Curious cut-aways

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Curious cut-aways

by

Devin Sloan

A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of

MASTER OF FINE ARTS

Major: Integrated Visual Arts

Program of Study Committee:
Anson Call, Major Professor
Austin Stewart
Sri Sritharan

Iowa State University
Ames, Iowa
2015

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DEDICATION

This thesis is dedicated to my mom and dad: without their continual patience and support none of this would be possible. I would also like to especially dedicate this to my always loving and caring wife Diana; Thank you for gracefully tolerating my many late nights and long rambling discussions about robots. Colin, Andrew, Byron, and Ed, the wisdom you all collectively bestowed upon me has been essential to getting this project to where it is today. Finally, Anson, thank you for trusting me to get this done.
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ABSTRACT

Curious Cut-Aways is a collection of five 3D modeled visual art pieces that show the inner workings of influential technologies. They were on display at the Ames Public Library and were created to promote a more positive view of technologies that are being developed right now. The creator of the artwork holds the view that many of the problems surrounding the adoption of technologies are related to a lack of interest or understanding of them. The work was designed to be easily approachable by presenting easy to understand details in both the visual work and the associated captions. Curious Cut-Aways aims to help change people’s perceptions of technology now in order to create a better future tomorrow.
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BIONIC ARM

Modern prosthetics have come a long way since the days of wooden limbs. Over the years, engineers have been working tirelessly to improve the function and appearance of prosthetics. One of the latest advancements in prosthetics is the bionic arm, which is designed to mimic the natural movement of a human arm. The bionic arm shown in the image has a similar design to current prosthetics and uses input from sensors to control the hand and fingers.

Some Nerve!
Modern bionic arms are controlled by nerve signals, which are transmitted through wires attached to the arm. This allows for precise control of the arm's movements. The bionic arm shown in the image has a similar design to current prosthetics and uses input from sensors to control the hand and fingers.

Six Million Dollar Man
Prosthetics like the one shown are expensive. They cost anywhere from $100,000 for a very basic model, all the way up to $100,000 for an advanced one like this. Despite the cost, modern prosthetics only last between two to five years of daily use, and must then be replaced.

Lithium Ion Battery Pack

Olympic Athlete
New research in materials have put some prosthetics on equal footing with even the best human bodies. In the 2022 Summer Olympics, South African runner Oscar Pistorius ran the 400m and set a world record in his category with prosthetic legs. While he did not win a gold medal, he is the first of many athletes to prove that technology can push the limits of the human body. Some people argue that prosthetics like these give them an unfair advantage. Some day we might see Paralympic athletes outperforming their Olympic counterparts.

Figure 4.13 Cross-Section of a bionic arm from Curious Cut-Aways
CHAPTER I
INTRODUCTION

Since the beginning of recorded history some individuals have had a knack for learning and discovering new concepts and information. Their brains make quick work of complex problems and they can understand concepts in new ways that few others can. The wealth of knowledge that these select individuals have contributed to society is very important but it is also worth acknowledging that what is easy for these individuals goes beyond the understanding of the majority.

Science communicator is the modern term for individuals who fill the role of middleman by communicating these complex topics to people who lack the means for deep understanding. While the insight into how these discoveries were made may not be important to many, the conclusions of the research can be. Technology is advancing more and more quickly as time progresses and out of this there is an increasing need for these scientific middlemen.

Science communicators have come in a wide variety of forms that follow closely with the communications technologies of their times. Presumably, it began with word of mouth then progressed into a form of writing that was simpler than the primary source. Today we see a huge range of science communication that ranges from television to the internet, in writing, illustration, and video, and now even in the form of interactive games. The thread of similarity that is identifiable through all of these mediums is “interestingness”. Most science communication relies upon taking what would normally be dry to laymen, and presenting the important information in a way that can pique people’s interest.
One of the more notable and personally influential scientific communicators is Stephen Biesty and his collection of cross-section work. Mr. Biesty’s work is notable for the extreme level of detail he presents in sophisticated buildings and machines (Figure 1.1). Every cross section he presents not only covers the important and more obvious attributes of the selected object, but also more obscure and mundane parts as well. His illustrations draw from vivid color use and an all-around busyness to draw his viewers in.

![Figure 1.1 Stephen Biesty’s illustration of a galleon (Biesty)](image)

Incredible Cross-Sections, Stephen Biesty’s most popular work, has sold more than 1 million copies and has found itself in many non-fiction children’s sections at libraries across the world. He has illustrated many follow up books as well that continue in the same vein of Incredible Cross-Sections. They have likely impacted many children, by inspiring an interest in science and engineering. Unfortunately, it has been many years since his last book was published and there is a perceivable void that his books once filled.
Curious Cut-Aways was developed to make the same complicated concepts more easily understandable to everyone. It is the first step in bringing cross sections for kids into the present through the utilization of 3D modeling. Finally, it is also an outlet to share a personal fascination in technology to a much wider audience than can be done by word of mouth.

Curious Cut-Aways aims to explore the five main areas of important technological development as stated by the visionary CEO, entrepreneur, and technologist Elon Musk. Mr. Musk stated in an interview that these technologies will shape the future the most:

- Space Travel
- Renewable Energy
- Artificial Intelligence
- Genetic Engineering
- The Internet

In response Curious Cut-Aways explores the following specific subjects:

- A hypothetical Mars base (space travel)
- A wind turbine (renewable energy)
- A Tesla Model S (also renewable energy)
- A data center (both artificial intelligence and the internet)
- A bionic arm (which broadens genetic engineering to bioengineering)
Curious Cut-Aways illustrates many years of personal research into technology and allows the sharing of this knowledge through an illustrated form of science communication. Curious Cut-Aways builds on the exceptional work of Stephen Biesty and allows for a personally fulfilling injection of 3D modeling, all while sharing a fascination about the future and of technology.
CHAPTER 2
INFLUENCES

From an early age I had a passion for science fiction, computers, and building objects. Some of my fondest and most vivid memories of childhood come from participating in related activities. Not only did these hobbies play a crucial role in my development, but my interest in them has carried through into my adult years and driven my current interest in art and science.

