

Design

The importance of
design in creating
quality products &
services

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Introduction



- Design leads to quality
- Innovative design isn't new

Design leads to Quality

Design is central to quality. Within manufacturing, roughly 70% of the cost of a product can be derived from design decisions; including material selection and manufacturing processing decisions. The remaining 30% of the costs make up production decisions like process planning and tool selection. However, more importantly, a good design ensures products are fit for purpose and customer requirements are met, creating a product of high quality, a product that people are proud of owning.

Design changes become increasingly expensive as you progress in the manufacturing cycle and the same can be seen with many processes. If you were designing a piece of software for example, the further away from the design stage, the more costly things become to change. This is because the committed costs increase and the effort to amend previous decisions grows exponentially. It is often well worth dedicating more resource in the design process, providing huge savings later down the line and potentially making all the difference between the success and failure of a product.



“ Within manufacturing, roughly 70% of the cost of a product can be derived from design decisions ”

The paperclip may not be the most exciting of objects, it is however a masterpiece in design. A paper clip has a near perfect design for its function. It is nothing more than 3 turns of a single wire, yet it effortlessly provides its function in a simplistic and satisfying way. From holding bank statements together, to providing the finishing touch to a painstakingly arduous university dissertation, the paper clip is something that we all take for granted. Over 12 Billion of them are sold each year in the US alone.

Unlike most everyday objects; keys, books or mobile phones, the paperclip hasn't evolved for a very long time. If you were to step foot into an office in 1895 having arrived by horse drawn bus, you would find a perfectly recognisable, silver paper clip being used to organise paperwork. The design has not changed and is unlikely to change anytime soon, it simply is too good a design. It holds lots of papers securely while being thin (not to bulk out files), uses a single, cheap and easily sourced material, can be easily inserted, is lightweight (requiring little extra postage), is very tough and reusable due to its material memory that automatically returns to its resting form.

This article will not delve any deeper into the specifics, but just appreciate how good a design the paperclip is, when prior to its invention, the only other way of holding paper together was with an iron pin that cut peoples fingers, left rusty stains and permanent holes in documentation.

Design leads to Quality

Innovative design isn't new

The importance placed of good design is not something new. Thousands of years ago, design was equally as important to quality as it is now, nothing has changed;

Design = Quality

Over 400 years ago, the North Atlantic island of Bermuda was facing a deficit of drinking water, with no freshwater springs, rivers or lakes. As a solution to solve this problem they looked to design. The design of their houses. Although they didn't have large reserves of water, they did experience high levels of rain fall. How would they go about collecting this rainfall? Design a low-cost roof that would help collect rain water, keep occupants dry, withstand extreme winds and hurricanes and also cool them from the roaring sun.

By addressing every requirement, a simple yet highly effective design solution was created:

Low Cost – made from limestone - readily available from local sources

Collect Rain Water – The design of a stepped roof - slowed down the flow of rainwater, allowing gutters to easily collect water to be stored in a tank under the house where temperatures were cooler.

Hurricane resistant – The high density of limestone compared to wood or other roofs meant it could withstand high wind speeds.

Cooling from sun - Using a white pigment to coat the limestone mortar, the light was reflected back into the sky and not into the building (reducing the temperature of the roof by up to 30 degrees Celsius on a sunny day and significantly reducing the temperature within the house).

This simple design demonstrates the strong power of designing things directly for their function.

Some of the techniques utilised here have become increasingly popular in modern times. In New York City over 10 Million sq ft of rooftops have been coated white. A cool roof can save air conditioning costs by as much as 40% as well as "offsetting 24 gigatons of carbon dioxide - the equivalent of taking 300 million cars off the road for 20 years, if utilised worldwide" – *The Berkeley Lab*



“Design is not just what it looks like and feels like. Design is how it works.” Steve Jobs

Design Simplicity



- Simplicity in design is of paramount importance
- Optimise products as a system, not as individual parts
- Poor design

Simplicity in design is of paramount importance

Keep things simple & focus on the end user

Engineering principles such as the Boothroyd method outline how the design of products should not only meet all customer requirements to their fullest extent but also, simultaneously be easy to manufacture and assemble (at a reduced cost). The principle outlines how the number of parts should be reduced as much as possible, the assembly time per part should also be reduced and a feedback loop to the manufacturing method will provide insight as to design changes. The exact same principle applies to project management. The end customer needs to never be dogma; however, the internal resource requirements also need to be addressed.

