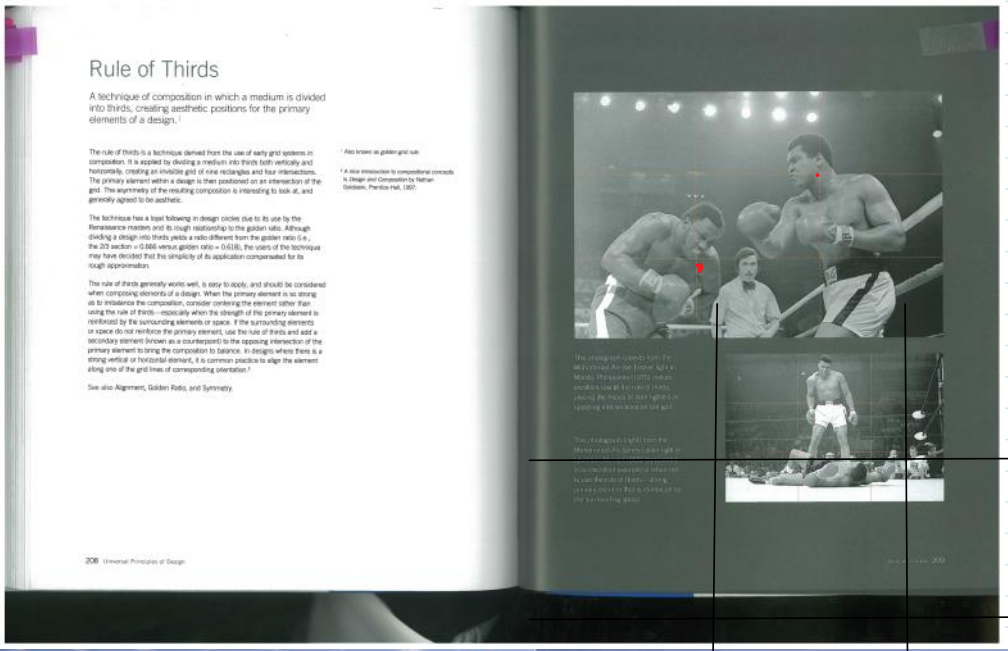
Consider area alignment when incorporating dissimilar elements into a composition. When objects are simple and symmetrical, align based on their edges, otherwise, align based on their areas. Unless there is some extraordinary overriding consideration, always hang pull quotes. Hang numbers and bullets when listing items, except when the items are meant to be subordinate.

See also Alignment, Good Continuation, and Uniform Connectedness.

The left column is center aligned based on the edges of the objects. The right column is center aligned based on the areas of the objects. Note the improvement achieved by using area alignment.

30 Universal Principles of Design

Area Alignment 31



Rule of Thirds

A technique of composition in which a medium is divided into thirds, creating aesthetic positions for the primary elements of a design.[1]

The rule of thirds is a technique derived from the use of early grid systems in composition. It is applied by dividing a medium into thirds both vertically and horizontally, creating an invisible grid of nine rectangles and four intersections. The primary element within a design is then positioned on an intersection of the grid. The asymmetry of the resulting composition is interesting to look at, and generally agreed to be aesthetic.

The technique has a loyal following in design circles due to its use by the Renaissance masters and its rough relationship to the golden ratio. Although dividing a design into thirds yields a ratio different from the golden ratio (i.e., the 2/3 section = 0.666 versus golden ratio = 0.618), the users of the technique may have decided that the simplicity of its application compensated for its rough approximation.

The rule of thirds generally works well, is easy to apply, and should be considered when composing elements of a design. When the primary element is so strong as to imbalance the composition, consider centering the element rather than using the rule of thirds—especially when the strength of this primary element is reinforced by the surrounding elements or space. If the surrounding elements or space do not reinforce the primary element, use the rule of thirds and add a secondary element (known as a counterpoint) to the opposing intersection of the primary element to bring the composition to balance. In designs where there is a strong vertical or horizontal element, it is common practice to align the element along one of the grid lines of corresponding orientation.[2]

