Beautiful Science
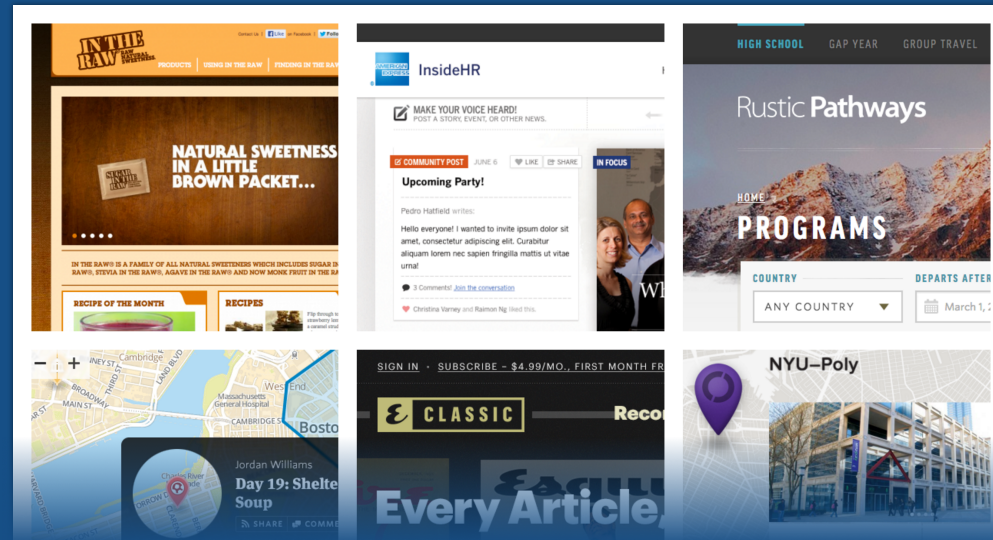
The Role of Aesthetics in Good Engineering

A Very Brief Intro

- What I do for a living – design and code websites.
- Grew up in an environment where the humanities and the sciences were blended. I never felt like I had to pick.
- Started college as a comp sci major but got frustrated. Moved to math. Eventually found design and got hooked.
- Needed a site; built it myself, got hooked on coding.
- Continued to grow in both areas. Started to discover "sixth sense" for organization and code structure. Allowed me to develop complex things with less code and fewer bugs than what I was seeing from other developers.
- I wasn't as good at certain things, but I was very good at this corner of engineering.
- My theory is that training and encouraging your sense of beauty can make you a better engineer. You can find solutions faster.
- And the good news is that everyone has a sense of beauty, it's in our genes.
- I want to discuss an example of this – called a "pub sub" architecture.

Directional Architecture vs. Pub-Sub
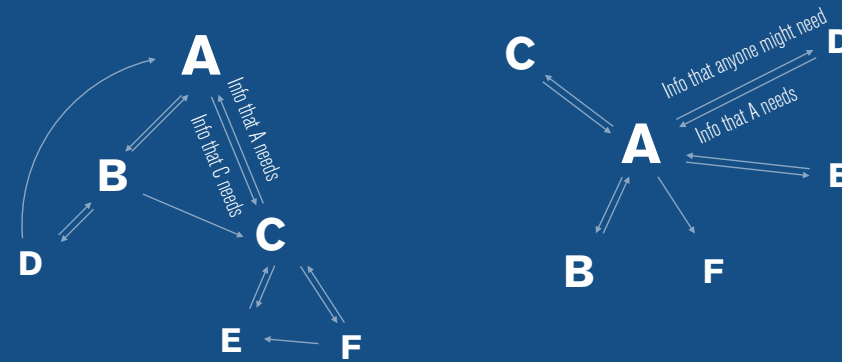
- So the tree on the left illustrates a typical application design paradigm. Each node (function) accepts and distributes data to others
- You have a major component A which calls some sub-components.
- The pub-sub model on the right (publisher-subscriber) means that the major component is in direct communication
- Each part has all information, but only needs to act on what is relevant to it
- Counterintuitive, but extremely powerful
- Elegant, minimizing the number of total connections.
- So this starts to get at what I mean by a beautiful engineering solution. But let's look at that word some more.

