# Kentucky St. Fence Rebuild: Planning, 3-D Modeling, & Philanthropic Construction

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A residential fence estimate, design, and rebuild was completed by Michael Cerone and Andrew Shafer, two Cal Poly San Luis Obispo Construction Management (CM) students for an elderly member of the local San Luis Obispo (SLO) community. The beneficiary lives on Kentucky St. near Cerone and has been living in San Luis Obispo for 30 years. The reconstruction idea came about when Cerone noticed her existing fence was extremely worn and damaged. Cerone suggested that he and Shafer could build her a new fence, free of charge. The beneficiary stated she could not afford to get a new one built professionally, a cost-free reconstruction was very appealing. The full scope of the project included conceptual estimates, computerized design, and construction, painting of the fence, and landscaping around the new fence. Funding for the project was secured by Labdesign, a Bay Area lab equipment installation company run by the parents of two Cal Poly alumni. Several logistical issues were encountered by the builders when constructing the fence, but they ultimately provided a high quality finished project. The completed construction made the beneficiary ecstatic, as well as providing rewarding learning experiences about construction processes and variability to the builders.

**Key Words:** Fence, Rebuild, Design, Construction, Residential

## Introduction

### *How the Project Came About*

The idea for a fence rebuild senior project came about when the two builders, Michael Cerone and Andrew Shafer, determined that they wanted to gain more real-life construction experience beyond the scope of their Construction Management (CM) classes at Cal Poly. Not only this, but the constructors also wanted to complete a project where they could see the direct results and philanthropic value to a local community member as opposed to a research paper that may not ever

serve any long-term benefit to others. When brainstorming ideas for a project, Cerone and Shafer started to hit a wall and could not come up with any potential beneficiaries to complete a project for.

However, one day Cerone was walking home and noticed an elderly member of the San Luis Obispo (SLO) community who lives on his street outside of her home adjacent to an extremely worn and damaged looking fence as seen in Figure 1 below. Cerone had seen this woman gardening in her front yard frequently when walking home from his Cal Poly CM classes.


Figure 1. Existing fence nearly falling over

Cerone then proceeded to approach the woman and introduce himself. He stated that Shafer and himself were looking for a member of the community who could benefit from a potential fence rebuild. As Shafer had built a fence with his father in the past, he had some pre-existing knowledge of how to complete such a project. The future beneficiary of the project stated she had wanted a new fence for a while but did not have the financial means to pay someone to build her a new one. Cerone then suggested to her the idea of a new fence rebuild that would be completed by himself and Shafer free of charge in order to help her get a new, quality fence as well as fulfilling their senior project requirements at Cal Poly. The beneficiary immediately jumped on the opportunity and said she feeling very grateful and blessed that Cerone had approached her with such a proposition.

## *Securing Funding*

Now that the builders had confirmed the project with the beneficiary, the next step was a crucial one: securing funding. Since the beneficiary could not afford a new fence rebuild, as well as the required philanthropic value associated with the project, the builders knew they had to find another source for funding outside of themselves. Cerone then reached out to family friends Linda Witkop and Matt Witkop, owners of the very lucrative Bay Area lab equipment installation company known as Labdesign, to ask them if they would be willing to provide funding for this project. The Witkop's agreed to make the donation for funding up to $1,500.00, giving the builders the financial parameters

for the fence rebuild. The approximately $450.00 of the $1,500.00 donation that were unused were then be returned to Labdesign by Cerone. After confirming the source of funding and how the fence rebuild could be turned into a group project through talks with Phil Barlow, Cal Poly Senior Project Director, the project was set and motion and the pre-construction phase began.

### *Property Survey*

The final step before beginning demo and starting to build the fence was to ensure that the new fence would be within the existing property lines. Although the builders were certain that the new fence would be within the property boundaries as they were building over the existing fence, they still wanted be diligent and confirm this was the case. Initially, Cerone and Shafer planned on using existing landmarks in the street and using a total station to survey the property lines. However, the beneficiary had existing property surveys done by an official agency just a few years prior and Cerone was able to use these surveys to determine whether or not her existing fence was still within her property footprint. Using the property survey to identify the benchmarks in the street on the property survey plan to see where her property lines were, it was then determined that the fence would clearly be within the beneficiary's property line as the fence would be built on the existing fence's footprint.