The oldest and most important influence on me is my parents. I am a fairly curious person, but my parents went above and beyond in enabling me to ask questions and discover things. My dad, who received the brunt of my questions, would often know the answer and would patiently explain it to me, regardless of the absurdity of the question. Other times he did not know the answers, but would still do the best he could. Years later, when I was older and more self-aware, I would think back and ask him the same questions from before and he would more readily admit that he didn’t know the answer. I’ve come to realize that it wasn’t the answers to the questions that made an impact on me, but it was the fact that he was never frustrated with me asking them. I see some parents being all too quick to dismiss a child’s curiosity and become frustrated with their chattiness. Curiosity is an immensely valuable trait for a child to have and encouraging it will build a life-long passion for learning. (Perry)

My mother, on the other hand, also played a valuable role in encouraging (and sometimes forcing) me to learn. She is one of the most determined people that I know and never gave up on me. It took me a long time to come to terms with it, but I now readily admit I have Attention Deficit Disorder (ADD). While I now view my short attention span
as a benefit, it made traditional schooling, which required sitting still and listening for extended periods, very hard for me. It was admittedly difficult to teach me unexciting topics like math, spelling, and reading. My mom stuck to it though. Despite me not enjoying those sessions as a child, they taught me that those subjects aren’t *that* bad, and even if they were hard, I could do it. I took those things I learned at home and they enabled me to become a competent student in school.

Finally, both of my parents contributed to my love for reading and learning random information. My mom was persistent in reading to me when I was too young to read to myself and, when I could read, she always ensured there was a steady supply of new books via the library. My dad on the other hand made a habit of taking me to the book store once or twice a week. Going to the book store was the pre-internet equivalent of browsing Wikipedia; anything I wanted to know I could find there.

Incredible Cross-Sections and by extension the work with Curious Cut-Aways, is a compliment to these early family influences. They provide a shotgun blast of information about a wide variety of topics, encourage viewers to learn more about the subjects at hand.

Sometimes pop culture is regarded as an inferior influence for artists versus traditional academic or professional critics. While there is valuable information to learn from these sources, we would be at a disadvantage to dismiss some of the messages present in the pop culture phenomenon. Popular culture, as its name implies has the ability to reach wide audiences and can inform and intrigue viewers without them even knowing. Where viewers might be turned off by the appearance of academics, pop culture draws viewers in with captivating storylines and general relatability.
Star Trek, specifically The Original Series (CBS), Star Trek: The Next Generation (CBS) and Star Trek: Voyager (CBS) primarily deals with topics which explore the human condition. Star Trek is all about contrast; there are few scenarios that can more succinctly demonstrate what it means to be human than having humans interact with aliens. Repeatedly, characters in the show are presented with situations where they must make difficult choices that could potentially strip away their humanity.

One of the main antagonists in the show, the species of half-organic, half-robot Borg, are a very clear representation of what happens when the efficiency of technology becomes the primary objective. In assimilating other species, the Borg strip away individuality and incorporate individuals into the hive mind. The Borg then typically make collective decisions that benefit the group but lead to the destruction of the individual.

In response, the Enterprise crew utilizes some human characteristic like creativity, empathy, or intuition to defeat their overwhelmingly powerful enemy. This repeated trope is used to explain that characteristics like these are the most valuable that humans possess.

Another pop-culture reference for understanding humanity in Star Trek is the character Data. Data’s continuing goal is to become more human. The main characteristic that separates him from the human characters is his lack of emotion which is something that his programing does not allow for. This lack of emotions gives him, the viewers, and outsiders the perspective of the drawbacks and advantages of having emotion. Star Trek continually juxtaposes emotion and the complexity of human psychology against the backdrop of cold, logical, futuristic technology. While not an exhaustive analysis of this contrast, it does provide many excellent case studies examining the differences between man and machine.
Deus Ex: Human Revolution is another powerful Pop Culture artifact that explores the future. (Ubisoft) Deus Ex very eloquently explores what the world would look like if it becomes socially acceptable for a person to become “augmented”, which in this case means being artificially enhanced through physical and neurological prosthesis.

A central concept to the game involves globalization and poverty. An overwhelming gloom hangs over the game's environments and much of it can be attributed to the very obvious income disparity between residents within the game. The player explores everything from boarded up Detroit tenements with squatters and gangs living in them, to the offices and work places of the corporate elite. In part of the game, Shanghai China has 2 levels; one suspended thousands of feet above the city where all the wealthy people live; and one below which is shrouded in permanent darkness; is full of the destitute, and is riddled with crime (Figure 2.1). The game forces the player to explore a future where the rich have been allowed to become richer and the poor have been forced into becoming poorer.

Figure 2.1 Deus Ex’s Shanghai, China (Ubisoft)
The player may come to the realization that what one feels is morally right may not matter if those who feel otherwise are put into an advantageous position. From the player's perspective, the advance of technology is unstoppable. The protagonist is repeatedly placed in situations where the only way to even the odds is by acquiring even more destructive technology. Balking at and pretending that these technologies don't exist or are unconscionable will not help the player, adaptation is the only solution.

The Martian is a commentary on the current state of science fiction and stands in contrast to the all-too-common dreary instances of a dystopian future. (Scott) The movie sees the United States in a very good position in the near future with regards to its space program. It is implied that billions of dollars have been invested in putting people on Mars (Figure 2.2) and things only get better for the space agency throughout the movie.