- Everything on the screen represents something we might call beautiful, from art to sports to nature.
- Not to mention beautiful smells, music, the sounds of nature
- What do they share?
- One Idea – Darwinian Theory of Beauty developed by Dennis Dutton: Beauty is an evolved sense that draws us toward things that are good for us.
- He cites studies showing a universal preference for a particular kind of landscape
- We find trees that fork closer to the ground to be more beautiful
- Some of our ancestors were drawn towards certain patterns, others repulsed by them. The ones drawn to the good things did better.
- My theory: Aesthetic judgment is a proxy for functional judgment.
- What's beautiful is what works…

- Look no further than nature
- Natural forms and patterns represent time-tested optimum solutions to complex problems.
- It's no surprise then that we find tremendous beauty in biological forms. They work really well, and their beauty is a signal!
- Returning to pub-sub, related to DNA
- Natural forms and patterns "feel right". When we think something "feels good", it could be our ancient brains telling us that it matches a solution observed millennia ago.
- So going back to design. What visual designers do is beauty to solve visual problems.
- Designers have a few heuristics to help in this process…
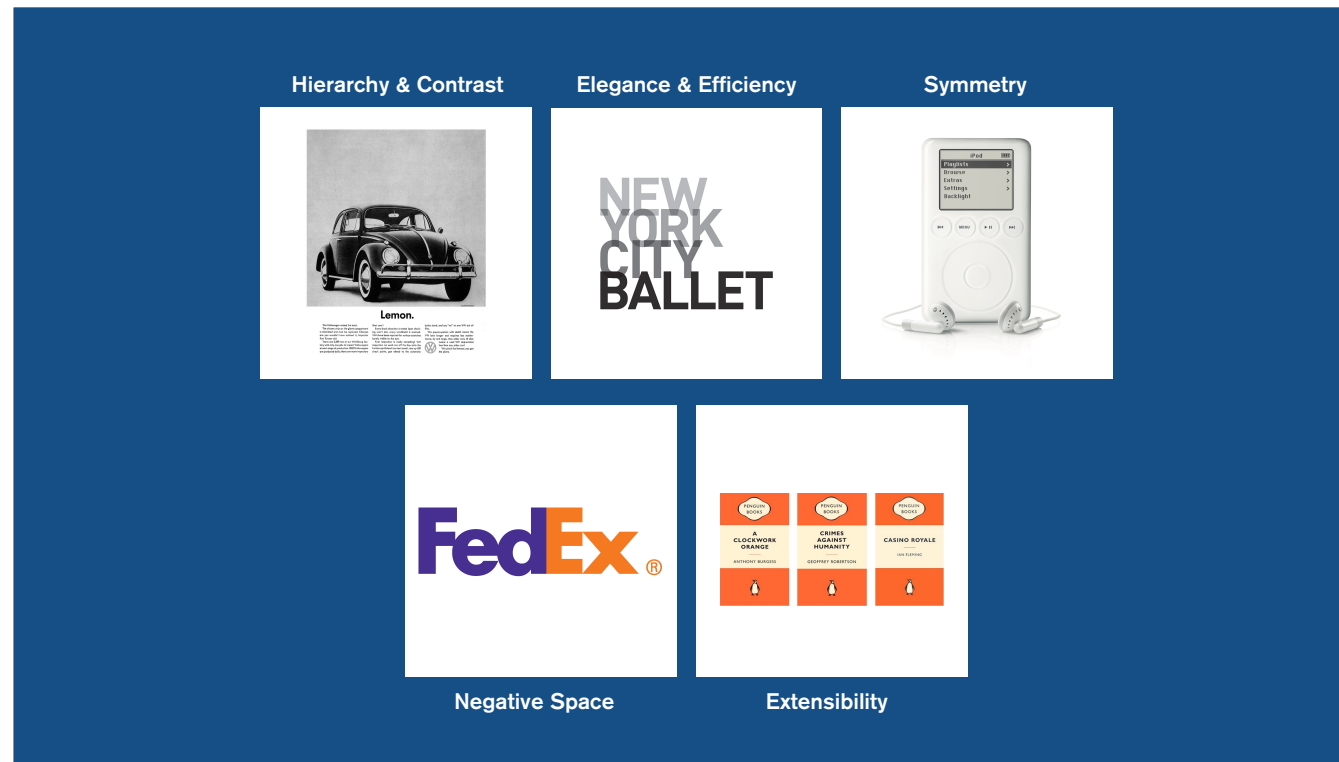