## Deliverables

### *3D Modeling*

Both builders then turned the estimate into two different conceptual 3D models to display to the beneficiary what the new fence would potentially look like. These models were created using the Building Information Modeling (BIM) software known as Archicad. This particular type of BIM was utilized due to its ability to display very realistic 3D renderings of different building systems that allow for maximum customization and accuracy of design. Shafer created a model that closely resembled the existing fence, and Cerone created a new design for beneficiary consideration.

Through online research, Cerone found different picket fence styles to consider and took measurements of lengths/heights of fence sections (6 foot height with approximately 30 feet of length), distances between posts, rail sizes, picket widths, etc. on the existing fence footprint in order to create a new, "low cost" model for a possible new fence design. This model includes callouts of each material and how they will be connected. The model consisted of 4x4 pressure treated lumber posts with (2) 2x4 Douglas Fir rails for 5.5", pointed-top pickets to be attached to. This model differed from the original fence design, which included notched picket tops and (4) 2x4 Douglass Fir rails, with one of the rails being placed horizontally at the top.

Since her deceased husband was a contractor, the beneficiary has immense knowledge and interest in residential construction and she wanted to be very involved in the process. So, Shafer and Cerone reviewed the designs with her to get her input. The beneficiary was very impressed by the level of detail that went into the models and liked the designs the builders had come up with. However, since Cerone's design did not match the existing fence they were connecting to, the beneficiary ultimately requested that they use the design Shafer created as it closer resembled the existing fence in order to maintain the aesthetic appeal and keep the cost as low as possible to leave room for potential cost overruns. Also, Shafer's design included more rails which would make the fence sturdier as this was another goal of the beneficiary's for her new fence. Details of Cerone's model can be seen in Figure 2 on the following page.

