The Integration and Advantages of Technology with Biomimicry with the Assistance of a new Engineering Design Process

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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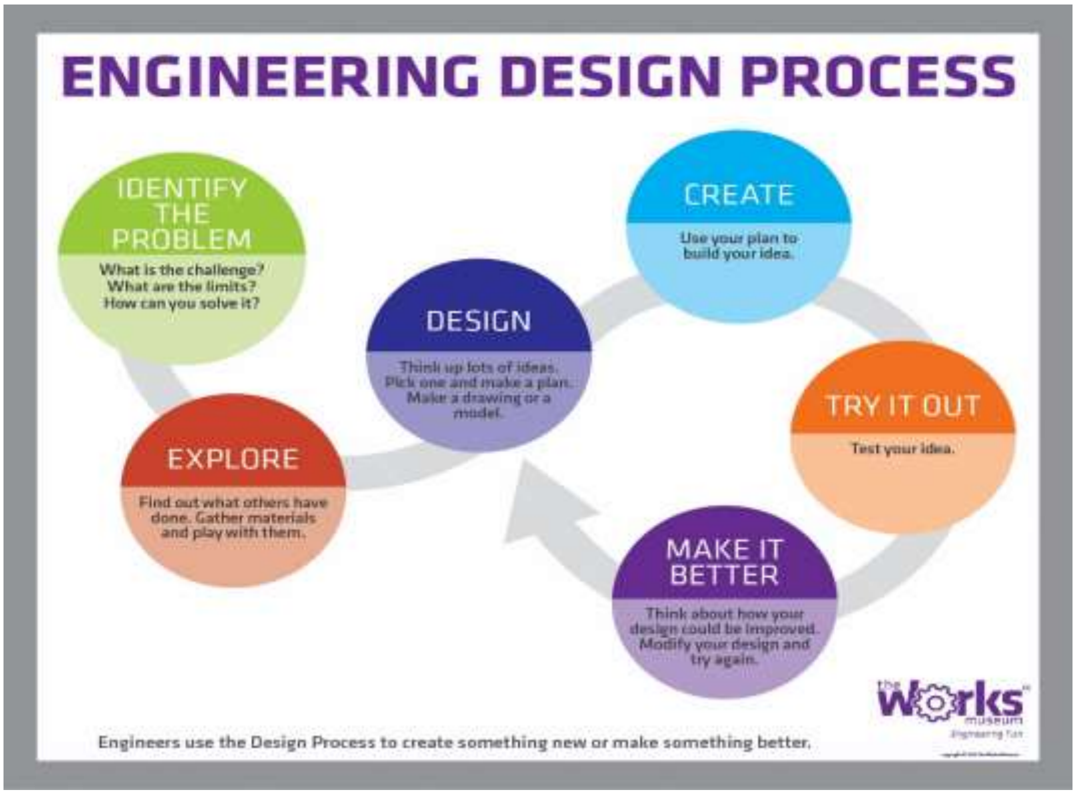
Introduction

Have you ever given thought as to the origins of particular technologies, instruments, or tools you see or utilize daily? Whether it is sitting at home or running errands, we move through life with the intention of engineering design, but often without fail to recognizing the ways that human design is informed by nature. Simple objects such as tape, Velcro, LED light bulbs, and suction cups were all inspired by nature: Tape, gecko; Velcro, burdock burrs; LED light bulbs, the firefly; suction cups, the octopus. Other inspirations like apartment buildings, shinkansen trains, and sonar technology are more prominent examples where we studied the natural world around us to develop technical artifacts. Being inspired by nature has more significance than most think. Studies show that not only can we learn from other species to improve efficiency in infrastructure and machines, but we can also advance our current technology even on the microscopic scale (Vanderbilt, 2012). In recent decades, engineers have created designs that lack creativity due to the mainstream teachings of engineering. Creativity, being the stepping stone of innovation, is lacking many aspects of engineering design. The introduction of creativity in engineering design can be accomplished by adopting the “free-form thinking” skill set that architecture use when creating their pieces. The free form method of thinking is most efficient when it’s mixed into the engineering design process. (Zong, Li, N., Lu 2017). The engineering design process prohibits free-form thinking because we are taught to approach problems tactically without considering other options like using nature as means of inspiration.

This paper analyzes cases in which engineers and scientists have imitated nature in creative designs of artifacts. The study of bio-inspired mechanics and biomimicry is relatively new compared to most fields, and its potential contributions to engineering design have not yet been realized. By creating a connection between nature and technology, we will be left with a systematic process that will allow others to gain insight and perspective to conduct a new form of applied science.