“We design it, you manufacture it”



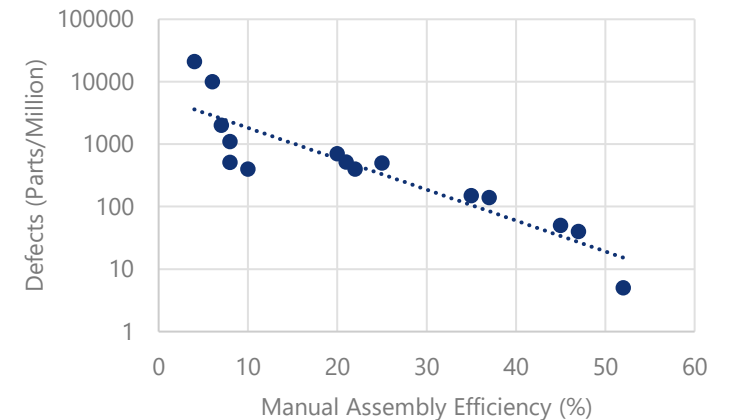
“We work together to produce the optimum solution for the customer and manufacturer.”

Designing products with manufacture and assembly considerations is not only beneficial to the producer, it is beneficial to the customer. Firstly and most importantly because it reduces the total cost of the product, which can then be passed on to the customer. But secondly because the simpler products are to manufacture, the more reliable and higher quality they are.

If you think back to the first motorcars. They were produced by craftsmen on a one-by-one, bespoke basis. This gave the huge benefit of customisation to the customer to which some extent is even better than what we have today. The problem with craftsmanship is that it is very time consuming and time equals money. The lead time for a car would be in the months or even years as the builder had to painstakingly source, reshape and assemble the different materials. The additional problem was the lack of consistency and therefore reliability. Cars would have to be tuned and amended on a frequent basis and repairs would be extremely costly and time consuming.

Nowadays, each operator's job role within an automotive plant is highly standardised and repeatable; leading to a consistently assembled car with much greater reliability.

Quality vs efficiency correlation



Simplicity is the grand aspiration for design.

“Everything should be made as simple as possible but not simpler”
Albert Einstein

“The ability to simplify means to eliminate the unnecessary so that the necessary may speak” Hanss Hoffman (artist)

Optimise products as a system, not as individual parts

Good design is sometimes missed or misunderstood by customers. For example, products use purposely cheap materials for certain parts to act as the point of failure and ultimately save customers expensive repairs. Let me explain this with an example.

A lawnmower is a complex machine, containing an engine, bearings, gears, blades, a throttle etc. When dismantling a lawnmower, it would be easy to inspect the gears and think the manufacturer had skimmed on material selection. The gears are often made of plastic and appear to be much lower quality when compared to the rest of the product.

The reason they are made of cheaper, low quality plastic is so that if the system comes under excessive stress, the gears are the first thing to break, thus preventing the more expensive, complex parts like the engine to fail. The designers could have easily used high strength steel gears but instead wanted to protect the system as a whole by making the point of failure cheap and easy to repair/replace.

This smart design would go missed by most consumers and from a business standpoint, you could say that they would be more profitable if they prioritised the expensive repairs. They have however, put the customer first and in the long run will reap the rewards.



In contrast to this, many modern cars have excessively complex and costly parts that can easily break. The average cost to replace a wingmirror in 1970 was £60 (equivalent modern value) compared to £310 in 2020. So why has the price of such a risk-prone part increased 5 fold? The answer is complexity. Wingmirrors now include motors to move in and out, heating elements to defrost and demist the mirror, indicator LED lights & even blind spot detection lights. In my opinion the old-fashioned, simple solution that consisted of just a mirror made much more economic sense. Even more crazy examples of this can be seen on high-end luxury cars, where skirts and trims (the areas that often get chipped & scratched) are made of carbon fibre, a material that was developed due to its high strength property; something that are not utilised at all by being used as aesthetic trims. The cost to replace a chipped carbon fibre trim on a McLaren for example can cost in excess of £10,000.

Poor design

To design is to **plan** the creation of a new product or service to **solve** a specific problem with a focus on maximising customer value and experience. The design provides the guidelines, parameters and processes for both physical products but also experiences, services and customer journeys.

For mechanical engineers, it is well cited that design is of paramount importance to the performance and success of a product, through manufacture, assembly and for the customer. The primary reason for this is that changes to design become increasingly costly as the lifecycle progresses. There are many other reasons; design is the largest contributor to quality.

