



HU 3910-D05

Replica Les Paul Guitar Build

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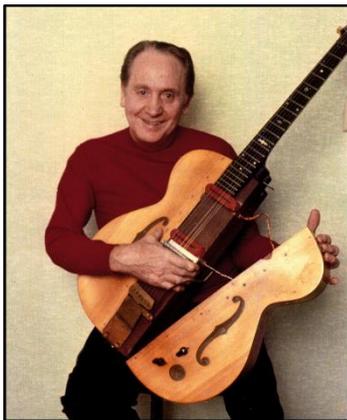
Submitted for the approval from:
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Background

Les Paul

Prior to the creation of the electric guitar, musicians had to stand in front of microphones to amplify sounds. Les Paul wanted to integrate these electronics to create a purer sound during amplification. With his creation of the Log and solid body guitar, he would later use this technology to create 8-track recording.

The Rail & the Log



The idea of an electric guitar started from Les Paul trying to amplify the sound of an acoustic guitar with a microphone. To do this, he created “The Rail”. It was a section of rail from a train track. A guitar string was strung over the railroad spikes and a microphone was played near the string. The log was a larger, more guitar like Rail. The Log is comprised of a 4”x4” piece of pine with modified acoustic guitar parts. Les worked in an Epiphone guitar factory used an Epiphone Broadway guitar neck and body in his design. Using a homemade bridge and pickups, he was successfully able to replicate the microphone using a few magnets, wire, capacitors, and resistors. To make the Log look

more guitar-like, he added the body of an acoustic guitar as removable “wings”. To conceal the electronics, they were placed in the lower wing¹.

From Old to New

The Log was the first version of the solid body electric guitar. This design later became the solid body guitar and was produced by Gibson. In the original design of the Log, a few parts were modified acoustic parts, and some were



¹Les Paul Foundation. (n.d.). The Electric Guitar - Les Paul.

homemade. For our design, we wished to use pre-build components and simply integrated them into our design. In the list below, the parts are listed along with their functions and important specifications².

- Pick-ups
 - Magnets that are wrapped in copper wire, creating a magnetic field. A two pickup guitar detects the change in the magnetic field (flux) and uses this signal as the basis for the sound.
 - There are different styles of pickups and we had difficulty determining which to use. p90s were suggested by our advisor.
- Bridge
 - This variable bridge gave us the freedom to shift our string spacing as we found other parts.
 - The tailpiece was our determining piece.
- Tailpiece
 - This trapeze tailpiece perfectly matches what the original long had.
 - Ours has a string spacing of 2 1/8”.
- Body
 - To make an authentic looking Log, we purchased a used archtop guitar.
- Neck
 - This neck was suggested to us from our sponsor for its high authenticity.
- String tuners
 - These tuners were chosen to match our peg head.
 - These are 3x3 individual tuners designed to be separate from one another.
- Wires
 - Connects the pickups to the hardware.
 - Hardware included one capacitor and two potentiometers (knobs) and 1 output jack.

² Long, N. (2017, February 14). Listen to Les, Part 1: The Gibson "Les Paul".

Methodology

Purchasing Parts

Our first thought was to purchase a guitar kit from an online vendor. This would solve two issues; 1) all the pieces we would need, would be included in this kit. The kit we investigated had two pickups and one set of tone and volume knobs, with one toggle switch and 2) With the right kit, we could find era appropriate pieces. The kit we looked into was a replica 1950's solid-body archtop electric guitar.

After some discussion with our advisor and sponsor, we agreed more authentic pieces could be found, and for a better bargain. Thus, began the hunt for individual components. A list of components and their specific names can be seen in a table below.

<u>Piece</u>	<u>Name</u>
Pick-ups	Epiphone Les Paul Special I P90 Pickups 2020 Black
Bridge	Archtop Guitar Bridge
Tailpiece	Kay Archtop Guitar Tailpiece - 4" Short Trapeze - 1940's 1950's Harmony Regal
Body	Silvertone Archtop Acoustic Guitar Body
Neck	NECK LPse Gloss Black Trap Inlay Maple / Rosewood Black Binding 22 Frets 24.75 Scale 12" Radius
String tuners	Economy Open Gear 3+3 Tuners
Neck Plate	Epiphone Steel Neck Plate + Screws
Wiring	Wiring Kit for 2-pickups with Toggle Switch

These pieces were secured used two online vendors. There was a combination of new and used parts. Pieces like the guitar body, tailpiece, and pick-ups were purchased used because they will be altered to make our Log more authentic. Other pieces like the wiring kit and bridge were purchased new to ensure their integrity. Once all the pieces were assembled, they needed to be measured to ensure accurate designs and schematics.

Drafting & Designing

This 24 fret, 24.75" scale length Gibson neck was our quintessential part, so everything had to be based on that. The distance from the 12th fret (middle) to the nut had to be the same distance as the 12th fret to the bridge. Once this condition was met, the other



pieces could be determined about that. Additionally, the neck pocket had to be cut into the Log. The neck base was measured, and the correct cuts were made into the Log base, with predrilled holes for the back plate. This neck uses mounting screws to secure it to the body, so the screw holes needed to be sized, and they're location on the neck needed to be spaced out.