Deconstructing the Engineering Design Process

To arrive at the goal of obtaining an advanced version of the engineering design process, we must first deconstruct it from the beginning. Following the figure below, the first step is “Identifying the Problem”. This step engages the engineer or designer to have a general



Engineering Design Process (The Works, 2008)

knowledge of the issue at hand. Having a certain goal in mind, the thinker must lay out or brainstorm what issue lies ahead, like physical limitations. The second step is the “Exploration stage”. Even though one may have a good base knowledge of the problem, this is not enough. Extensive research is needed in order to understand the system truly. Collecting knowledge of the system requires extensive research on all areas that are physical and theoretical. Some may gain knowledge through example. It is possible that a person can learn via instructions, thus giving him/her experience in mastering material manipulation. Theoretical research refers to the study of its physical and biological function. Now that an understanding of the problem at hand is completed, the next step of “Design” can commence. This is the step where using the collected knowledge can draft a blueprint or map out a visual representation of the system.

The blueprint can consist of a range of inscriptions, from a list of materials and its dimensions to basic instructions with diagrams. Doing so aids other engineers on what one is thinking. Not only is this a crucial step for an engineer, but this also becomes an opportunity for creativity to take its first form. The designing phase gives visual aid to the engineer. With the understanding of a particular element from nature that is to be implemented, the engineer can render the system to cater to a new creation. This is where bio-inspired mechanics/ biomimicry is embedded in modern mechanics.

Many inventions, like Velcro, were inspired by nature (Tan, 2016). Velcro, which has been around since the ’50s, was created when the Swiss electrical engineer, George De Mestral, was hiking and wondered why burdock seeds would stick to fabrics. The functions of the small thin arms that extrude from the center of the plant pod that reaches out in all directions to grab onto animals passing by to pollinate/relocate were introduced in the engineering process's design phase. The act of taking and replicating a function and developing a new form of technology has not only been done by many but also yields performance improvement. Many institutes and companies have adapted their thinking in experimenting with new products.

Another example where engineers have creatively adapted nature into design is a company like Boston Dynamics. BD created a four-legged nibble robot that is equipped with a sensor that is able to map environments, avoid obstacles, climb stairs, and open doors. One may think that this creation is, while impressive, not that practical. Adam Ballard, BP's facilities technology manager, stated, "There are thousands of pounds of pressurized combustible material out there. High-pressure oil and gas can create risks for people working in close proximity. If we could have a robot with the proper sensors out there, we'd much rather do that." (Ballard, 2013) proves its practicalities. One function that can be observed is its movement. Spot being the robot's name is articulated enough to mimic a four-legged animal. The ability to move in all directions and climb up straits makes for a better method in creating a robot if its goal was to manage pressurized combustible material and high-pressure oil and gasses.

Without biomimicry's implementation, robots that are capable of doing the same job wouldn't necessarily have arms or legs but instead have wheels that hinder the robot's ability to maneuver over different surfaces, including stairs. Other than facilities being managed, Spot has also been integrated into NASA's mission. With their ability to walk over rugged terrain, rovers with traditional wheels are soon to be phased out of commission. In the years to come, the practice of creating technology inspired by nature will instill a dramatic change perspective that brings creativity.

The following few steps in the engineering design process "Create," "Testing," and "Making it better" are all equally important steps compared to the rest though the main focus lies on the steps mentioned earlier, for they are the backbone of inspiration and biomimicry in its essence. In general, the method of mimicking a particular function and manipulating it to foster nature's attributes can be used toward a pre-existing technology to enhance its efficiency.

Taking a Lead from Architecture

Taking a close look at architects and their work, we notice a trend that much of their creativity stems from symbolism and how a building, sculpture, or art piece influences the view.

Many aspects of lighting, texture, and environment can change a viewer's emotions or thought and fuel creativity. That same skill needs to be introduced into engineering practice. The free-form thinking is a characteristic of design that is not bounded by the rules of physics. It allows people to ignore the ordinary habits of design (Gore ,2016, p 39). When engineers are told to design a bridge, this school of free-form thinking forces those who would instead start by drawing a straight line from one end of the road to another and then add structural beams for support to start by looking to nature for inspiration. Because straight lines and other engineering rules do not bound nature's design, it will seem foreign but rather liberating. According to Massimo Majowiecki "Freedom of expressiveness now creates "architectural objects" featuring a shape that, in most cases, has nothing to do with structural principles" (Majowiecki, 2006). Majowiecki coins free-form design as FFA, free form architecture. Through his analysis, Majowiecki states that architectural structures such as leaning and twisting buildings, sculptured bridges, free-form enclosures, and the like are created through free-form expressiveness, the shape of which often has no correlation with structural concepts. Would really help to have an illustration or two here. The unconstrained movement of the engineer's pencil or mouse when building a structure with a goal in mind will leave him/her with a slight sense of uncertainty but provide a foundation to build upon by planting a seed of creativity.