Figure 2.2 A very expensive ship that got the astronauts to Mars (Scott)
Despite the protagonist Mark Watney getting stuck on Mars, a number of very positive events happen. The first is that the expensive and humanistic decision is made to save him. While it would have been very easy for NASA to pretend he didn’t exist and leave him for dead, they do not. They then call for some of the greatest minds in the world to come together to make a rescue plan. A large amount of bureaucracy is cast aside and ideas are even fielded from lowly engineers. The most hopeful thing that happens in the entire movie is that nations work together to bring him home. China ultimately extends an olive branch to the United States to make the rescue mission happen.

A particular take away from this movie is the spirit of cooperation. Too many modern science fiction movies pit one group against another and the conflict is ended through combat and heroism. The Martian arrives at its conclusion through cooperation, humility, and diplomacy. This is not only a more interesting conclusion for the movie, but it is also an excellent outlook for humanity.

Humanity needs more cooperation. The constant “us versus them” that pervades the media is a narrow and unhelpful point of view. Humanity would benefit from looking at the big picture, individuals must look beyond what is an immediate threat to themselves, and consider how their actions will impact others and the future. Just because an individual has the ability to improve themselves through technology, it does not mean they should ignore the condition of everyone else.

Beyond pop culture, a person who exemplifies this big picture world view is Elon Musk. He spent millions of his own dollars funding what he views as technology that will benefit humanity on a large scale. While many of his technological contributions won’t
affect individuals directly, his investments will have long lasting benefits for future
generations. (Vance)

Elon Musk made millions of dollars during the dot com era in the areas of internet
search and finance. While he could easily have spent the rest of his life simply enjoying his
fortune, he made an all-in investment on what were viewed as two very risky ventures,
SpaceX and Tesla Motors. (Vance)

SpaceX is currently one of the biggest names in commercial space flight and is valued
at around 12 Billion dollars. (D'Onfro) Recently, it won a prestigious contract to ferry
astronauts to the space station via NASA’s Commercial Crew program. (NASA) SpaceX
was created out of Elon Musk’s “obsession” with colonizing Mars (Vance), and along the
way Musk aims to decrease the cost of space flight through reusable rockets. (de Selding)

A dramatic drop in the price of sending things to space will have profound effects on
how easily space can be utilized to benefit people on Earth. In addition to making what
would otherwise be a very expensive mission to Mars cheaper, it will also decrease the price
of doing research in space, as well as potentially harvesting minerals. These could very well
be the biggest first steps in making the human race more Star Trek-like.

Tesla Motors, Musk’s other big gamble took the auto industry head on by developing
one of the first commercially viable electric cars. Musk feels very strongly about the
consequences of global warming and the lack of action taken by the government in slowing
down or reversing it. (Vance) Tesla Motors, is contributing to the reversal of global warming
by providing the means for consumers to lose their dependence on fossil fuels. While doing
this, Tesla has also created one of the safest and most desirable cars on the road, and is well
on its way to commercial success without the help of an incumbent automotive company.

(Gordon-Bloomfield)

Elon Musk’s bold vision for the future is an ideal that should be appreciated and strived for and Curious Cut-Aways aims to put these innovations in front of as many eyes as possible. For real positive change to happen we can’t rely on one person doing it by themselves; everyone needs to change their mindset and support this positive action.
3.1 The Creation of Art

Art has distinguished itself in many different ways over the centuries and continues to do so presently. This distinction of phases is studied and contributes to the pillars of what contemporary art education is. The characteristics of art itself have varied widely and many times over the centuries, and some art that is on the leading edge has on many occasions been cast aside and discredited as either not art or some inferior brand of it. Many recognizable individuals in the history of art have been discredited during their lifetimes and some have even died without their works being known, only for critics to later realize their brilliance. I’ve spent a large amount of my higher education studying this cycle of artistic movements, and I’ve come to realize that this cycle is pervasive throughout society; it is by no means limited to art alone. This cycle of resistance to change pervades politics, religion, science and the majority of other fields of study. History repeats itself and some people shun new ideas and technologies. Some fail to grasp the benefits of what they are witnessing, and cling to the ways they have always done things.

A cursory look at politics in the United States also demonstrates this fact. The majority of the voting populace in this country forgoes the official party names of Democrat and Republican and cuts straight to what they are: the party for change, liberals or progressives, and the party that wants to keep things how they were, the conservatives. American politics demonstrates change and resistance to change on in institutional level. Religion too shows a similar cycle of wanting to move forward but also being held in place.
For example, technology provided the means for every person to affordably own a Bible but this change was resisted by the church because it would upset the balance of power. Gutenberg’s press allowed the Bible to be distributed in the colloquial language to virtually everyone who wanted one. All these new eyes allowed for differing interpretations of the Bible and ultimately led to a fracture in Christianity and contributed to the Protestant reformation. This cycle of resistance to change is even more readily observable in science and is a hot topic of the 2016 presidential election. Global Warming is a scientific observation that is accepted by more than ninety five percent of current practicing climatologists, yet it is disputed by many politicians and voters alike. An inevitability of global warming is permanent negative change of the environment with effects ranging from a decrease in arable land to a loss of livable land to the ocean. If it is ignored for too long it could even mean the end of the human race as we know it.

As long as humans are thriving, technological advance is inevitable, both with its negative and positive consequences; the psychological need of some humans to reject this advancement and not adapt is holding us back from our true potential The tendency of some to ignore observable evidence puts the human race’s continued existence in great peril. Therefore it is the duty of those with understanding to protect humanity by bringing to the forefront all of their knowledge in an effort to stamp out ignorance and apathy. Artists have played a crucial role in the history of conveying ideas of change, but as previously mentioned even they have resisted change. Much of the time this resistance came from obvious outside influences; for example, church officials in the past have been reluctant to let the masses see certain subjects within art. But also resistance has come from much less obvious influences
and even from pure personal conviction, which manifests itself as a resistance to certain techniques or media.