Good design often goes virtually un-noticed because it provides no problems/barriers for the user, instead it is intuitive and easy to use. Bad design on the other hand, is identified very easily, if you have ever complained about a product, not known how to use it or mis-used it then that is a prime example of poor design. Wherever possible, utilise peoples' familiar gestures & ergonomic movements within product design. For example; in order to unlock an iphone, you swipe it like you would with a latch and you hear a sound that signifies it is open.



The above example perfectly demonstrates the need to differentiate between products.



The choice of this carpet design for a staircase was clearly overlooked, I have a strong suspicion a few people will be falling down these.

Error Proofing



- What is biomimicry?
- The immune system
- Lotus leaves
- Velcro

Latent Human Error & Poka-Yoke

Products & processes should be designed to not only be intuitive and easy to use, they should also be fool-proof & inherently safe wherever possible.

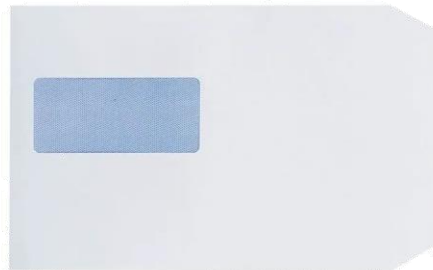
A latent human error is a poor design that leaves itself open for human error. An example could be a car that allows children in the backseat to open the rear doors as the car travels at full speed. Another example could be a car that keeps the doors locked upon power failure, leaving the passengers locked inside the vehicle.

It is impossible to remove all latent human error, you cannot make a knife that is able to effectively cut through meat but cannot cut your finger. Error/fool proofing principles should however be utilised wherever possible. Poka-yoke is a Japanese word that describes mistake proofing measures. Evolving from the original work bakayoke which literally meant 'foolproofing', Poka-Yoke was used as a more polite and positive word. The use of the word was popularised by Shigeo Shingo in the 1960s.

Examples of Poke-yokes can be seen in the following:



Lawnmower – Deadman switch. Cannot start the engine and have blades rotating without your hand on the controls.



Envelope with clear plastic window. The mistake of sending a letter to the wrong person/address can be eliminated by using an envelope with a clear plastic window. As you can see through to the letter, it is not possible to write the wrong address onto the envelope.

Circuit breakers provide a very simple example of poke yoke parts of the system. Within a buildings electrical system, electrical overloads can result in fires. Instead of allowing the electrical devices to overload, circuit breakers error proof the circuit by breaking when the load becomes too great.



Sinks have an overflow hole placed just below the height of the tap, these act in a very similar way to circuit breakers. Instead of allowing the sink to overflow and cause a flood, water is diverted down the drain when the level reaches its maximum desired level.