- Visual designers use a few key rules of thumb to guide their problem-solving.
- Elegance and efficiency: Using as few parts as possible to get the job done
- Hierarchy and contrast: Parts should have distinct jobs. If two parts do similar jobs, combine them
- Negative space: The area created around a shape is its own area. Draw one shape, you're actually drawing two. This creates "free" value which you can use to aid your solution.
- Symmetry: Indicates harmony between parts of the system
- Extensibility: Means the system can grow without strain
- This is a template for how we can use beauty in a technical context too.
- I want to look at some examples…
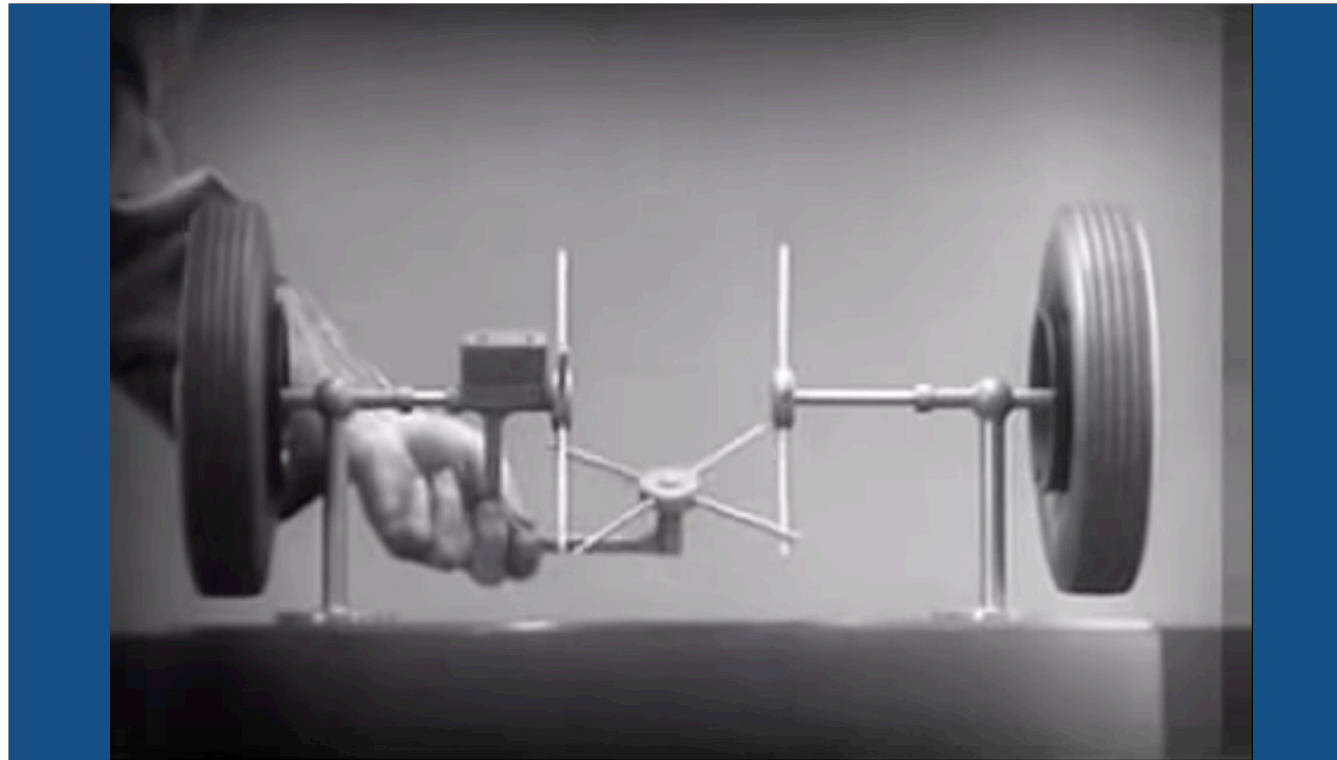
- This is a differential gear
- Problem: Driven axle in a car was connected to both wheels, led to breakages
- Exhibits elegance, symmetry, hierarchy. Nothing can be subtracted. Everything does a distinct job.
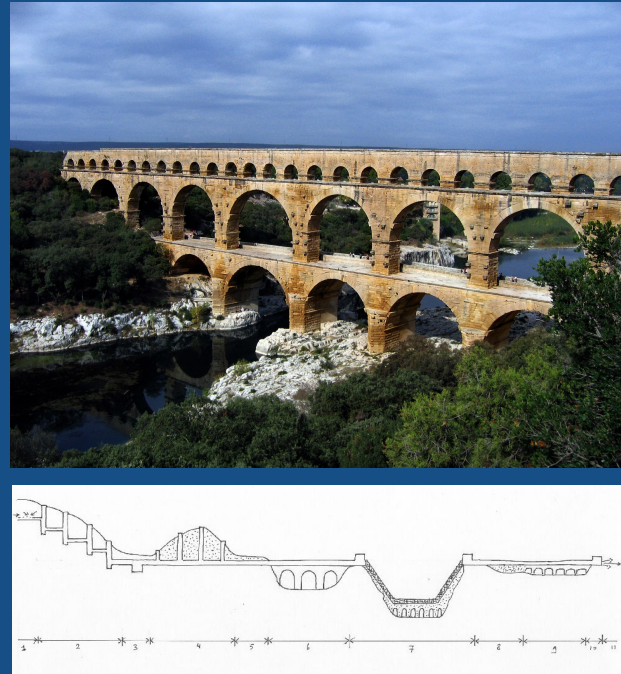
- The aqueduct system developed by the ancient romans is a marvelous civil engineering accomplishment
- Problem: Getting water from the closest source is nearly impossible.
- Solution: Let gravity do the work.
- Problem: Getting water across a large gap
- Solution: Let gravity do the work again – use a siphon
- Powerful use of negative space. Identified existing free energy source instead of using man power
- Extremely extensible system – establish core patterns, make as many as you need
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- Finally, want to talk about morse code.
- Problem: Existing solutions display transmitted letter on screen, but required 5 wires and could only transmit twenty letters. Unreliable – hard to scale. Impossible to do more languages.
- Solution: Instead of providing clean output, invent an easy-to-learn alphabet so you can transmit messages over only one wire.
- Exploits negative space of human knowledge, that people can learn to translate the output really easily.
- Very elegant and efficient.
- Superbly extensible – enabled communication in any language
- Most of us have heard of Morse code, but what's less known is that he was a painter before he was an inventor!

- No doubt his sense of light and shadow, symmetry and contrast helped his pursuit of beauty in engineering.
- I believe that all human beings have an ingrained urge to seek beauty. If we can harness that urge in technical problem solving, we can find better and faster solutions.
- Thank you!

Further Reading

- Dennis Dutton: *The Art Instinct*
- Dutton TED talk: *A Darwinian Theory of Beauty*
- Charles C. Adams: *Technological Allusivity: Appreciating and Teaching the Role of Aesthetics in Engineering Design*
- John Maeda: *The Elements of Simplicity*
- Don Norman: *The Design of Everyday Things*
- Fujimura: *Silence and Beauty*

- Thank you!