### *Estimate*

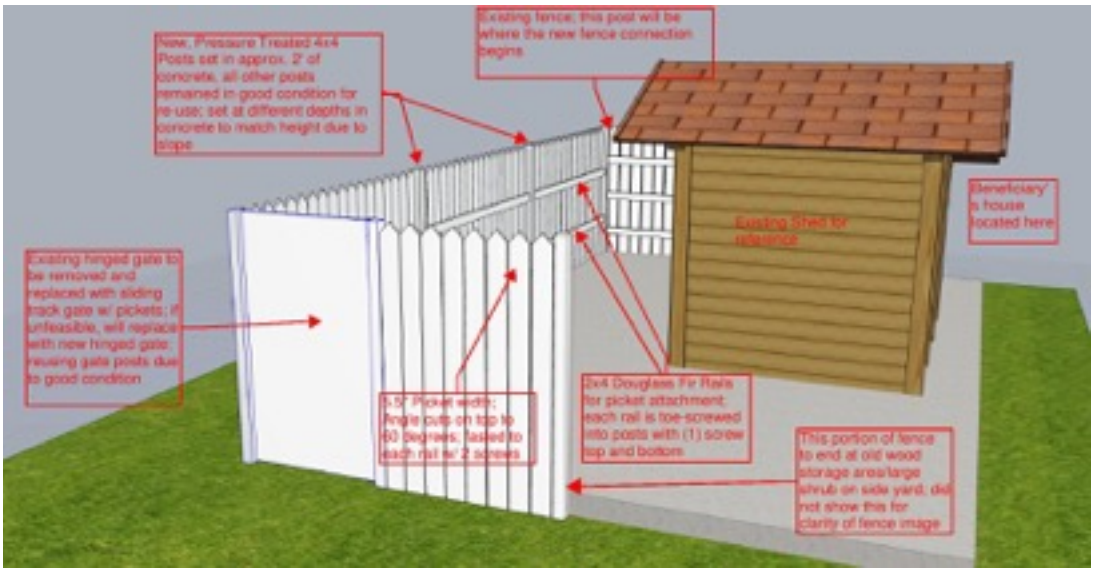


Figure 2. Cerone's "Low Cost" Conceptual 3D Model for possible new fence design

The builders then chose Shafer's model per the beneficiary's request and turned it into a conceptual estimate through utilization of online research and knowledge obtained from previously completed CM courses at Cal Poly. Due to his pre-existing knowledge in fence construction firm building one prior, Shafer spearheaded the efforts to create a realistic fence estimate using Home Depot material prices within the $1,500.00 donation budget and ultimately came up with an estimated cost around $800.00. With repurchasing of materials and added expenses, the final costs came out to about $950.00.

## Construction Process

### *Demo*

To begin the construction of the fence, the builders' first step was to take down the existing fence. Out of the beneficiary's and the builders' desire to keep the fence as cheap as possible to stay within Labdesign's donation limit, it was decided that reusing posts from the existing fence that remained in good condition would be a great way to implement value engineering. So, it was decided that the posts connecting to the gate would be reused, but all other posts except one would be removed and replaced with new ones for a total of two new posts. The old fence was then cautiously demoed using framing hammers and crowbars for the top rails, a drill to remove screws for the pickets, and a monkey wrench to remove the gate hardware to prevent any damage to the surrounding garden.

As they did not have a jackhammer, Shafer and Cerone had to dig holes around the two existing concrete post piers that were to be removed in order to wedge the piers out of the ground. The builders also had to be very careful not to damage the existing posts that were to be reused, so demo had to be done in a very controlled manner. The first step was removing the pickets, then removing the top middle and bottom rails, and then finally removing the posts and existing concrete piers. After the fence was demoed, Cerone and Shafer took the scrap wood and concrete piers to be stored at Shafer's home in SLO.

## *Piers & Posts*

The first step to building the fence was to mix, pour, and set concrete into approximately 24” deep by 24” wide circular holes for the new 4x4, 8’ tall pressure treated posts to be set in. The holes were dug using shovels, and shaping the holes was difficult as the constructor of the existing fence made his piers significantly different sizes. Backfilling methods were utilized in order to make the two holes even for the posts to sit in properly. For the hole that required backfilling, the builders opted to use a Sonotube to ensure the posts would be properly poured to the right shape. Before adding concrete into the holes, 3” of gravel was poured to allow for drainage. Once the concrete was mixed, it was poured into the holes and troweled using pieces of rebar that were purchased at home depot. Once the concrete was poured, the 8’ posts were set into the concrete.

To ensure the new posts lined up with the existing posts, that the fence would be level across the top, and run in a perfectly straight line, the builders used leveling string to keep the posts in line. A level was then used at the top of the posts to ensure each post was level. Since there is a slope to the grade that the fence is being built on, the post higher up the slope of the hill was set a few inches deeper in order to match heights with the other post that had been set at a lower elevation of the slope. The posts after being set and leveled can be seen below in Figure 3. After the posts were set, the concrete hardened and the holes were then backfilled with native soil to hide the piers below grade as well as filling in the holes for the posts.

Figure 3. New posts set in concrete and completing leveling process

## *Rails*

Once the posts had been set in the concrete and the concrete piers cured and hardened, the builders’ next step was to place to top, bottom, and middle rails for the pickets to be attached to, as well as a

horizontally placed top rail capping off the posts. To do this, a leveling line was pulled from the existing fence section to the existing gate post along the fence section parallel to the street to ensure that the 2x4 rails would be in a perfectly linear fashion from post to post. After this, measurements were taken from post to post to ensure that the middle and bottom rails properly fit within the posts without bowing because they fit too snug or having exposed screws from not fitting tight enough. For the horizontally placed top rails, the measurement was taken from the center of each post that are to be connected to ensure that the top of the fence looks to be fully continuous.

