Creativity and Inspiration: Our exhibit, *Nature's Fault*, is focused on the science and mathematics behind plate tectonics. The exhibit will be stimulating for all ages, illustrating the cause and effects of tectonic activity, including earthquakes, volcanoes, and tsunamis. The centerpiece of this exhibit is a 120-foot tall volcano, cut away at its midsection, flush with the Science City building. The volcano's 20-foot-diameter crater will be placed above the edge of the Science City building. The volcano will have a radius of 60-feet and will be tangent to the north and west edges of the area. The top of the volcano extending over the Science City building gives the impression that the volcano erupted on the edge of Science City and consumed part of the interior of the building. On the wall flush to Science City there will be a cross-sectioned view of the what the volcano would look like inside. The shape mirrors the smaller, more geometric Arvin Gottlieb Planetarium, making the planetarium resemble a smaller volcano in the same chain. The rest of the space afforded to us will be used for supplemental exhibits to educate visitors on other tectonic effects such as tsunamis and earthquakes. The visual stimulation of seeing ruined buildings will open a door in the viewer's mind showing the power of tectonics. *Nature's Fault* utilizes several activities as well as cutting edge technology to captivate viewers as they travel on a path that expands their understanding of common natural disasters. The exhibit will focus on volcanic eruptions, earthquakes, and tsunamis and will tie all three of these disasters back to tectonic plate movement and mathematics. One of the main purposes of the exhibit is the connection between subjects such as science, mathematics, and history. When exploring the volcanic portion of the exhibit, visitors will be able to explore the formation of lava tubes and view a cross section of a giant stratovolcano. Concepts such as volcano types, magma, lava flow, and the Volcanic Explosivity Index (VEI) will be explained with mathematics where applicable. The Seismic Simulation Shack outside of the monolithic volcano will be focused on earthquakes and tsunamis. There are three exhibits inside the shack that are focused on tsunamis and earthquakes. The equation for the Richter scale of an earthquake, $M = \log_{10}(I/S)$, based on the intensity (I) of a standard magnitude (M) earthquake (S), $M_S = \log_{10}(S/S) = \log_{10}(1) = 0$, will be provided. The equation $h_s/h_d = \sqrt[4]{H_d/H_s}$ describes the relationship between the height of the tsunami (h) and the depth of the ocean (H) in shallow and deep parts of the ocean. Visitors will be able to manipulate the equations to create simulations of tsunamis and earthquakes or choose from a number of historic disasters. An understanding of tectonic activity connects several ideas that include formation of mountains and rifts, volcanic and seismic activity, and location and form of land masses. Also included in the Seismic Simulation Shack will be a globe to show the layers of the earth via a cutout view. This cutout is set into the corner of the room to maximize our space within the shack.

While on our tour of Science City, we came to the conclusion that there was a lack of exhibits on Earth Science and mathematics. The word that came to our minds was *iconic*, which guided our group toward tectonic science. Naturally, the most iconic exhibit that could be made concerning tectonic activity was an enormous monolithic volcano. From there, we decided to create a layout of a ruined city with supplemental exhibits of tsunamis and earthquakes. The general public is very familiar with these tectonic effects, but very few have the mathematical understanding of such an event. It is this lack of understanding that is the driving force behind the inspiration to educate people of all ages on what causes them and how we measure their intensity. With the earth being a constant hotbed of tectonic activity, informing the public on this subject will be very beneficial and it is this fact that will keep this exhibit relevant in the future. A knowledge of tectonic activities will enable the general public to better prepare for such events. The constant shifting of Earth's tectonic plates will ensure mathematical relevance of this exhibit for years to come. Plate tectonics will continue to alter the formation of oceanic and continental boundaries and over time will change the geography and topography of the earth. Natural disasters such as tsunamis and earthquakes are in constant need of better detection systems and more accurate prediction methods. This exhibit will inspire the next generation of scientists and engineers and drive them to enhance this ever growing field of science and mathematics.

Interactive Exhibit Engagement: Towering high above Union Station, our exhibit takes advantage of the large outside area with a massive volcano, *Mt. Tectonic*. The volcano is the main attraction of the entire exhibit, *Nature's*