Sometimes a simple slip of the tongue can betray a person’s true convictions about what is actually art. On multiple occasions I myself have been victim to a distinction between “digital art” and “actual art”. I’ve been told by respectable mentors that because I was doing it “on the computer” that it wasn’t actually drawing. This often unfounded resistance to new forms and usages is a travesty. While legacy materials and techniques still play an important role in contemporary art, they also possess limitations. Those limitations come in a variety of forms but one of the most critical elements that traditional mediums can lack is novelty. Novelty is a fleeting quality that is especially poignant for the general public. Children for example, can be quick to dismiss older mediums, and as a result they fail to analyze the meaning when it is presented to them. Newer mediums, like digital art for example, generally possess more panache and novelty than more traditional mediums allowing the audience to stay tuned in for longer. New mediums and techniques must continue to be developed for new generations of viewers. Artists potentially have tremendous skills in communication; they take raw information that they gather and convert it to work that transcends the source material. This transcendence comes in many forms, some of which are tremendously valuable to their given audiences. Artists sometimes take what they have learned in an effort to ask questions to the viewer. Perhaps the artist sees a current event and takes issue with a particular facet of it. The artist presents their information in a way that challenges the viewer and begs them to ask questions about their personal understanding. On the other end of the spectrum however, it is sometimes required
of an artist to present the answers to questions. Artists utilize their skills in communication to design work that conveys their message skillfully and efficiently to their viewer.

In many cases it is apparent that the artist is either mostly answering or mostly questioning, but it is also very important to remember that this is a spectrum and rarely is the artist purely doing one or the other. Much of the time, contextual clues within the artwork can lead to uncovering the artist’s feelings on the subject matter. A certain shade of colors can convey emotion; a certain line value for example can demonstrate anger or happiness. A lot can also be ascertained about the artwork by the context in which it is presented. Some artwork that relies on technical accuracy that doesn’t allow for variance in color and line can be analyzed, in part, by the accompanying pieces. The viewer can begin to tell the opinions of the creator by finding commonalities between pieces, and even by the absence of certain features within them.

Art, when viewed in the context of how it changes, functions similarly to the advancement of technology. Many of the same principles that can be applied to understanding art can also be applied to understanding how technology develops. Curious Cut-Aways was created with these understandings in mind, and they can potentially inform the viewer as to why the artist made the decisions they did.

3.2 The Diffusion of Innovation

There is an observable resistance to change in humans. The go to reaction for many is to maintain course and keep doing what has been done.

New technologies are often ignored or disregarded without ever being fully analyzed. News of new technology is read or heard via word-of-mouth and is all too often dismissed as
too complicated to be understood. Rather than trying to understand the topic at hand, people often allow others to compose their opinions for them. These opinions can be heavily biased and omit certain information in order to present it in a particular light.

The simple principle of economics is that there is far too much work to be done for a single person to thrive on their own (Investopedia). As a result people specialize in certain tasks that they can do faster than others, and can spend more time doing it. Goods and services are later exchanged in order to provide everyone with the adequate means to survive. This system not only pertains to tangible goods, but also extends to intellectual ones. Scientists and philosophers receive payment for their services in thinking about concepts.

The role of a scientist is to utilize the scientific method to make observations of phenomena and then record them. The role of a philosopher can be to amalgamate these disparate observations and generate conclusions based upon them. Due to nature not being completely understood at this time, there is not enough information to generate an infallible opinion. New information is constantly being created, thus new opinions should constantly be formed, and old opinions should constantly be adjusted.

Opinions based on first hand experiences are superior to opinions based on the conclusions of others. When opinions are self-generated they are more malleable and susceptible to the holder’s personal scrutiny. Reliance on external sources to create a fully formed conclusion results in less intimacy with the facts that lead to that conclusion. In many cases, personal responsibility is deferred to figures in the media and the holder no longer has to concern themselves with the consequences.

New technologies are constantly being developed with the potential to have a tremendous positive impact on society. A small fraction of the possible users, the early
adopters, embrace this new innovation first. Sometimes, the new technology is simply not
good enough or not ready for the masses and is cast aside. If the technology is good, early
adopters pass along positive feedback to other users and over time the technology is adopted
by the masses.

Late adopters may feel as though they simply don’t have the resources to explore new
technologies. Learning new processes takes time, investing in new technology takes money,
and sometimes the innovation does not affect them directly so late adopters let early adopters
figure out if things will pan out.

![Figure 3.1 Diffusion of Innovation S Curve](business-planning-for-managers.com)

That is okay. The purpose of Curious Cut-Aways is to help viewers understand that
complex future technologies are approachable. Curious Cut-Aways provides a gateway for
further understanding and an opportunity for the viewer to create their own opinions, so that they can more intelligently make decisions about what is right for themselves, in the future.
CHAPTER 4
CROSS-SECTIONED TECHNOLOGIES

4.1 Overview

This section of the thesis will explain why the selected technologies were included in this project. It is far more important for these areas to be explored as opposed to focusing on one particular instance of it. In place of that, this section will discuss the circumstances surrounding these technologies and why these types of technology are so important.

4.2 Wind Turbine

Earth is facing two major global crises: The first is that there are very fast, possibly permanent changes being made to our environment as result of man-made global warming, and those changes have the potential to displace millions of people and endanger global food supplies. The second is that we are running out of the necessary resources to sustain our increasing population levels (Figure 4.1). With its nearly limitless supply, renewable energy technologies make strides against both of these issues and for that reason they are some of the most important areas of research that are currently being explored.