Once the rails were appropriately fit between the posts, they were toe-screwed into the posts using 1 screw at top and bottom of each 2x4. First, the top screws were drilled in one side at a time and checked with a level to ensure that the rail was level with the posts. After this was confirmed, the bottom screws were toe-screwed in. This process was repeated for all 4 bays of fencing to be built (excluding the section for the gate) and once this step was completed the rails and posts were painted with two coats of primer followed by a finish painting of two coats of high-quality, white paint.

## *Pickets*

Figure 4. Pickets preparing for attachment to rails, both fully painted

Completion of construction and painting of the rails and posts was followed by the installation of the pickets. Notched-top, 6’ tall, 5.5” wide pickets were used for this project. Each picket was secured to the top, middle, and bottom rails using 2 screws going into each rail through the pickets; they were also to be fully primed and painted (two coats of each) as seen in Figure 4 above before attachment to the rails. This would ensure they were fully covered in paint as the edges would not be able to be reached with a paintbrush once they were attached to the fence frame.

Once attached, touch-up paint was used to cover the screws to make them less visible on the pickets. In order to determine how high the pickets were to stick out over the top rail, a level was used to guide the heights of the new fence pickets to the tops of the existing fences pickets to ensure they were at the same height to avoid any unappealing appearance.

Due to the previously mentioned slope of the grade, the 6’ tall pickets fit perfectly without needing the length to be cut down for the vast majority of the first bay that connects to the existing fence.

However, once the slope began to get more significant, the 6’ pickets needed to start having the length cut down with Shafer’s circular saw in order to keep the pickets’ bottoms even with one another. To determine the lengths required to be cut off the pickets, a measurement was taken from the top of the notched picket that was already in place to the top of the picket that was to be placed adjacent. This distance was then cut off the length of the picket to ensure that both the tops and bottoms of the pickets lined up. This process was repeated for all four bays requiring new pickets.

The last picket that was to be placed on the fence section parallel to the street and the section perpendicular to the street ended up slightly extending beyond their respective posts by about 3/4” to an inch. To remedy this problem, the builders used a table saw to make rip cuts down the pickets and then matching the angle of the notch on the pickets. This allowed these picket to fit perfectly flush with their respective end posts, while still maintaining the aesthetic appeal. Since it was hardly noticeable that one picket was thinner than the others, this appeared to be the best solution.

## *Gate*

The last remaining structural task of the fence after complete installation and painting of the pickets was to install the gate. The builders originally opted to provide the beneficiary with a new, sliding gate that rested on a track. However, due to some low quality construction she had received in the past, a sliding gate was not able to be put in because of existing site conditions (that will be discussed later) and the beneficiary opted to keep the existing hinged frame style instead. Since the existing gate frame was old and worn, the builders purchased a new hinged gate frame identical to the beneficiary’s old one. With this frame, three 2x4s were installed into mounts within the gate to provide a surface for the gate pickets to be attached to in the same fashion as the rails on the fence. These 2x4s were first fully primed and painted with 2 coats of each, and then securely fastened into the gate frame mounts with screws as seen in Figure 5 below.

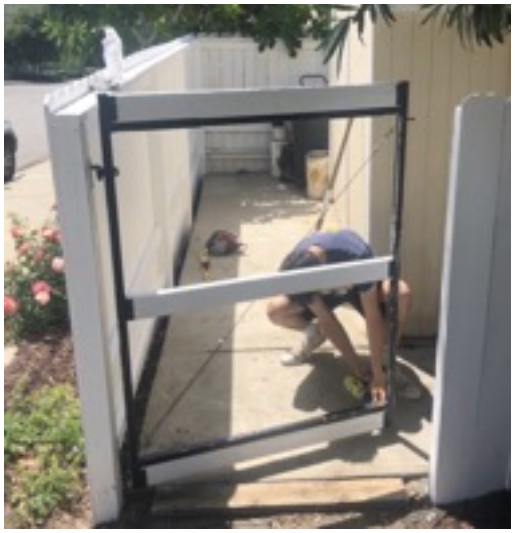

Figure 5. Gate frame with rails installed, no picket attachment yet

After the gate frame 2x4s were placed and new screws were provided for the existing gate hardware, the pickets were then ready to be attached. Before putting them on the gate frame, the pickets needed to be cut to match the height of the fence sections that were built adjacent to the gate. After these cuts were made with Shafer's circular saw, the pickets were then fully primed and painted before being attached to the frame in order to minimize the amount of paint that would get on the existing black metal gate frame. Once painted, they were then screwed into each of the 2x4s on the gate frame with two screws on each 2x4, identically to the way the pickets were attached to the normal fence.