Fault. Before the visitors enter *Mt. Tectonic*, they must walk through a village resembling Pompeii on a "lava flow" path which leads visitors through the various parts of the exhibit. Seismic Simulation Shack, the only freestanding building, contains many interactive demonstrations as well as static information. The visitors first enter the building and see a series of displays explaining faults and how they create earthquakes. Visitors will use the information from the displays as a basis of knowledge for their journey through *Nature's Fault*. To demonstrate earthquakes from an civil engineering standpoint, the visitor will build a structure at one of Destruction Junction's three earthquake tables. Each table's surface will vibrate and shift to simulate an earthquake. Each table will have a dial to allow the user to select the magnitude of the quake, showing how the Richter Scale is logarithmic. A water tank in the building allows visitors to create small-scale tsunamis, and a knob on the side of the tsunami tank lets them increase and decrease the power of the tsunami. Above the tank is a display showing the magnitudes of tsunami-causing earthquakes on the Richter scale and the forces they create. In the building across from the entrance, there is a 3D model of the Earth's layers. The layers will accurately represent all of Earth's layers from the crust to the core. On the far wall is a projected image of Kansas City. The visitors will turn a dial to see the different effects an earthquake would have on our city. The projection will show what Kansas City would look like after earthquakes of several different magnitudes. The majority of the exhibits are kept inside to prevent issues with the weather conditions; people can venture outside to get a deeper understanding of a natural disaster's aftermath. There will be a courtyard with a massive globe showing the location of Earth's tectonic plates. This globe will rotate so the visitor can see the entire earth and observe the plate's locations with respect to the continents. In addition to the globe, the courtyard will contain several partially destroyed buildings contribute to the Pompeii theme. When the weather is decent, kids will be able explore these ruins. Walking up the "lava flow" path the visitor will enter the base of *Mt. Tectonic*. Inside the volcano will be several related activities. In the first activity visitors will be able to view different volcano types by pressing a button labeled with a specific volcano type, then a volcano of that type will spew "lava", represented by red water, down its sides. The buttons will be on the volcano control balcony, which is located above the magma chamber that allows visitor to view the volcano types from a new perspective. In *Mt. Tectonic* there will also be a miniature volcano with projections of lava flowing from it. As the visitor draws their finger down the volcano, lava will follow the path they draw. The main attraction of *Mt. Tectonic* will be a magma chamber where the visitors can enter and gain a unique perspective on the inner workings of a volcano by viewing a volcanic eruption while hearing the sounds and feeling the vibrations.

Social Media and Supplemental Materials: Our team designed and developed a website because we believed that it was the most effective and efficient way to educate users on STEM concepts and to advocate the Battle of the Brains competition. A website allows us to interact with the largest amount of people possible, while being informative and educational about STEM concepts involving Earth Science. The website is broken up into easily navigable tabs where users can learn about: our proposal, each team, information on team members, the Battle of the Brains competition, social media pages, Earth Science activities, and educational videos about Earth Science. Users of all age groups can access STEM content, including several games over earthquakes, volcanoes, and tsunamis. The *Stop Disasters* game is a simulation of earthquakes and tsunamis and their effects on cities and coastal areas, where users can prepare for a disaster by building shelters, ocean walls, or even seismic sensors. *Tsunami* is an interactive quiz to help teach users about tsunamis, how to prepare for a tsunami, and why a tsunami happens. *Volcano Explorer* is an educational game in which users can inspect famous volcanic eruptions, look inside and explore a volcano, and even build and simulate their own volcano. Our games while fun and interactive also captivate our younger audience and educate the adults on Earth Science. We have a multitude of informative videos that encompass earthquakes, volcanoes, and tsunamis. These videos vary from explain how volcanoes are formed, to the movement of tectonic plates. Our website can be found at **http://www.naturesfault.com**. Our team created Facebook, Twitter, and Instagram pages to showcase STEM concepts that pertain to Earth Science. Our Twitter page, *Nature's Fault*, exhibits a plethora of insightful videos for the public over geology, meteorology, and oceanology. Likewise, our Facebook page, *Nature's Fault*, shares the same educational videos, but also includes fun quizzes over earthquakes, volcanoes, and tsunamis for our followers to take and share with their friends and families.

Constructability: *Nature's Fault*, while large in size, will effectively use all of the space available within the footprint. While a majority of the exhibits are inside to keep accessible in all weather conditions, people can venture outside to

get a deeper understanding of tectonics. The volcano itself would be built using steel I beams with a painted concrete shell in order to hold up to the elements. Within it the 4D magma chamber movie theater will be created by using seats that move on servo motors to simulate a volcano eruption, along with the projector and screen. We originally had decided to have two floors, but because of safety concerns we made it so that the entire exhibit is on one floor with a small balcony. The volcano control balcony will be accessible via a staircase with railings (appears as ramp in animations). We are aware that this does not fit in ADA regulations and would therefore like to include a wheelchair lift so that everyone would get the full *Mt. Tectonic* experience. Outside the volcano, the Seismic Simulation Shack will have a metal roof that will require minor maintenance. Outside the shack a globe will comprise of a steel structure with a fiberglass epoxy shell to make it weather resistant. The center of this globe will contain lights to illuminate the earth's core. The sample city of Pompeii can easily be constructed of brick to give it a realistic feel while being naturally weatherproof. In our design we have fully utilized the constrained budget to create an exhibit that will be weatherproof, educational, and iconic.