Relying on fossil fuel sources is currently seen as the norm, and it should not be viewed that way. While it is currently easier (and in many cases the only option) to utilize them for fuel sources, the longer they are utilized the more of an impact they will have on the world.
Figure 4.1 Projected population levels over time. (DDS Research)

Not only does the burning of fossil fuels affect the environment with every day use but the extraction and transport also have significant negative effects. A large amount of the political unrest in the Middle East can be linked to oil. The United States has a vested interest in oil assets in that area of the world which has contributed to a permanent military presence there. Perhaps, if we weren’t interested in maintaining control over oil in that area, much of the political unrest that currently exists would not be occurring today. (Verrastro, Pumphrey and Hegburg)

Beyond having a day-to-day impact on the environment, there have also been a number of notable disasters related to fossil fuel. The biggest and most notable being the BP oil spill in the Gulf of Mexico: two hundred million gallons of crude oil were spilled over eighty seven days. That is the equivalent to twenty Exxon Valdez spills, which also had a
huge negative impact on wild life. Estimates have shown that the BP oil spill directly contributed to the death of eighty two thousand birds, six thousand sea turtles, twenty six thousand sea mammals, and an unknown but likely huge number of fish. (Center for Biological Diversity)

Oil however, is not the only fossil fuel impacting the environment. Coal slurries have been accidentally spilled as well. One incident in North Carolina resulted in eighty-two thousand gallons of coal ash water being spilled directly into a river. (Shoichet)

Both coal and oil are diminishing resources which have resulted in higher prices. The prices have driven energy companies to find new non-renewable resources to dig up. Notably, fracking has resulted in an environmental impact in some areas. Video can be found of tap water that is flammable (Gas Drilling Awareness Coalition), research studies have shown an enormous amount of carcinogenic chemicals to be found in fracking fluid (Hoffman), and there has been an increase in earthquakes in areas around fracking sites. (NPR)

The transport of fossil fuels, primarily oil, also has a very significant impact on the environment. Ships traveling through international waters are not beholden to typical environmental protection rules. As a result oil carriers run on very low quality fuel that burns dirty. It is estimated that ships contribute 2.3% of all carbon dioxide emissions in the world. (Transport and Environment)

Fortunately, there is hope in renewable energy sources. A number of high profile companies are making very vocal and public stands about utilizing renewable energy. Apple has publicly stated that it intends to be entirely carbon neutral eventually. It already produces 87% of the renewable energy necessary to power its headquarters, its stores, and its data
centers. (Temperton) Tesla’s “Gigafactory” will also run entirely on renewable energy sources, a massive array of solar panels line its roof. Finally, Google uses 35% renewable energy for all of its services, and has made notable large investments in the renewable energy arena. (Google)

Figure 4.2 Cross-section of a wind turbine from Curious Cut-Aways

Wind turbines are amazing feats of engineering and many minds must work together to create even better and more efficient versions of these machines. The sooner the world eases its craving for dirty non-renewable energy sources, the sooner our environment and future will be safe.

A Turbine was chosen specifically for Curious Cut-Aways (Figure 4.2) for its ease of access to an informed source, Professor Sritharan, an advisor on the project. Something solar related was considered at first, but ultimately set aside because the technology doesn’t lend itself to ease of illustration. Wind Power is also relatable for Iowa residents as there are an abundance of them near Ames, where the show was put on display.
The illustration shows a wind turbines most important parts in a streamlined manner. Wind turbines are very complicated machines with a lot of intricacy, much of which is related to safety and monitoring. What the illustration includes are the parts that more or less would be used to make a turbine functional. Now, next time a viewer sees a wind turbine, they will hopefully be able to understand what is happening mechanically to generate power and how it benefits them.

4.3 Tesla Model S

In 2008 Tesla rolled out its first car, the Roadster. It was seen as an oddity by some and an interesting project by others, but the general consensus was that it was a historical fluke (Edmunds.com). Elon Musk, the new CEO of Tesla at the time, was a virtual unknown with a lot of ambition and not a lot of clout to back it up (Raj). Years earlier he had a messy break up with PayPal, a company he had helped found and expand, which left him with a lot of money, but not necessarily a great reputation in Silicon Valley (Vance).

Somewhat against the odds, Tesla announced their next vehicle, the Tesla Model S, in 2008, just as the Roadster was going into production. (Raj) Once again the car was viewed as ambitious, but the media was not sure what to think as it’s not very often that a new auto company materializes and announces its intentions to completely transform the consumer auto industry. However, that’s exactly what Tesla did. (Topolsky)

With its promise to put mass produced electric cars in the hands of consumers everywhere, it began a wave of change that is still rippling through the auto industry today. The older and entrenched auto makers are still scrambling to keep up and it might already be too late for them to get an edge. (Neil)
In addition to making an electric car, Elon Musk is also creating the infrastructure for mass production. A five billion dollar “Gigafactory” (Figure 4.3) that is currently being built in the Nevada desert is poised to double the worldwide production of lithium ion batteries. Soon Tesla will not only control a highly desirable commodity of vehicles, but it will also control the majority of the parts required to build them. (The Motley Fool)

Figure 4.3 A render of Tesla’s 5 Billion Dollar Battery Factory. (Tesla Motors)

One of the most common complaints lodged against electric (and hybrid) vehicles previously was that it was not economical to buy one. Tesla is aiming to completely change this outlook by making a big and somewhat risky investment in the production of high quality batteries. By utilizing economies of scale it aims to drastically reduce the price of electric vehicles and their expensive batteries. Tesla is relying on consumers to see the very visible benefits of electric vehicles when making their next car purchasing decision.