As was the case with two of the pickets on the actual fence itself, one of the gate pickets needed to be trimmed to fit between the posts. The same method of using a table saw to make a rip cut was employed, and the angles of the notches were constructed to match. This allowed the pickets to fit perfectly on the frame, with very minimal reduction in aesthetic appeal. Once all of the pickets were properly secured to the gate frame and it was ensured that the gate would properly close, a new lock was installed on the post to match the gate fame color and replace the old broken one.

## *Final Clean & Close-Out*

After completion of the gate construction the fence was then entirely finished including painting, leaving only a final cleaning of the job site remaining. There was an extensive amount of paint required for the fence, and the builders had made a decent sized mess on the surrounding concrete with paint splatter even after putting tarps down. To remedy this, a power washer was used to rid the concrete of any spilled paint, as well as cleaning the new and existing fences. For the concrete, the power washer was used at a very high setting to make sure all the paint came off the ground to keep the beneficiary's side yard looking nice. For the fences, a lighter setting was used to clear off any dirt, dust, etc. from the fences as an added bonus. The completed fence can be seen in Figure 6 below.

Figure 6: Finished fence including painting and gate

Paint had also gotten onto the black metal hardware for the gate frame, making it look very unprofessional. To remove this paint, the builders used paint thinner and brushes to scrub off all of the white paint from this hardware. The final step to clean-up was removing debris from the beneficiary's garden and providing new mulch for her garden as an added bonus. The beneficiary was extremely pleased with the quality of the finished project and unexpected bonuses of power washing and landscaping, and stated that she could not be more grateful and appreciative for Shafer and Cerone providing her with a new fence free of charge.

## Project Issues & Lessons Learned

### *Building On a Slope*

Although the builders successfully completed a high quality fence for their beneficiary, this project did not come without a variety of obstacles that provided the builders with new construction knowledge. One big challenge for the builders when constructing the beneficiary's new fence was accounting for the slope of the grade that the fence section parallel to the street was to be built on. From the beginning of the fence where it attaches to the existing fence, the grade is about 8" lower than the other end where the fence attaches to the existing gate post. This presented the builders with a unique situation, as the slope was not great enough to stagger the fence height in a way that would be aesthetically pleasing, nor was this what the beneficiary particularly wanted to have as it would not match the existing fence.

To adjust for the slope, the builders had to be very careful to use leveling lines and a leveling tool to make sure that they did not accidentally slope the fence up or down along this section; the goal was a straight line that is perfectly level from post to post. The level line extended from the existing fence post to the existing gate post, and the tops of the posts were lined up with this string. To make the new posts line up in height, one of the posts was set slightly deeper in concrete. Once the posts were lined up, it was much easier for the rails to be placed level and in a straight line since the builders had ensured the posts were at the same heights.

As one who had never constructed a fence before, building on a slope was a very new and intimidating challenge for Cerone. Despite having experience working with wood to complete the construction of a shed in a residential construction course at Cal Poly, building on a slope was a whole new beast. Shafer and Cerone had to come up with this method that could allow for a level fence that accounts for the slope without creating a skewed appearance of the fence. Previously mentioned, similar issues were encountered with the pickets but remedied by trimming the picket heights to keep the top of the notches on the pickets at the same height above the fence.

### *"Measure Twice, Cut Once"*

Another lesson that Shafer and Cerone learned was the old saying heard in their residential construction class with Eric Brinkman stating to: "measure twice, cut once". Essentially, this means that you should always double check your measurements for lumber to ensure that you only need to make one cut at the right size. This prevents one from cutting the lumber too short and needing to get a new piece of wood and running up the costs, or not cutting the timber too long and having to spend extra time re-cutting. Although they had learned this lesson before, without a teacher/supervisor or more people helping them build the fence, these small errors were easier for the builders to miss.