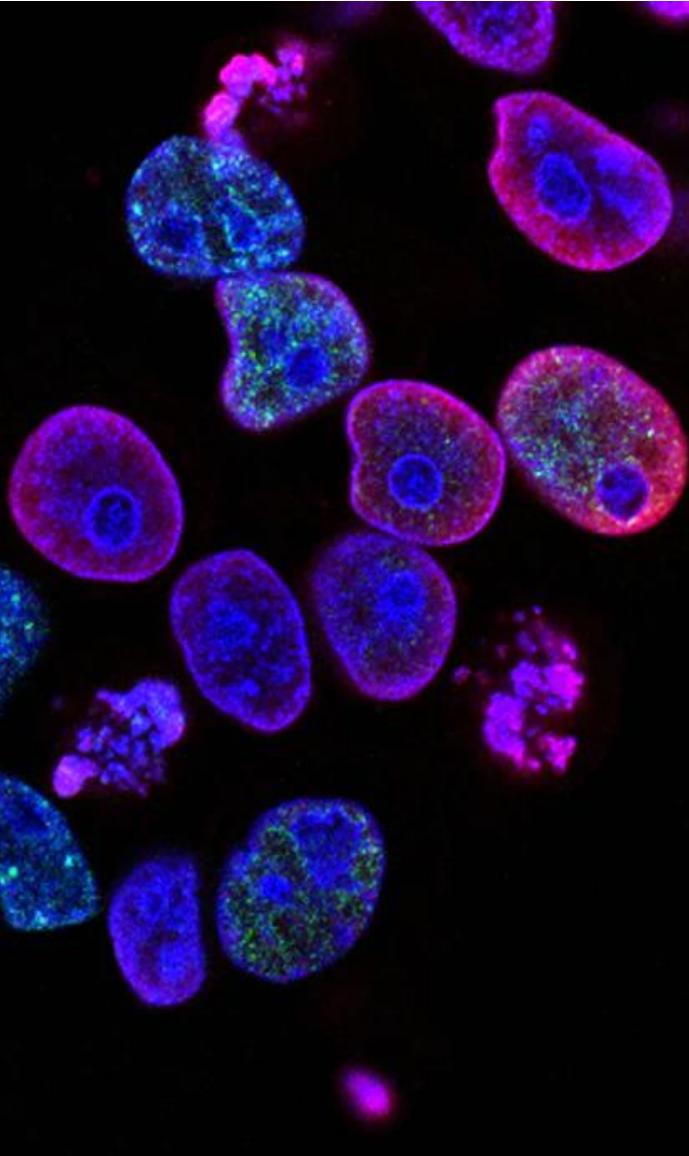
Biomimicry



- What is biomimicry?
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Biomimicry Examples

Immune System & Anti-Virus IT Software

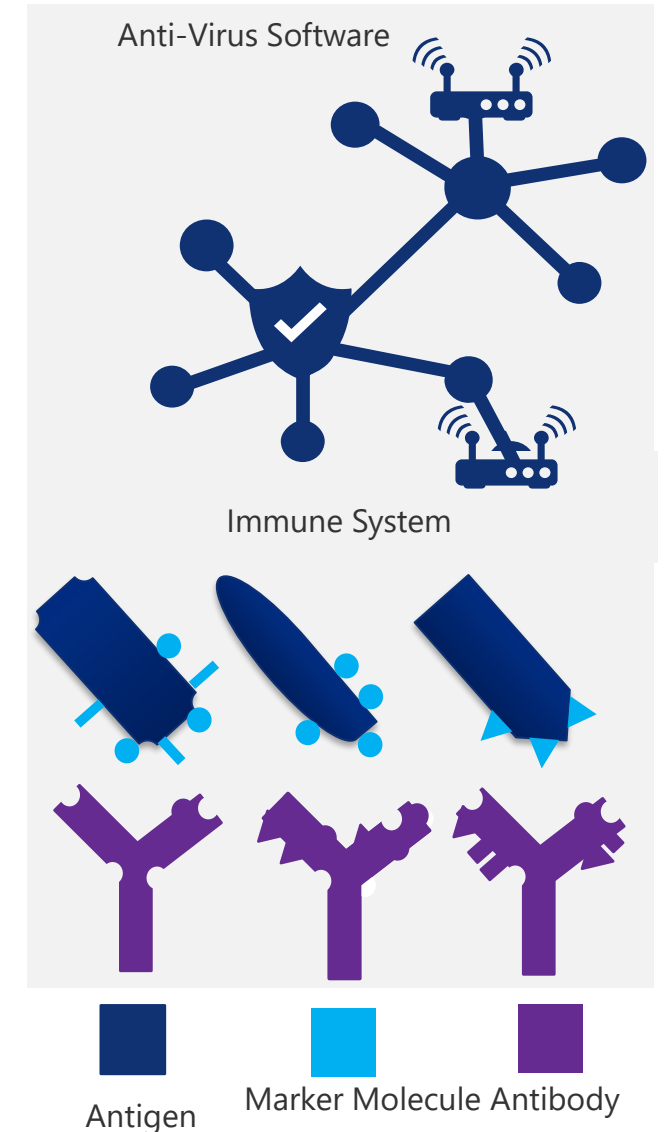


Over the past 3.8 billion years, the design of nature has evolved. Making miniscule changes in form, shape, properties and processes. Nature has been conducting its own research and development to find what works best.

Traditionally, engineers would rely on previous successful product designs as a foundation for improvement. By instead looking at nature for inspiration, brand new designs can be created, utilising the natural R&D that nature has been conducting.