While the seventy thousand dollar sticker price on the Model S is somewhat high to truly be considered a vehicle for the average consumer, it was a financially safe price to start at for the company. Early adopters and influential tech entrepreneurs (Figure 4.4) were the financially well-to-do target audience for the Model S. This vocal and publicly admired group of buyers has resulted in a lot of positive press for Tesla. This press has made
investing in Tesla a less risky venture which has allowed them to pursue even more ambitious goals. The recently released Model X has received rave reviews and there is a building excitement for the announced but not yet shown Model 3. (Young)

The Model 3 is where things could truly see widespread change. It is rumored to start out at half the price of a low end Model S, and may present a more feasible purchase for a much larger audience. (Moseman) While the Model 3 is still probably going to be more expensive than the average sedan, there are a number of benefits that might encourage potential buyers to look past the sticker price.

First, it is battery powered, meaning it doesn’t directly burn a fossil fuel. Even when the increased price of an electric bill is factored in, many buyers are still finding that they save money on energy. (Tesla Forums) Secondly, if the Model S is any indication, electric vehicles are very safe. Because there is no heavy engine in the front of a car, there is a much larger crumple zone for head on collisions. (Tesla Motors) The passenger is insulated against potential injury, which may eventually reduce insurance bills. (Department of Motor

Figure 4.4 Nvidia CEO Jen-Hsun Huang stands in front of his new Tesla Model X (NVIDIA)
Finally, if the Model 3 also contains Tesla’s auto pilot system, we may see a further reduction in driving related accidents as well as more enjoyable commutes. (Car and Driver)

Figure 4.5 Cross-section of a tesla Model S from Curious Cut-Aways

The Tesla Model S has been chosen for illustration in Curious Cut-Aways because it represents a milestone for the auto industry. (Figure 4.5) No other electric car has generated nearly as much buzz upon its release as the Model S has and for that reason, it is likely the most relatable instance of an electric car.

When creating the text for the piece there were three things that needed to be communicated most clearly: safety, efficiency, and autonomy. Curious Cut-Aways aims to portray the vehicle in the most desirable light possible, and all three of these features are important factors to interested parties.

The Model S is one of the first in what will likely be a new automotive trend. What the future holds for cars can be gleaned from the Model S’s portrayal in Curious Cut-Aways.
The future is bright for the electric car, and Curious Cut-Aways aims to share that message of innovation with its viewers.

### 4.4 Mars Base

One of the most truly terrifying thoughts to ponder is why haven’t we encountered any other life outside of earth. One of the most obvious solutions is that there is nothing else out there, we are the first, and humans are alone in the universe. However, when the Drake equation is utilized this possibility becomes less likely. (In a Nutshell – Kurzgesagt) The universe is huge and has an enormous amount of possible locations to harbor life. (SETI Institute) Our sun and solar system aren’t particularly young, old or spectacular, so it stands to reason that we are likely not the first. (Sharp)

The next possibility is that the Earth and its combination of characteristics are exceedingly rare. Instances of Earth-like planets might be so astronomically far apart that signs of life reaching from one planet to another would either fade out in transit or simply take so long to get here that we just haven’t gotten them yet. This is a more likely possibility than the previous two solutions, because the sheer number of stars favors this solution. (Urban)

The third and arguably scariest commonly held possibility is referred to as the great filter. It posits that we are not the first and that we are not rare, but that sentient life is in some way self-destructive. Soon after (or before) civilizations gain the ability to look beyond themselves and reach out to the cosmos they are snuffed out in one way or another. Some causes might be natural, like a volcanic eruption, a rogue asteroid, or a high energy gamma ray burst that vaporizes everything. The other possibility is that civilizations destroy
themselves. Perhaps it is through weapons of mass destruction, maybe through accidental global climate change, or some other created technology like an artificial intelligence that undoes everything. (Urban)

This line of reasoning, referred to as the Fermi Paradox, succinctly declares, “We are rare, we are first, or we are fucked.” (Urban) While there is not much humanity can do about the first two of those possibilities, there are a number of ways we can handle the third.

The first way we can ensure our survival is by being proactive in governing ourselves. While this will help ensure our collective longevity there are a number of scenarios that are beyond our self-governing capabilities. Obviously, since we have no control over natural causes, no amount of governing will prevent a doomsday asteroid from crashing into Earth. Furthermore, there are certain lawless political situations and groups that will operate outside of the control of people looking out for our best interest.

The second way we can help ourselves is by increasing our odds through technology; namely, expanding beyond Earth. (Daum) There are certain technologies that are being developed such as warp drives (Moskowitz), and physics research that may someday unlock abilities like interstellar or interdimensional wormholes (Grush) that will enable us to travel far beyond our solar system. At this time, however, our most reasonable option is visiting our intrasolar neighbors through conventional technology. (Vance)

The idea of creating a Mars base has been a common theme in the media. Companies like Space X and organizations like NASA have been working with the public to generate ideas about what a potential permanent colony on Mars might look like (Figure 4.6). Various possible scenarios have been explored, and resulting solutions have been put forth. (NASA)
A significant problem is that Mars is difficult to reach. The distance between Mars and the Earth changes as they orbit the Sun, which means resupply missions can only be launched during optimal alignment windows. If a problem occurred outside that time, it would make it much more difficult to mount a rescue mission.