To relate this occurrence where creativity is born, I will use an early memory from my own childhood that is typically shared amongst many engineers. Thinking about a time where the television or playing outside did not spark any interest, I turned to play with Legos as a form of entertainment. Dumping my collection of random Lego pieces out onto the floor, the scattered variety of pieces to choose from seemed endless. The beauty of free-form thinking is in the freedom to pick any block and attach it with another without any rules or thought to where the structure was going. The decision of what I was going to build came along the way and switched directions in many cases. The endless possibilities of free-from thinking when playing with Legos need to be adopted and placed into the teachings of engineering. The only difference between Legos and engineering is that the final product does not change. The process from start to finish has expanded so that an array of avenues can be taken arrive to at the final destination.

In summary, a method that would instill creativity in an engineer's mind when attempting to solve a problem is not only turn to nature for inspiration but to also learn from an architect. Architect are taught to use symbolism and meaning to create structures and engineers have the ability to do the same. Using a nature as a way to problem solve may seem unnatural but the boundless possibilities foster a way of thinking that navigates through unventured methods of engineering that yields better results. This method is one that needs practice and time. Therefore, an effective engineer would have to adopt this skill early on in study of engineering.

Adding a New Step to the Engineering Design Process: Infrastructure Design as an Example

As engineers continue to embrace nature as a learning platform, creating a new invention has to change due to the unconventional methods of creativity and production of new devices. Referring back to the engineering design process, a new step is to be added to ensure a change in thinking makes for a new path in technology. During the design step, a new step should follow. This step should ask the following questions in this order:

- Is the operation or function of the device in production have similar traits found in nature?
- If so, why should such a function be implemented into the design?
- Does this implementation yield a better outcome than the original design?

- Does this change in design alter the device’s intentions?

Asking such questions creates a train of thought and engages engineers in an unorthodox way of thinking. As humans, we have many limitations. Physical limitations that we have adapted to by the means of technology. We use tools, clothes, shelter, and many other supplementary additions that help us with survival. We do not adapt well to the weather environment compared to other species. We have to shelter our body with clothes even with the smallest changes in weather, our movement is limited by our physical structures, so we build machines to compensate for them. We are also very vulnerable to diseases and other microbial infections. By learning from their species, we can learn how to survive and even dramatically decrease our mortality rate.

Among sustainability, business-as-usual is a method of thinking that many engineers fall into the habit of. Regarding the scale and efficiency of creating something new, many innovations that have made the quality of living extravagant are not typically thought to have long-lasting effects on the environment and social/ethical culture. Training a new age of engineers to look at living systems as a source of knowledge is bound to our way of thinking and seeing things.

To better illustrate this phenomenon, we can take examples from our current quality of life. Analyzing our infrastructure of modern society, we live in houses, apartment buildings, cover long distances with cars, and even travel to a different continent by plane. Let’s imagine a world where we collectively as a human race were closer or hyper-conscious of mother nature. What would our day-to-day look like? Would we live in houses that are built so that wildlife can flourish without intervention? Would we still cut down large acres of woodland to build suburban homes? Would the city still have an abundance of tall buildings and have gid patterned roads? Observing depictions and illustrations of what life for the human race would look like in the future, dating back from the ’20s, the way we live has rooted itself in our daily lives, government, and much more. We must extrapolate information from multiple research that can deduce that biomimicry has its benefits. The main objective of this research is that the engineering design process lacks any formulation for innovation. the lack of innovation can be change by tweaking the engineering design prosses to question the normal school of thinking in respect to engineering by using nature as a way to try something new.

Conclusion

Innovating new technology via biomimicry is only a subcategory of methods in bettering the future. This can be achieved through remodeling our way of thinking, which ultimately yields improvement in our engineering designs. Modifying the engineering design process by adapting creative strategies in engineering and drawing inspiration from nature has the capability to go beyond the traditional methods of creation and construct technology that pushes the boundaries of engineering. A substantial amount of research has shown the benefits of biomimicry, and the implementation of nature’s designs would formulate a significant advancement in technology (Mather, 2017). Although the engineering design process is an incredibly useful method for getting started on a problem, it also allows individuals to consider various solutions in order to reach their target. Engineers will work beyond the box and impose a new viewpoint to the complexity of the issue when free-form thought is used. When we use nature as a catalyst for free-form thought, we expand our problem-solving options. Free-form will adapt our way of thought in a variety of ways, including bio-mimicry. With time and the help of engineers with these skills, our social norms and society can develop into one in which we exchange innovations and explore new possibilities.

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{ex #2. According to Morris of IDEO "in the event of ….." (Morris, 2021, p. 8).

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