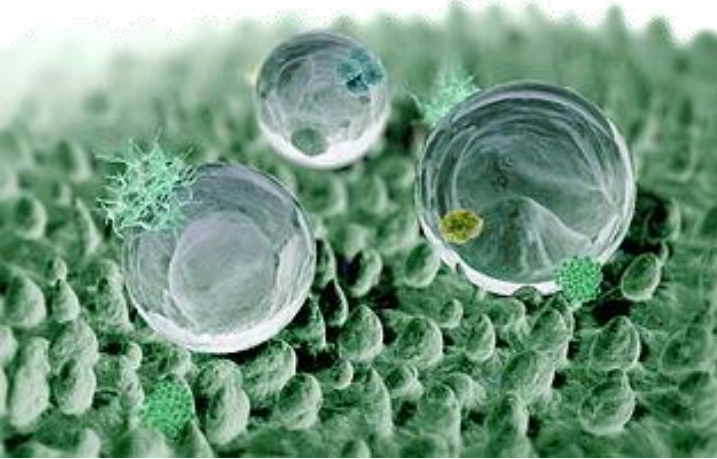
The immune system

The key to a healthy immune system is its remarkable ability to distinguish between the body's own cells—self—and foreign cells—nonself. The body's immune defenses normally coexist peacefully with cells that carry distinctive "self" marker molecules. When immune defenders encounter cells or organisms carrying markers that are identified as "foreign," they quickly launch an attack. Anything that can trigger this immune response is called an antigen. An antigen can be a microbe such as a virus, or even a part of a microbe. The unique ability to detect threats, abnormal conditions and attacks makes the immune system extremely effectively at protecting human life. Although every person's body operates in unique conditions with differing blood types, nutrient intake, activity level etc, the immune system 'learns' to detect abnormalities specific to each individual. This extremely powerful natural behavior has traits that are highly desirable as a product. Replicated into an anti-virus/malware software, this natural process can be utilized to ensure IT systems can detect abnormalities, prevent phishing attacks, viruses or even unique threats that are unknown. By using nature as inspiration, enhanced customer value can be created that greatly outperforms traditional algorithms or virus detection software.