When construction the rails for the pickets to attach to on the fence, the builders made sure to measure precisely when determining the measurements for the cuts to be made with a saw. However, despite their best efforts, the builders unfortunately cut several different 2x4 members too short, and had to spend extra time and money going to Home Depot to replace the wood. Similar issues also happened when adjusting the picket heights which also required the repurchasing of some pickets that had been improperly cut due to measurement error. After making this mistake early on, Cerone and Shafer made sure that this would never happen again by always double, and even triple checking their measurements to avoid wasting material, money and time.

## *Drawbacks of Wood*

Despite gaining extensive knowledge in wood construction pros and cons in various Cal Poly CM classes, the builders learned a lot of lessons about using wood as a material throughout this project. For starters, a huge issue plaguing the project was the rainy season in SLO and the amount of water than was being retained in the lumber during storage. When purchasing the wood from Home Depot, the builders realized that all of the wood they were purchasing was completely water logged. This required them to let the wood dry for a day or 2 before they wanted to start building with it.

However, after the wood dried, Cerone and Shafer noticed that many of the members had begun to bow and/or warp, especially the pickets. Although the two had learned to account for this in residential construction, the physical act of knowing how long to wait for the wood to dry, how to store it properly, etc. were practical applications that the builders were not fully prepared for. This was not a huge a huge issue at first, but as the wood began to lay out in storage in the beneficiary's side yard, the bowing got even worse for some of the pickets. These members then had to be replaced as well, which ultimately upped the cost of the project. When getting the new wood, the builders learned to make sure they were storing the wood in a perfectly flat area without too many members stacking on one another to prevent any future warping. This helped them in ensuring that the re-purchased wood would not have the same issues as the members that had to be replaced in the first place.

## *Unexpected Circumstances*

Throughout the project, the builders also learned how to handle unexpected site conditions. When originally opting to put in a sliding gate on the beneficiary's fence, it was observed that the surrounding concrete and asphalt was poured in a manner that would not allow for this without doing extreme, precise demo with a jackhammer. As learned in residential construction courses at Cal Poly and through talks with subject matter expert (SME), Eric Brinkman, the builders knew that if their work remained within the property lines and solely consisted of a new fence, then a permit was not required from the city to build this. However, the asphalt that was incorrectly poured would potentially impact the road, and therefore require the builders to obtain permits and deal with various issues surrounding the city of SLO. Even if this asphalt was able to be removed without obstructing the road, it would leave a very unappealing, exposed area around the fence that the builders were not equipped to handle. This was also a primary reason for keeping the well-conditioned existing gate post parallel to the street.

Not only were there unexpected site conditions, but shortly after beginning demo on the fence, the state of California was put into a shelter-in-place order due to the COVID-19 virus, with tickets being given to anyone gathering in public. This delayed the project and resulted in the builders being forced to leave the beneficiary with a completely demoed fence for almost two weeks as it was not permitted by law to be outside working. As an elderly member of the community, the beneficiary is an extremely at-risk person for contracting the COVID-19 virus and the builders could no longer

interface with her in person which took away much of the collaborative and rewarding elements of the project. This also showed the builders a real-life example from their commercial construction course at Cal Poly of a force majeure situation that completely halts a construction project. By seeing this, the builders realized there project was effected drastically and this put into perspective the damage that this virus must have done to large-scale, commercial projects.

Due to COVID-19 restrictions and unexpected site conditions, the builders had to learn how to adapt. This taught the builders how to work with what they can and have available to still complete their intended scope of work as best they can. These conditions encouraged creativity as well as value engineering to re-use existing pieces of the original fence when required. Even though a construction project may not go according to plan in all aspects, that it is still very possible to create a high quality finished product no matter the circumstances if you think critically and get creative; this is a skill that the builders will remember to use throughout the entirety of their construction careers.