The other large hurdle is that it is very expensive to put vehicles into space. For example, the most expensive structure ever created is the International Space Station, ringing in at around one hundred fifty seven billion dollars. An immense amount of research and testing is required for vehicles to be viable in space. Not only do they have to endure the blisteringly hot and frigidly cold vacuum of space, but they must also be able to resist direct radiation from the sun all while keeping what’s inside them in livable conditions. On top of surviving in space, rockets must be able to travel through the forces that our atmosphere and our gravity puts on them. The slightest malfunction of any
part can result in catastrophic failure and “rapid unplanned disassembly” of the space vehicle (Figure 4.7). (Bellows)

Figure 4.7 Rapid unplanned disassembly. (Squad)

As a result of this, every bit of mass that is put into space has a very high associated price tag and needs to be as efficiently designed as possible, which accrues even further costs. So many variables are at play in a Mars mission that the collective undertaking will require unprecedented cooperation not only between countries and companies, but also with the public.
Figure 4.8 Cross-section of a Mars base from Curious Cut-Aways.

The illustration of a Mars base within Curious Cut-Aways aims to make people at least aware of the challenges ahead. (Figure 4.8) Increasing the public’s awareness will lead to more potential creative solutions for those challenges. Positive portrayal within the media is essential for getting the NASA’s Mars program off the ground and helping people to understand the importance’s of the space program will make it a more politically safe allocation of tax money.

The illustration of the Mars base is the most speculative piece within Curious Cut-Aways. Because none of the plans for a Mars mission have been finalized, or in some cases even started, it presented a tremendous amount of freedom in its portrayal. While it did allow for mostly free reign, a realistic approach was still taken.
Due to the size of a potential Mars Colony a hexagon layout was used to show different parts that might potentially be very far apart. Different potential building techniques were also chosen, showing a 3D printed building being constructed, landed vehicles being attached, geodesic structures housing plants, and prefabricated structures being used for living quarters.

Traveling to Mars is one of the most ambitious undertakings ever made. In addition to having the invaluable benefit of potentially averting our total annihilation, the research process that is involved will likely spawn amazing new technologies and solutions we haven’t even begun to comprehend yet. Earth’s greatest minds need to be motivated towards working on this project as soon as possible, and the sooner that happens the safer we, as a species, will become.

4.5 Data Center

Arguably the most influential technology that has been made operational during our lifetimes is the internet. With the internet have come sweeping changes to virtually all areas of commerce, and it has found a place in almost everyone’s lives. It is working its way towards becoming a readily available resource for almost everyone on the planet, and the many people who still lack a connection to it (roughly sixty percent of the world) are significantly handicapped. (International Telecom Union)

For those connected to the internet, no longer does one simply have to give up on wanting to know something then and there (Figure 4.9), now that information is available on a little electronic device that can be kept in a pocket. Rather than having to keep information
you already know bottled up, people can easily share anything from pictures of their cat, to a
disaster they’re witnessing with anyone who happens to be watching.

The internet has also played a tremendous role in connecting disparate groups of
people who are interested in niche information. Whether an individual is looking to connect
with other fans of an obscure TV show or band together with others to build a rogue state, a
quick search of Google can put them in touch.

Figure 4.9 Life before Google. (Shoebox)
While the internet is tremendously powerful, at the same time, for many it is shrouded in mystery. Many people who use it regularly have no understanding of its inner workings.

People with a hint of tech savvy have probably all heard questions like, “What is wifi? Is it in the air?” and “Chrome says it can’t connect to the DNS. What even is the DNS?” and “How do I get to The Google?”

A lot of the ignorance about how the internet works comes from a simple lack of interest. For many the internet consists of a little icon that is tapped on their computer or cell phone. How they are connected to the information they want is irrelevant for those people; as long as they get it, they don’t care how it got there. (Linshi)

In reality, the internet is actually fairly sophisticated and there is a noteworthy amount of change constantly happening to it. While one doesn’t need to (and probably couldn’t) understand everything about how the internet operates, a basic amount of interest and knowledge will go a long way. (Titus)

The current hot button issue in regards to the internet involves what it means for information to truly be free and how (or if) that information should be governed. Our current version of the internet was originally designed to be an academic system for sharing information quickly between colleagues, and as result security was not an important factor. (Internet Society)

Today, the effects of those design decisions are still with us. The big governments of the world are working to lock down just what kind of information can be shared and who has control over it. They are working to determine if it is within their rights to monitor all the information that is passed around or whether that information is owned by the people creating it. (Estes)
While this sort of discussion does need to happen, the way the United States government has gone about it is morally and ethically questionable. Firstly, in the name of national defense, back room dealings led to the creation of systems, like PRISM, that tracked all phone and internet records going through the United States. These systems were built without the knowledge of the public and were only revealed when Edward Snowden illegally released information about them to news agencies (Figure 4.10). The reason for the secrecy surrounding it is due to the outcry that arose after the system was revealed; many people felt that it infringed upon their constitutional rights. (Sottek and Kopstein)

Figure 4.10 The United States government started collecting phone data in 2007. (Tech Crunch)
The second important discussion is about all information being treated equally. While in the United States “internet fast lanes” were struck down by the FCC, they were recently voted in favor of by the European Union general assembly. They allow for certain information to be paid for to go faster. Companies with more wealth and influence can pay internet service providers for their information to be passed along more quickly and easily than other companies. The heavyweights of the internet can pay to have an advantage over smaller startup companies leading to less competition and could lead to consumers receiving biased information. (Collins)

Figure 4.11 Cross Section of a Data Center from Curious Cut-Aways

Curious Cut-Aways goal with its data center illustration is to show that the internet can be a very tangible thing that requires complex infrastructure. (Figure 4.11) The office space within it was made to look lived in to give the implication that a lot of manpower is...
required for its operation. The warehouse was given lots of detail to demonstrate the enormous amount of resources required to make it functional.

Freedom of information on the internet must be protected, if not for the current generation, then for the next one. A slight perversion of rules governing freedom of information now will lead to even greater advances against freedom in the future.