Student Involvement: Our team is a diverse group. Consequently, we had many ideas that were viable throughout the design process, but only some could be implemented. Before our group's trip to Science City, we were set on "EnerTrees," two large trees that would explain different energy concepts. When we visited Science City, we realized that energy is already a prevalent theme. However, Earth Science was nowhere to be found. We noticed some scattered exhibits that explained small aspects of Earth Science such as, flooding, topography, and tornado chambers, but there was nothing that did it justice. We decided to focus on tectonic plates, specifically the disasters caused by them. Besides changing theme, we decided against several other ideas for interior exhibits. One of these was having individual "shacks" for natural disasters: landslides, tsunamis, earthquakes, and hurricanes. The team dismissed this due to lack of space, budget, and maintenance. Another idea that was dismissed was having an entire volcano on the pad. The issues with this were the slope would not be accurate, and the volcano would not have been tall enough to be iconic or interactive, as there would not have been sufficient interior space. Lastly, we omitted having a liquid simulating a lava flow that could be piped and recycled up through the volcano because it simply would not work with the outdoor constraint. Something of that viscosity would likely be molasses or sugar based, and therefore attract animals and insects. While brainstorming, we used the internet, online databases, and scholarly articles. *Nature's Fault* is directly related to STEM careers as it pertains to the scientists who study natural disasters and the engineers who deal with them. The scientists include Vulcanists, Seismologists , and Oceanographers, and the engineers include Civil Engineers and Environmental Engineers. Our design is truly a STEMfest!

Budget:

Item Name	Qty	Price per Item	Final Cost	Item Description
Volcano				
Steel Plates 1/4"	12,644 sqft	$3.25	$41,093	Structure for Volcano
Steel I Beams	50,000 lbs	$.95 per lbs	$47,500	Structure for Volcano
Paint	16000 sqft	$1	$16,000	Cosmetics
Lights	10	$25 /per roll	$250	16.4 ft roll of weatherproof LEDs
A. Volcano Varieties				
Mini Volcano Displays	6	$1,000	$6,000	Showcases different types of volcanos
Controls	6	$60	$360	Buttons that control the volcano's explosion
Pumps	4	$100	$400	To simulate the volcano explosion
Wooden Posts	6	$16.97	$102	4 in. x 4 in. x 6ft.
Rope	1 roll	$55	$55	1 in. thick 70 ft. long
B. Volcano Simulator (magma chamber)				

Shaker seats	3	$8,000	$24,000	4D simulation of volcano eruption
Projector	1	$1,600	$1,600	Displaying the process of a volcano
Screen	1	$500	$500	Displaying the process of a volcano
C. Volcano Tracer				
Mini Volcano Display	1	$1,000	$1,000	Showcases lava flow down a volcano
Kinect Sensor	1	$150	$150	Senses where the user wants lava to flow
Seismic Simulation Shack				
Building	1	$43.66 /SF	$65,000	Cost for the structure
TV Monitors	4	$400	$1,600	TV Monitors that explain tectonic plates
Destruction Junction Table	3	$1,000	$3,000	Visual representation of the effects of earthquakes
Tsunami Generator Tank	1	$4,000	$4,000	Visual representation of the development of tsunamis
KC Mural TV	1	$800	$800	Visual representation of the effects of earthquakes
Model of Earth's Layers	1	$2,200	$2,200	Visual representation of the structure of the earth
Metal Roofing	12	$125	$1500	Buildings Roofing
Outside the Volcano				
Brick	2000	$70.25	$1400	Buildings to show the effects of natural disasters
Globe	1	$9,700	$9,700	10 ft. diameter sphere
TOTAL:			$228,210	

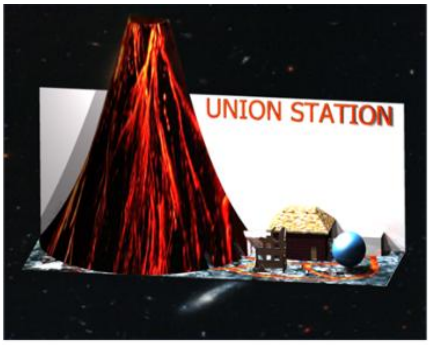

Fig 1: Overall view of Exhibit

Fig 2: View of inside of volcano

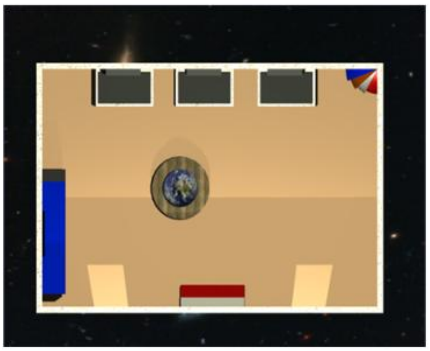

Fig 3: Bird's-eye view of tectonics building

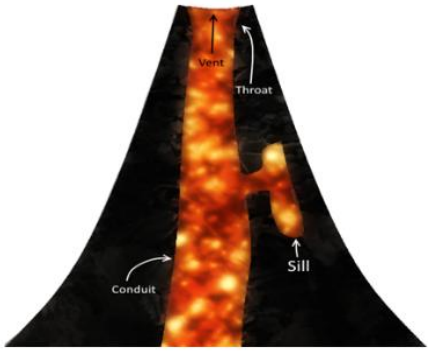

Fig 4: Cross-sectioned view of volcano