All pieces were individually measured so our scale length would be accurate. A complete list of parts and their dimensions can be seen in Appendix 2. From the pictures of Les Paul holding his Log, as seen above, we determined the distance between the bridge and the tailpiece, the spacing between the two pickups, and the buffers between the bridge and lower pickup and the neck and the neck bridge.

Building

Our greatest challenge was assembling all the pieces and building our Log. There were several steps involved, and some had to be chronologically. In this section, we discuss how pieces were mounted, cuts needed, component placement, and notable comments. Due to the amounts of steps, this section will be a combination of bulleted lists, long descriptions, and pictures.

First task was to cut the Log body to length and shape:



- Our archtop body is 20” long so, the Log was cut to match. Cut was made using a 6” blade on a table saw.
- Next was the neck pocket. The neck was measured, and a pocket was chiseled out of the Log to match.
- For a smoother finish, all faces, edges, and corners were sanded with 80 grit and 120 grit sandpaper.

Second task was to cut body and add accommodations to fit mounting pieces and circuits:

- Tape placed around body to protect finish from the saw and to prevent splitting the finish from the blade. Tape also made guideline easy to see.
- Body cuts were made based on where the original neck was straight down the length of the body.
- Body is thin and is comprised of layered wood. To prevent cutting and splitters, the edges were sanded and rounded.
- 4 holes were drilled into the bottom wing so the hardware can have external access (control knobs, toggle switch, and output jack).

Third task was to correctly place the pickups in relation to each other and their respective components:

- Relief holes were drilled into Log to accommodate bottom screws.
- Small cut made on the side for wire to flow uninterrupted from pickup to hardware.

Fourth task was to assemble wiring and place it into the removeable wing piece



- Mocked up circuit on cardboard according to diagram³.
- Soldered connections.
- System was then moved and mounted on body.

Fifth was the neck.



- Bushings were placed in peg holes and secured with gaff tape
 - Holes are non-standard size, so they move around
- Tuners were placed in bushings and were secured to the back of the peg head

³ Steward-MacDonald. (n.d.). Metric 3-way Toggle Switch.

- On the base of the neck, 4 holes were drilled for the neck plate screws

- Attaching Items
 - Tailpiece was centered and mounted using provided screws
 - Bridge was placed according to our 24.75" scale length
 - Neck secured to the Log using the 4 neck screws.
 - Screws function more like pins: holes were made in the Log so the screwheads can rest inside the Log. Tension from strings keep the neck in place.
 - Wings secured using Velcro strips.

Results



Overall, our project went better than anticipated, as we were able to deliver a complete guitar. Of course, this term presented challenges within themselves with the orders of social distancing, but we were able to work around it. Lauren was able to get most of the parts delivered to her house, where she took most of the

