

A black and white photograph of a guitar neck. The image shows the fretboard with strings running diagonally from the top left towards the bottom right. A metal plate, likely a bridge plate or a reinforcement plate, is visible across the middle of the neck. The plate has several circular holes and is secured with screws. The background is dark and out of focus, emphasizing the guitar components.

Component Analysis Wooden Guitar Neck

Grzegorz Borkowski (P151794)

Materials & Manufacturing - Assignment 2

Table of Contents

1.	Introduction	3
2.	Wooden guitar neck – component analysis	3
2.1	Materials used and construction	4
2.2	The manufacturing process	5
3.	Alternative solutions	
3.1	Alternative materials	7
3.2	New manufacturing processes	9
4.	Conclusion	10
5.	Bibliography	11

1. Introduction

Guitar necks have traditionally been made from wood. The 6-string guitar neck, as we know it today, have appeared in 17th century and the first electric guitar neck was made in 1931. The history of string instruments, with wooden necks, however, can be traced back over 4000 years.

2. Wooden guitar neck – component analysis

A typical electric guitar wooden neck is shown on *fig. 1*

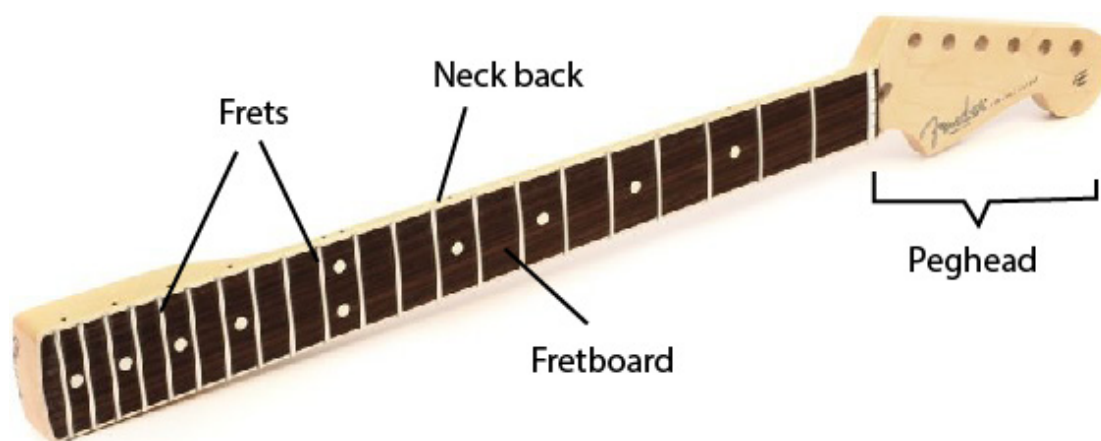


Fig. 1 Electric guitar neck

2.1 Materials used and construction

Materials used:

Most guitar necks are made of mahogany or maple wood. Less popular types of wood used for manufacturing guitar necks include: afromosia, bocote, ebony, bubinga, canary, cocobolo, goncalo alves, imbuia, koa, korina, limba, padouk, pau ferro, purpleheart, satine, walnut, wenge and ziricote. These are hardwoods, most of them being exotic and rare.

The guitar neck has to withstand high tension of the strings, which depending on the gauge of the strings, ranges from 85 to 150 lbs for electric guitars. Of the two most frequently used, maple wood scores higher on Janka hardness test, therefore it is more resistant to tear and wear. Maple is also less prone to be tonal changes and warping caused by shifts in humidity, therefore it is a better choice for stage performance than mahogany.

Choosing wood for guitar neck is not only the question of wood hardness to handle the tension applied by the strings. Different level of wood stiffness affects string tension at pitch. Necks made from different woods will therefore produce different tone of the instrument.

Construction:

There are several different configurations for guitar neck construction, which varies depending on design and guitar type. Solid body electric guitar with bolt-on necks and laminated fretboard configuration is shown as on *fig. 2*, and example of how neck is bolted onto the guitar body is shown on *fig. 3*.

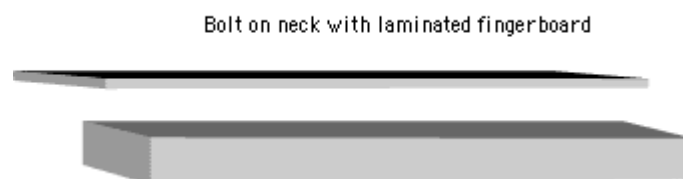


Fig. 2 Guitar neck back and fretboard config. for solid body electric guitars.



Fig. 3 Wooden neck and guitar joined with bolts.

In case of maple guitar neck, the top of the neck can be used as fretboard. Fretboards, however, are usually made of separate piece of hardwood, usually rosewood or ebony. The choice of fretboard wood makes more significant difference to the guitar tone, than the wood used for the neck back; and contributes to overall aesthetic appearance, playability and feel of the guitar neck.

For frets, silver nickel, stainless steel or other hard materials are used.

2.2 The manufacturing process.

For solid-body guitar, a single hardwood blank is selected. The blank can be from flatsawn or quartersawn wood. The latter being more expensive, is less frequently used, offers better dimensional stability but can be too stiff in some cases. Wood carving into desired shape can be achieved in two different ways.

In handmade manufacturing, solid wooden block is cut to rough size with a band saw. Excess material is then shaved off using power and hand tools.

The other approach utilises more modern technology with Computer Numerical Control machine. This approach requires CAD file to feed data to CNC driving computer. Although CNC process is also relatively slow, it still offers advantage over the method mentioned above – parts can be machined with high accuracy. For high volume production, multiple CNC machine must be employed.

After the neck machining is finished, truss rods and neck reinforcement are installed under the fretboard. The rods will allow for later adjustment to counteract the warping and twisting caused by humidity and aging. The truss rod groove runs along the guitar neck, just under the fretboard as shown on fig. 4.