Biomimicry Examples

Lotus leaves and self cleaning roof-tiles

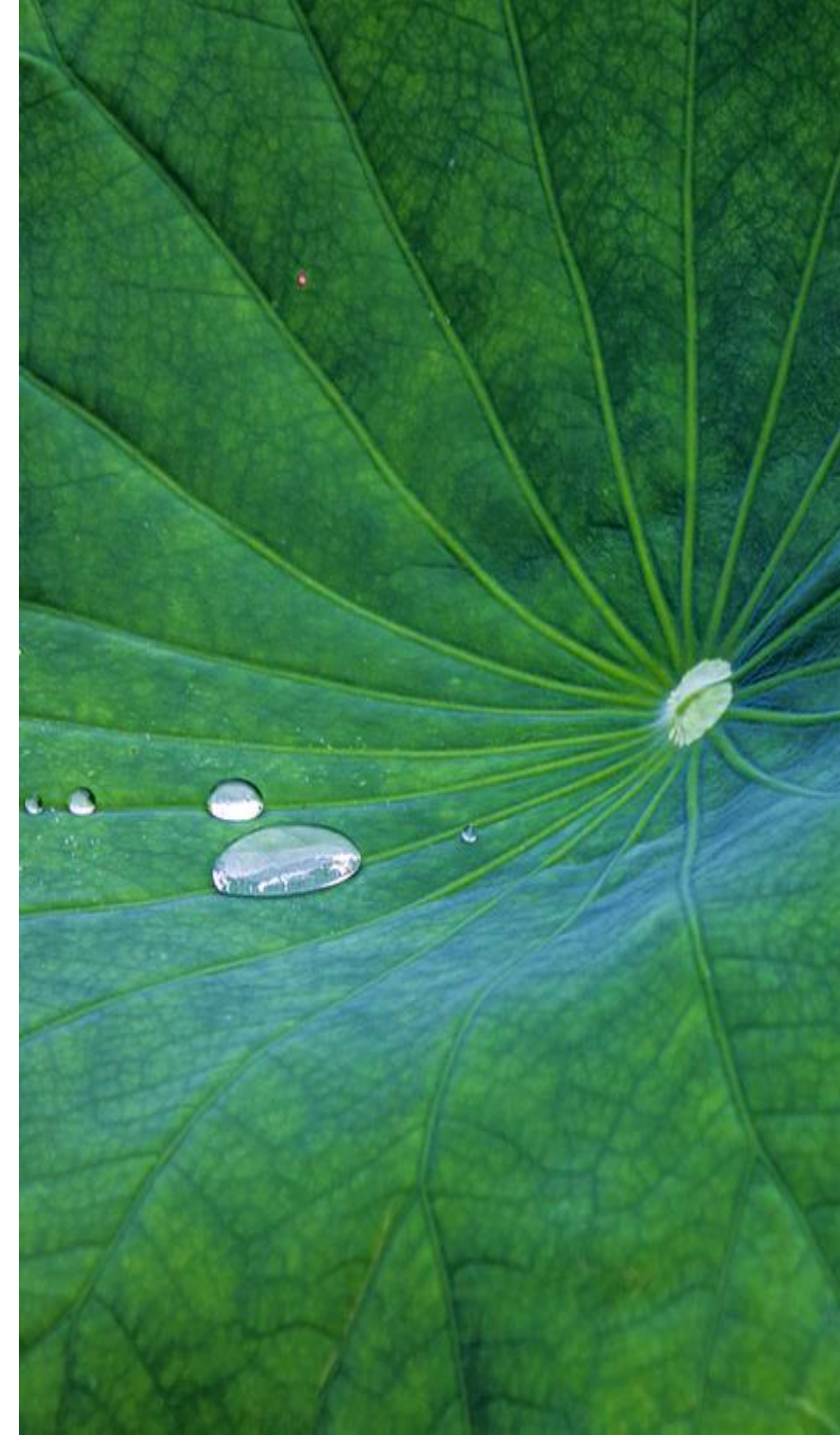


Just like how humans want things to remain clean, nature desires the same. As humans, we want things to remain free from dirt because we know products degrade faster when dirty, look less attractive and often perform worse.

For plants, keeping leaves clean is extremely important. The dirtier the leaves are, the less light can be transformed into energy through photosynthesis. Staying clean is a matter of life or death.

When examined, lotus leaves use no chemicals or complex processes, instead, the physical design of the surface keeps itself clean. The name to this phenomena is called the lotus effect. Dirt particles are picked up by water droplets due to the micro and nanoscopic architecture on the leaves surface, which minimises the droplet's adhesion to that surface. This self-cleaning surface design provides huge customer value when used to eliminate our need to regularly clean things. Examples include self cleaning roofing tiles that could last 5x longer than normal ones. Self cleaning cars where the rain cleans the car for you. By spending the time/resource to research design and strive for 'right first time' design, the need for sub-processes becomes eliminated and customer value is enhanced. As stated before; design is the main contributor to quality.

Invented in 1969, Gore-Tex™ can repel liquid water while allowing water vapor to pass through. Through extensive research and development, Goretex have embedded the waterproof properties into the product itself by selecting the optimal density of weave. Unlike other waterproof materials that have hydrophobic coatings, Goretex has the design inbuilt into the product much like the lotus effect.

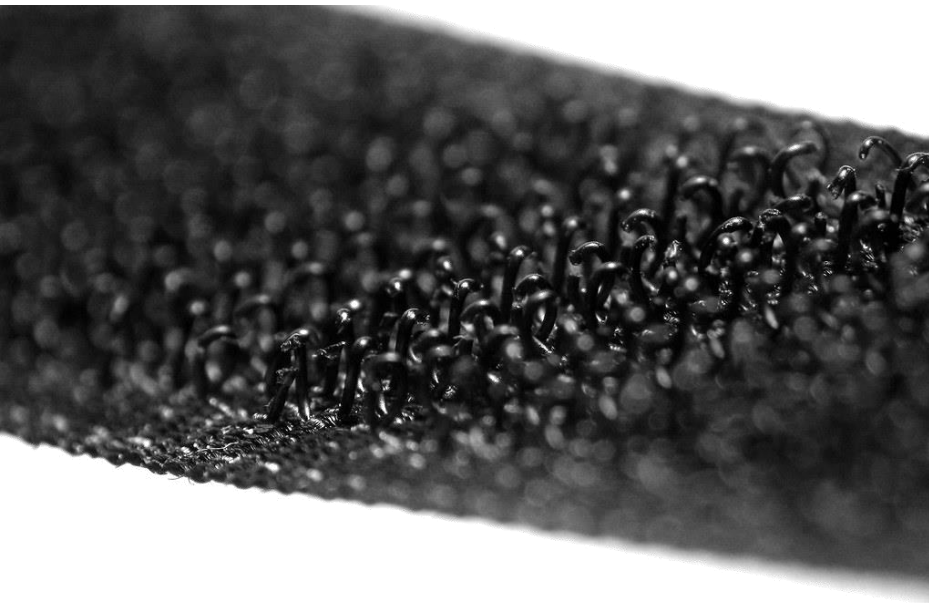


Biomimicry Examples

The burdock plant & Velcro

While hiking with his dog, a Swiss man called George de Mestral found that his dog became covered in burs from the burdock plant. These burrs appeared to stick to the dogs fur. Upon inspection under a microscope, he discovered it was covered in tiny hooks which caught onto clothes and fur.