4.6 Bionic Arm

Biomedical technologies have made incredible leaps and bounds in the last one hundred years. Medical advances have taken humans from being at the mercy of many diseases to being in control of some of them. The collective knowledge of doctors and scientists has taken humanity away from some of the horrifying consequences of disease, and provided us with the ability to combat it and fight back from what was once viewed as a hopeless situation. In the last one hundred years we have exponentially increased our ability to identify diseases, find their sources, prevent their transmissions, and repair possible damage caused by them.

While it is important to focus on developing drugs to fight the diseases themselves, collecting data on their occurrence is just as important and has opened up many new fields of study. The new prevalence of internet-connected mobile devices has given doctors the ability to monitor patients in real time. (Herzog) Devices have been developed that passively monitor the body and wirelessly transmit data back to scientists. (Apple) New deep learning algorithms automatically sift through huge received data sets and can find new patterns that would otherwise be undetectable. (Keshavan) Computers and the internet have played a huge role in making humans healthier by predicting when and how diseases are acquired. A
new generation of scientists with a background in both computer science and medical science are required to push these technologies further. (National Institute of Biomedical Imaging and Bioengineering)

We are just beginning to unlock the secrets of the brain, and understand how it works. Recently, the neurons from the brain of a worm were simulated on computer and then uploaded to a robot. The robot performed functions similar to the worm without any explicit instructions to do so. While the worm’s brain is not hugely complex, this is a crucial first step into the future of not only medicine, but also into artificial intelligence. (Dorrier)

We have grown organs out of generic stem cells, and we have begun to grow those stem cells from other cells like skin cells. With further development of this technology we have the potential to create personalized versions of any organ in the body. (Medical News Today) This tech can also potentially be used to grow artificial meat and negate some of the effects of ecological energy flow. (Future Food) Meat production through this method will create a new industry, and will require a shift in knowledge for food growers. (Reynolds)

We are utilizing previously dangerous viruses to inject DNA into cells to prevent disease. Recent progress with this technique has led to a promising future for people with Parkinson’s disease. With an expansion of viral therapy some hereditary diseases may even be completely wiped out. (Wong)
Finally, there have been amazing advances in prosthetics. Recent developments have given amputees the ability to control prosthetic limbs by simply thinking about it (Figure 4.12). Innervation techniques have provided a more seamless interface for prosthetics to understand what the brain wants them to do. (The New York Times) Furthermore, new technologies are also being developed that allow the brain to gain senses from the prosthetic. (Talbot) Recently, a previously disabled man, Oscar Pistorius, ran in the Olympics despite his prosthetic legs. Immediately following his qualifying, discussion was raised about whether or not it was fair to non-augmented competitors. In the not too distant future we may see cases of Paralympic athletes outperforming traditional ones. (Eveleth)

This phenomenon could potentially go beyond physical prosthetics, too. Coupled with advancements in our understanding of the brain it could lead to the complete eradication of mental illness, as well as increased cognitive ability.
A future question that we might one day be taking very seriously is whether or not it would be in our best interest to replace a perfectly functioning body part with an artificial one. Even if one chooses not to partake in augmentation, how much of a disadvantage would one be at to people who do choose to be enhanced? Where should the line be drawn in the number of enhancements a person can have before they’re not a human anymore? The old question applies, “How many parts of a ship can be replaced before it’s not the same ship?”

The illustration of a bionic arm within Curious Cut-Aways takes a more here-and-now approach to prosthetics. (Figure 4.13) Rather than looking far into the future and how prosthetics might look then, Curious Cut-Aways demonstrates how some of the most advanced ones look now.

Figure 4.13 Cross-Section of a bionic arm from Curious Cut-Aways

The bionic arm within Curious Cutaways was built with identifiable off the shelf parts for its processor and microcontroller. This was done to emphasize the “do-it-yourself”
nature of this robotic arm. As this technology becomes more standard, there is potential for non-professionals to begin working with it, allowing for creative advances in the field. This potential avenue for development needs to be made as widely known as possible, and Curious Cut-Aways aims to spread the word.

Medical technology is advancing at a very fast pace. Before we know it the time will come when some biomechanical science fiction constructs will be real ones. While it may be scary to think about some of these advancements, it is something that must be done now. Even if an individual sees being non-augmented as the ethical choice, there will always be another person who doesn’t see it that way. Non-augmented people will be at a radical disadvantage to the others and we could potentially see another avenue for inequality amongst individuals. Preparing for these future eventualities now will benefit everyone later.
 CHAPTER 5

SUMMARY AND CONCLUSION

Curious Cut-Aways was created in response to a perceived lack of knowledge and interest in technology. It digs right into some of the biggest and most influential technologies that exist right now, and begins explaining them in a way that almost everyone can understand. Curious Cut-Aways is not the conclusion, but is just a step along a very long road of bringing the general public up to speed about what the future holds. While it does not tell the viewer everything about the chosen technologies, it does aim to pique the viewer’s interest into knowing more about them. A generally heightened public interest in these technologies will allow for more informed decisions to be made about the direction humans are taking and those informed decisions have the potential to save humanity from dire consequences.

Curious Cut-Aways cannot complete these goals alone, many others must make an effort to inform the public, as well. The exhibit was deliberately shown in a public place of learning in a format that is easy to comprehend by many people, but that is not the only way to convey its message. Many other mediums and locations are prime for getting the message out. This important work in the field of science communication needs to continue into the foreseeable future or the progress that has been made may be for naught.

The present is an incredible time to be alive. Progress is being made in so many different directions. This progress has the potential to improve the lives of everyone on Earth. To fully utilize these advances though, knowledge of it needs to be available to everyone. The direction humanity takes should not be limited to a select few, and it should
not be taken lightly. It is the duty of everyone to make informed decisions about the future for not only themselves and their little place, but for everyone and Earth as a whole.
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