Fig. 4 guitar with the fretboard removed, showing the cut for thruss rods. Here: truss rods replacement.

The fretboard installation is one of most critical operations and high level of precision is required. Finally the frets are pressed into the fretboard. Sanding of the whole neck and filing the frets ensures smooth finish.

3. Alternative solutions

3.1 Alternative materials

Historical perspective

It has been four millennia since the first neck for strings instrument was made. The choice of material was limited to natural materials. Wood was an obvious choice, being abundant, workable, stiff enough to support string tension and harmonized with the material composition of the whole instrument body that was also made of wood. Changing material for the sound box, as can be observed on example of banjo, significantly changes the tone.

Even today, when the choice of materials is much wider, wood remains the primary material for building guitars, acoustic and electric alike. While some of the technical properties such as strength and weight to size ratio can be found in other materials, changing material will impact the tone. For electric guitars, which have solid body and no sound box that amplifies string vibration, material choice for the body is less critical than for acoustic and classical guitar.

The wood used for string instruments is sometimes called *tonewood*. This term encompasses all woods that possess good tonal properties, soft woods used for guitar bodies and hard woods used for guitar necks. Wood is also chosen for its beauty and uniqueness from one piece to another.

New approach

Manufacturers have made guitars from, and experimented with materials such as fibreglass, Plexiglas, graphite and carbon fibre, metals and other composite materials such as flax linen and bio-resin made from industrial waste.

Aluminium neck offers some advantages over traditional wooden neck. It has been reported that guitars with aluminium necks produces *“beautiful chime like tones and brutally abrasive sounds”*. Such changes in tonality may be desired for some kinds of music. Aluminium neck are strong and unlike wood, aluminium is isotropic, i.e. properties such as strength are the same in all directions. Aluminium is much heavier than wood by volume, weighing 2720 kg/ m^3 compared to maple – 755 kg/ m^3 . However, due to high strength of aluminium, hollow neck designs are possible, reducing the weight, saving material and increasing resonance properties of the instrument. Example of aluminium bolt-on neck is shown below on *fig. 5*.



Fig.5 Solid aluminium guitar neck.

Other advantages of aluminium guitar neck, from players perspective include: better playability with smaller neck profiles and hard wearing fretless fingerboards (fretboards), *fig 6*.



Fig. 6 Bass guitar with fretless fingerboard.

3.2 New manufacturing process

T-6061 aluminium billet is used for guitar neck. It is fully machined with computer-driven CNC machine. The neck back, fretboard, frets and headstock are all machined as one piece to high-precision standard.



Fig. 7 Guitar necks machined from aluminium billets.

Aluminium corrosion (aluminium oxide) acts as a protective layer and does not differ much in colour from uncorroded aluminium. Various finishes for aluminium are available such as anodising and laser etching. Some finishes such as painting may not be desired, due to wear.

String tuners are later installed onto the neck which is then attached to the guitar body with bolts and neck plate. No truss rods inside the guitar neck are needed. A bolt on aluminium neck can be installed on metal as well as wooden body guitar.

4. Conclusion

Guitar neck is the most critical part of guitar in terms of durability. Manufacturers of guitars have been experimenting with different materials for guitar necks. Although traditional materials, various types of woods, are favoured by many players; new materials offer some unique properties. These properties are reflected in different tonality and add to the range of aesthetic possibilities of the instrument. CNC machining is possible with wood and aluminium, and for pieces requiring such high precision this is the fastest option as well.

5. Bibliography

1. Lefteri, C. (2012) *Making It, Manufacturing Techniques for Product Design*, 2nd ed. London: Laurence King Publishing.
2. Thompson, R. (2011) *The Manufacturing Guides, Prototyping and Low-Volume Production*. London: Thames & Hudson.
3. Thompson, R. (2007) *Manufacturing Processes for Design professionals*. London: Thames & Hudson.
4. Green, D. W., Winandy, J. E., Kretschmann, D. E. (1999) '*Mechanical Properties of Wood*', General Technical Report [Online]. Available at: <https://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr113/ch04.pdf>
5. http://www.eguitarplans.com/assets/making_a_guitar_neck.pdf
6. <https://www.dawsons.co.uk/blog/which-fretboard-wood-should-i-choose>
7. http://www.stewmac.com/HowTo/Online_Resources/Neck_Building_and_Repair_and_Setup/Neck_Construction_Tips_and_Techniques.html
8. <https://www.wired.com/2016/05/3000-guitar-made-solid-linen-looks-plays-like-wood/>
9. <https://reverb.com/uk/news/3-times-electric-guitar-makers-tried-to-ditch-wood>
10. <https://reverb.com/news/headless-guitars-who-makes-them-and-why>
11. <https://www.guyguitars.com/eng/handbook/BriefHistory.html>
12. <https://menga.net/maple-vs-mahogany-electric-guitar-necks>
13. <https://www.elixirstrings.com/support/string-tension-for-tuning-guitar>
14. <https://www.seymourduncan.com/blog/the-tone-garage/fret-sizes-and-materials>
15. <https://www.ohc.net/flat-sawn-vs-quarter-sawn-lumber/>
16. <http://guitarbuilding.tumblr.com/Neck>
17. <http://www.warmoth.com/guitar/necks/neckwoodspop.aspx>
18. <http://www.madehow.com/Volume-1/Guitar.html>
19. <https://www.electricalguitarcompany.com/>
20. https://www.simetric.co.uk/si_wood.htm
21. http://www.frudua.com/seasoning_guitar_wood.htm
22. http://mojobob.com/roleplay/weight_chart.html
23. <http://asm.matweb.com/search/SpecificMaterial.asp?bassnum=ma6061t6>