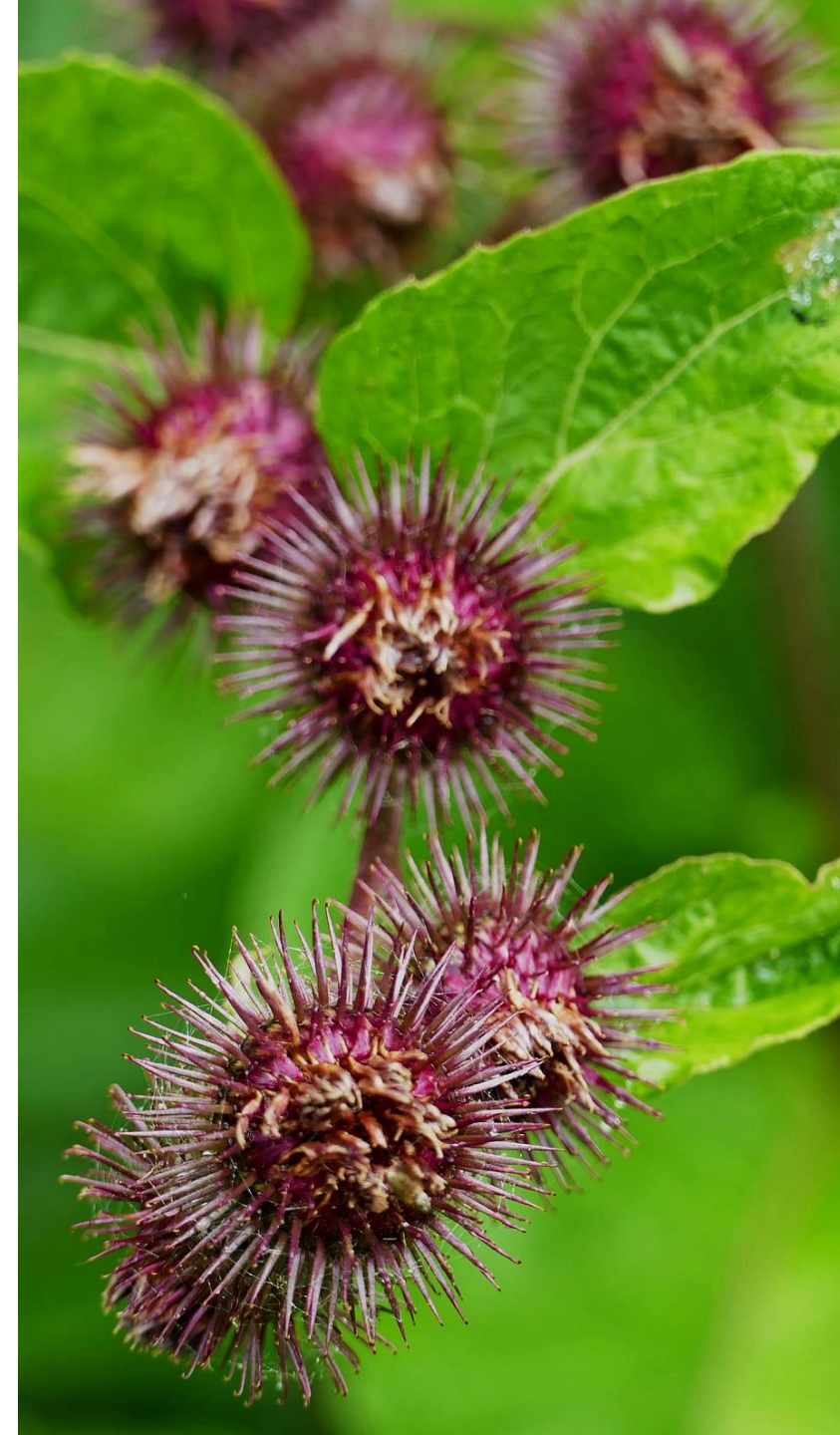
After years of refinement, he developed two materials that could replicate this phenomena, using hooks and loops to achieve a strong and consistent fastening mechanism.



Velvet Crochet

The name Velcro came from the combination of the words; velvet & crochet.

The use of Velcro's amazing product was popularised largely due to the use by NASA in spacesuits. The design of Velcro provided a structural fastener that was light weight, simple to use and easy to sew onto clothing. NASA even put it onto the base of astronauts shoes to allow them to have better adhesion to the floor as well as attaching them into their hammocks to sleep.



Biomimicry Examples

The bullet train & the kingfisher

The Shinkansen, known by many as the bullet train, was first built in 1989 to connect distant Japanese regions with Tokyo, the capital, to aid economic growth and development. Upon its first journeys, a problem was identified. As the train entered tunnels at high speeds, a sound wave was formed, squeezing the air and propagating down the tunnel, resulting in 2 issues; Firstly it slowed down the speed of the train due to its air resistance, secondly it caused a very loud bang as it exited the tunnel – resulting in nearby windows being shattered when in densely populated areas.