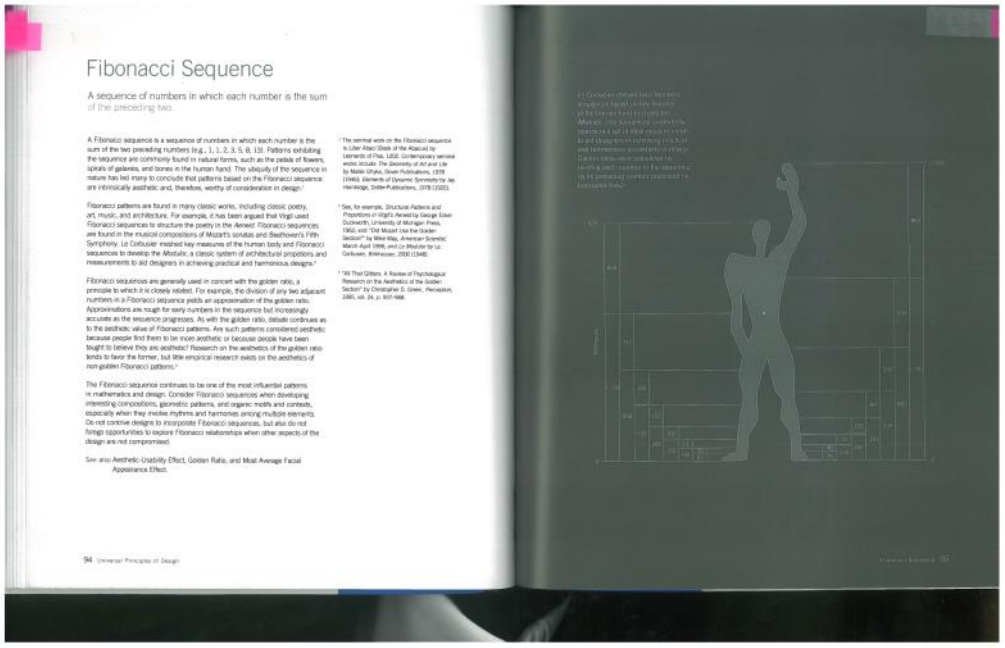
See also Alignment, Golden Ratio, and Symmetry.

[1] Also known as golden grid rule.

[2] A nice introduction to compositional concepts is *Design and Composition* by Nathan Goldstein, Prentice-Hall, 1987.

https://en.wikipedia.org/wiki/Rule_of_thirds#/media/File:RuleOfThirds-SideBySide.gif

The rule of thirds was first written down by John Thomas Smith in 1797.



Fibonacci Sequence

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

A Fibonacci sequence is a sequence of numbers in which each number is the sum of the two preceding numbers (e.g., 1, 1, 2, 3, 5, 8, 13). Patterns exhibiting the sequence are commonly found in natural forms, such as the petals of flowers, spirals of galaxies, and bones in the human hand. The ubiquity of the sequence in nature has led many to conclude that patterns based on the Fibonacci sequence are intrinsically aesthetic and, therefore, worthy of consideration in design.[1]

Fibonacci patterns are found in many classic works, including classic poetry, art, music, and architecture. For example, it has been argued that Virgil used Fibonacci sequences to structure the poetry in the *Aeneid*. Fibonacci sequences are found in the musical compositions of Mozart's sonatas and Beethoven's Fifth Symphony. Le Corbusier meshed key measures of the human body and Fibonacci sequences to develop the *Modulor*, a classic system of architectural proportions and measurements to aid designers in achieving practical and harmonious designs.[2]

Fibonacci sequences are generally used in concert with the golden ratio, a principle to which it is closely related. For example, the division of any two adjacent numbers in a Fibonacci sequence yields an approximation of the golden ratio. Approximations are rough for early numbers in the sequence but increasingly accurate as the sequence progresses. As with the golden ratio, debate continues as to the aesthetic value of Fibonacci patterns. Are such patterns considered aesthetic because people find them to be more aesthetic or because people have been taught to believe they are aesthetic? Research on the aesthetics of the golden ratio tends to favor the former, but little empirical research exists on the aesthetics of non-golden Fibonacci patterns.[3]

The Fibonacci sequence continues to be one of the most influential patterns in mathematics and design. Consider Fibonacci sequences when developing interesting compositions, geometric patterns, and organic motifs and contours, especially when they involve rhythms and harmonies among multiple elements. Do not contrive designs to incorporate Fibonacci sequences, but also do not forego opportunities to explore Fibonacci relationships when other aspects of the design are not compromised.

See also Aesthetic-Usability Effect, Golden Ratio, and Most-Average Facial Appearance Effect.

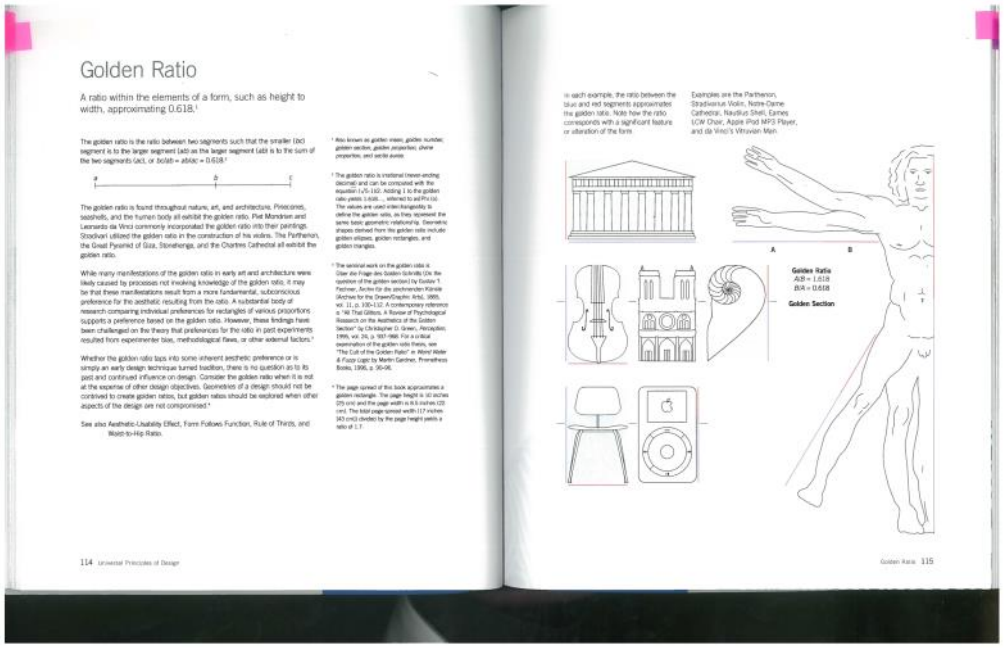
[1] The seminal work on the Fibonacci sequence is *Liber Abaci* (Book of the Abacus) by Leonardo of Pisa, 1202. Contemporary seminal works include *The Geometry of Art and Life* by Matila Ghyka, Dover Publications, 1978 (1946); *Elements of Dynamic Symmetry* by Jay Hambidge, Dover Publications, 1978 (1920).