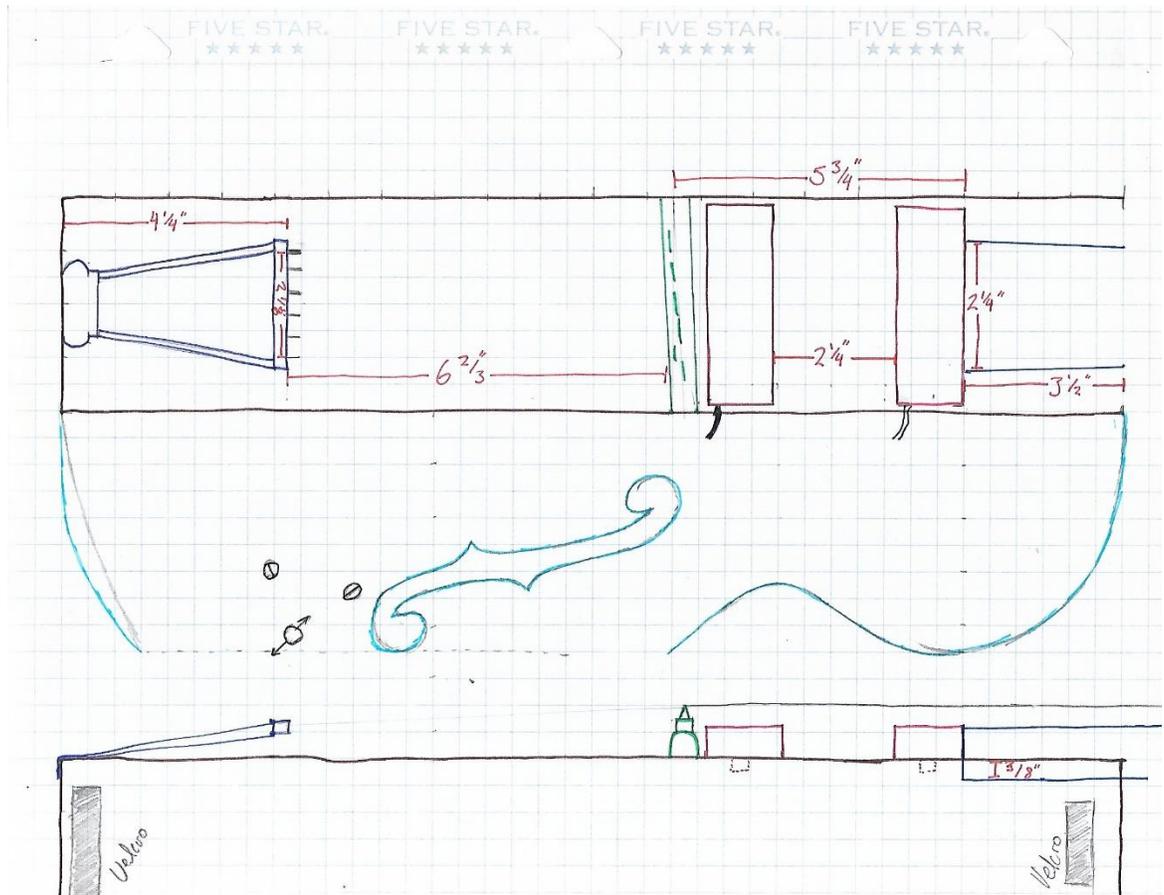
measurements. We were both able to meet up and exchange parts. Ryan was able to get the archtop body cut in half with the help of his Grandfather. After that, it was mostly a matter of drilling holes and cutting notches into the 4x4 log piece. We ran into some trouble with attaching the neck. The neck pocket had to be cut using a hammer and chisel because we did not have the tools to make this cut correctly. Also, the log piece was too tall for any screw to attach the neck to the neck pocket, so we had to improvise. What we ended up doing was cutting in notches into the neck pocket so that the screws could almost sit in place. We also had the problem of wiring the circuitry for the guitar as neither of us had a soldering iron nor have we really soldered much before. Lauren was able to get an iron and try her hand at wiring the volume and tone knobs to the pickups. Ryan was then able to finalize the guitar by attaching the final pieces of the pickups, bridge, etc. to the Log body. He then strung it up and we finally had an actual guitar.

Conclusions

Although this project is done, there is still a lot of room for improvement. As said before in the results section, our neck is not entirely secure. When tuning the guitar, Ryan noticed that the neck would lift to an unfavorable angle because the neck is only secured by pins. The neck also sits crookedly in the pocket, so the strings don't sit perfectly over pickups. This is probably since the cut we made for the pocket was made using a hammer and chisel. Going forward, another team might want to use another 4x4 for the Log piece and make more accurate cuts with the proper tools. The tailpiece is slightly bent so that also makes the angle of the strings awkward. The bridge is a bit too long, so the feet are poking out the side of the Log and rubbing against the body, which in turn loosens the Velcro bonding that keeps the wings attached to the Log. This can be addressed by getting a more appropriately sized bridge. Another problem, that could be addressed was that the tuner bushings are incorrect. This is because the peg holes are non-standard size, making the tuners fit incorrectly. This can be fixed by getting different tuner bushings. Another thing that a team in A-term should think about is about the wiring of the guitar. This is because neither of us had an amplifier to use to plug into the guitar to be able to test if it would work. This is something that a team in the future might be able to work on and make sure works if they have the tools.

Appendices

Appendix I: Blueprint of Log body



Appendix II: Measurements of Components

Pickup

	Inches
Length	1 1/4
Width	3 1/4
Height	5/8



Bridge

	Inches
Length	5 3/8
Length of foot	1 5/8
Width	1/2
Height	1



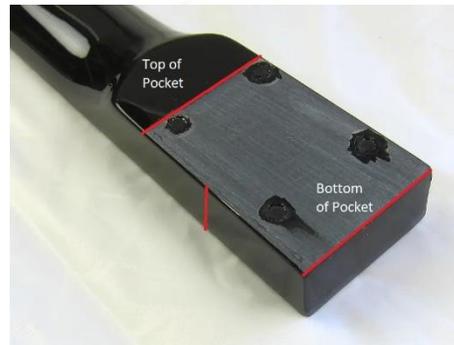
Tailpiece

	Inches
Length	4 ¼
Width	2 ¾
String Spacing	2 ⅛
Base width	2 ¾
Height	2



Neck

	Inches
Length	18 ¼
12 th fret to base	6 ½
12 th fret to head	12 ¼
Length of pocket	4
Width	
Nut	1 ⅝
Top of neck pocket	1 ¼
Bottom of neck pocket	2 ¼
Height	
Neck pocket	1
Screws	
Hole size	½
Width apart	1 ⅜
Length apart	1 ¼



Body

	Inches
Length	20 in
Width	
Bottom bulge	15 ¼ in
Top bulge	11 ⅛ in
Height	3 ⅝ in