Luckily the general manager of the technical developments department was a birdwatcher. Having watched a kingfisher break the surface of water with little splash, he based his design drawings on the design of the birds' beak. The years of evolution that had enabled the kingfisher to catch fish with precision had answered the engineering design problem they faced.

In the end his design resulted in 30% less air resistance than before.

Scientists at the University of Cambridge have recently mimicked the vivid colours seen on a butterfly's wings. Unlike traditional pigmentation, butterflies get their colour when light bounces off tiny nanostructures on their bodies. Researchers believe this breakthrough may eventually lead to butterfly-encrypted currency designed to thwart counterfeiters.



Summary



- Design leads to quality
- Simplicity is key
- Use poka-yoke devices where possible
- Learn from nature

Summary

The collection of ideas, examples and stories in this article have hopefully provided some ground rules as well as inspiration for good design.

Design is quality

Well thought out, functional design always triumphs in the end, as good design creates quality products & services. Think of the revolving door. A door that is always open yet always closed, a door that allows people to enter and leave at the same time yet blocks the natural elements outside. The most impressive design aspect of the revolving door goes unnoticed by many. It was created out of necessity for skyscrapers; due to the large pressure difference between the air conditioned inside and hot outside, a conventional door would be impossible to open from one side and if kept open would cause the cold air to flood out.

The ability to simplify means to eliminate the unnecessary so that the necessary may speak

If you can eliminate a part, a manufacturing step or a feature and still achieve the same result, do it. Every product requires manufacture, the easier and cheaper it is to do so, the cheaper it can be sold and the more desirable it will be.

Nature provides inspiration for design

Whether you are designing the nose cone of a high speed train, a fastening mechanism to be used by NASA or an advanced antivirus software, nature provides a lot of the answers.

The biomimicry institute provides lots of interesting case studies, information and developments into how we can use nature to make the world a better place. Whether that be learning from dolphins on how they send signals underwater or learning from mosquitoes to create a painless needle, look to nature for inspiration.



FlowPlus™



- What we can do
- Where we can help

FlowPlus

What is **FlowPlus™** and what do we do?

About Us

With headquarters in London, FlowPlus™ is a specialist in operational improvement, with a fundamental principal that by making processes flow we can create vast improvements in productivity & cost reduction. We help you work smarter by creating solutions that eliminate non-value added activities, enhance quality, reduce costs, improved delivery, transform culture & enable growth.

Our approach is deliberately different. We believe sustaining results is the true test. That's why we follow a 3-step process; Assessment, Implementation and Sustainability.

We work hand in hand with our clients, delivering at the place where value is added. Together, we crack some of the largest and most complex challenges in the public and private sectors, by pinpointing and implementing the changes that have the greatest impact.

Our promise is simple: we'll leave your Organisation better equipped to solve future challenges without us. We believe we have done a good job when we are no longer required.



FlowPlus

The 3 Services We Provide

FlowPlus™ Assessment

“Recognising the problem is more important than finding a solution, because the exact description of the problem leads almost automatically to the correct solution.” *Albert Einstein*

For that reason we believe that it is critically important to get things right first time and ensure we are solving the most impactful problems, with the biggest potential.

The creation of your company DNA profile allows us to use various benchmarking methodologies to conduct a ‘gap to potential analysis’, identifying your improvement potential using an audit of over 30 criteria. A roadmap and action plan is then created to bridge the gap and ensure long term, sustained improvements in growth, quality, cost & delivery are achieved.

FlowPlus™ Implementation

Our Industry experts utilise our selection of bespoke tools to work directly with you. We believe that if you don’t change, then you can’t improve, and change needs to take place where you work. For that reason we don’t produce reports from behind a computer, we roll up our sleeves and solve the problems as close to the source as possible.

Consulting is what we do. We identify the problems that are most significant, and work with the teams to create permanent solutions.

We are so confident in our expertise & methodology that we only charge on the results we deliver. It eliminates any risk to our clients and shapes our organisation to evolve & continuously improve the tools and ways in which we work.

FlowPlus™ Sustainability

In order to sustain improvements, we strive to develop the skills internally so you can solve problems on your own. We do this partially through training but also through the introduction of an improvement framework/routine to ensure a continuous improvement habit is maintained.

The combination of both a routine, and the ability to overcome firefighting by solving problems at the root is the magic formula.