[2] See, for example, *Structure Patterns and Proportions in Virgil's Aeneid* by George Edwin Duckworth, University of Michigan Press, 1962; and "Did Mozart Use the Golden Section?" by Mike May, *American Scientist* March–April 1996; and *Le Modulor* by Le Corbusier, Birkhauser, 2000 (1948).

[3] "All That Glitters: A Review of Psychological Research on the Aesthetics of the Golden Section" by Christopher D. Green, *Perception*, 1995, vol. 24, p. 937–968.

https://soundcloud.com/robertinventor/fibonacci-rhythm-no-bar
https://www.facebook.com/david.canright.1/videos/vb.1534748873/10205137603829769/?type=2&theater Music with both pitches and rhythm determined by Fibonacci series

https://www.youtube.com/watch?v=RjM8AaNSjhA&index=1&list=PLC1VCzU4q6ohKrlZAscdjylx-gjmPuI2x How to draw a Fibonacci spiral



Golden Ratio

A ratio within the elements of a form, such as height to width, approximating 0.618.[1]

The golden ratio is the ratio between two segments such that the smaller (bc) segment is to the larger segment (ab) as the larger segment (ab) is to the sum of the two segments (ac), or $b/a = a/c = 0.618$.[2]

The golden ratio is found throughout nature, art, and architecture. Pinecones, seashells, and the human body all exhibit the golden ratio. Piet Mondrian and Leonardo da Vinci commonly incorporated the golden ratio into their paintings. Stradivari utilized the golden ratio in the construction of his violins. The Parthenon, the Great Pyramid of Giza, Stonehenge, and the Chartres Cathedral all exhibit the golden ratio.

While many manifestations of the golden ratio in early art and architecture were likely caused by processes not involving knowledge of the golden ratio, it may be that these manifestations result from a more fundamental, subconscious preference for the aesthetic resulting from the ratio. A substantial body of research comparing individual preferences for rectangles of various proportions supports a preference based on the golden ratio. However, these findings have been challenged on the theory that preferences for the ratio in past experiments resulted from experimenter bias, methodological flaws, or other external factors.[3]

Whether the golden ratio taps into some inherent aesthetic preference or is simply an early design technique turned tradition, there is no question as to its past and continued influence on design. Consider the golden ratio when it is not at the expense of other design objectives. Geometries of a design should not be contrived to create golden ratios, but golden ratios should be explored when other aspects of the design are not compromised.[4]

See also Aesthetic-Usability Effect, Form Follows Function, Rule of Thirds, and Waist-to-Hip Ratio.

[1] Also known as golden mean, golden number, golden section, golden proportion, phi proportion, and sectio aurea.

[2] The golden ratio is irrational (never-ending decimal) and can be computed with the equation $1.\sqrt{5}/2$. Adding 1 to the golden ratio yields 1.618..., referred to as Phi (φ). The values are used interchangeably to define the golden ratio, as they represent the same basic geometric relationship. Geometric shapes derived from the golden ratio include golden ellipses, golden rectangles, and golden triangles.

[3] The seminal work on the golden ratio is *Über die Frage des Goldenen Schnitts* (On the question of the golden section) by Gustav T. Fechner, *Archiv für die zeichnenden Künste* (Archives for the Drawn/Graphic Arts), 1865, vol. 11, p. 100–132. A contemporary reference is "All That Glitters: A Review of Psychological Research on the Aesthetics of the Golden Section" by Christopher D. Green, *Perception*, 1995, vol. 24, p. 937–968. For a critical examination of the golden ratio theory, see "The Cult of the Golden Rules" in *Weird Water & Fossil Logic* by Martin Gardner, Promethius Books, 1996, p. 95–96.

[4] The page spread of this book approximates a golden rectangle. The page height is 10 inches (25 cm) and the page width is 6.5 inches (16 cm). The total page spread width (17 inches [43 cm]) divided by the page height yields a ratio of 1.7.