

That Tube Sound: Users of Vacuum Tube Guitar Amplifiers in the Digital Age


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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Among all instruments, few symbolize power, individuality, and style better than the electric guitar. However, an electric guitar must be paired with an amplifier, which is critical to manipulating the signal coming from the guitar and increasing its volume to a level that can be heard among other instruments. An expensive electric guitar with poor amplification can sound terrible, and many electric guitarists find that the amplifier plays just as much, if not more, of a role as the guitar itself in producing their desired sound.

When the electric guitar and amplifier were invented, vacuum tubes were the only available method of amplification. Early rock musicians in the 1960's increased the volume on their amplifiers to create a new distorted sound that quickly gave the electric guitar new compression, sustain, and feel that characterized rock, punk, and metal music (Poss, 1998). In distortion, overloaded tubes clip the guitar signal, and demands on the amp's speakers and transformers exceed their design limits and alter the guitar's sound beyond the intended functionality of the amplifier (Barbour, 1998). Once distortion became a desired characteristic amongst guitarists, amplifiers and effects pedals entered the market that allowed users to replicate the sound of an overdriven amplifier at low volume. Generally, the critical factors in an amplifier's sound are how it equalizes, distorts, and recreates the tone of the guitar (Poss, 1998). The main categories of professional amplifiers that exist today are tube, transistor (solid state), hybrid (tube and transistor), and digitized modeling amplifiers.

In order to learn more about these musicians and their motives, we must first set some limits and context to the research. Because tube amplifiers have been around since the creation of electric guitar, we will only be concerned about studying groups of guitarists in the last 10-20 years, when there are plenty of alternatives available to traditional tube amplifiers. Also, this study will focus mainly on the United States, Canada, and the United Kingdom, where the

popularity of electric guitar music surged in the 60s-70s, continuing to heavily influence guitar players today

Review of Research

There is ample evidence that early tube guitar amplifiers behave differently than solid state amplifiers, and that these differences can contribute to a perceived better sound. To begin, when pushed past their limits, tubes distort differently from transistors. Tubes exhibit soft clipping, which creates few high order harmonics, compared to transistors which exhibit hard clipping, which can lead to a harsher distortion sound (Hamm, 1973). Furthermore, heavy negative feedback featured more prominently in transistor amp designs tends to “square up” the distortion, creating more high order harmonics that can be perceived as harsh or unmusical in many contexts (Atwood in Barbour, 1998). Barbour also contends that transformers, which are not present in transistor amplifiers, create a compressing effect that some players may associate with superior amplifier sound and feel (Barbour, 1998). Other factors include, but are not limited to: time domain distortion due to tube capacitance, duty cycle, and nonlinearity (Pakarinen & Yeh, 2009, Hamm, 1973, Santo, 1994), changes in frequency response due to the transformer (Bussey, 1981), and tube rectifiers adding power “sag” that can be felt when guitarists play at their amp’s limit (Hunter, 2018). Keepports’ study of distorting tube amplifiers showed that tube amplifiers tend to emphasize even order harmonics at low distortion levels, and odd order harmonics at high distortion levels, while solid state amplifiers created odd order harmonics even at low distortion levels (Keepports, 2017).

There is research that points to nonscientific or emotional factors as being another significant factor in why guitarists find tube amplifiers appealing. Barbour calls this a “cultural

bias” that originated in the 1950s and 1960s when many rock and roll icons got their sound from using tube amplifiers, and musicians trying to replicate that sound decided to use tube amplifiers as well (Barbour, 1998). Dumoulin and Gauzente found that hobby guitarists view famous guitarists with mythic and iconic status, and that this contributed to their decisions in which instruments they use (Dumoulin & Gauzente, 2013). Venkatesan’s surveys about listener’s interpretations of music found that people associate music that seems authentic as more emotional, suggesting that musicians who wish to connect emotionally to music they play may decide to use amps that they perceive as authentic, rather than practical or affordable (Venkatesan, 2018). Furthermore, there is documentation that musicians use subjective adjectives to describe how their amplifiers sound and respond. Bussey’s research found that guitarists often use negative adjectives such as “thin,” “hollow,” and “metallic” to describe transistor amps, and positive adjectives such as “warm,” “rounder,” and “punchier” used to describe tube amps (Bussey, 1981).

Overall, the existing research shows that the guitar playing populous generally prefers tube amplifiers to solid state amplifiers, with a survey by Herbst published in 2019 finding that 72% of the guitar players surveyed preferred tube amplifiers, with the runner up being 13% in favor of modelling amplifiers designed to replicate tube amps (Herbst, 2019). The sound, feel, and experience associated with tube amps is vastly preferred by guitarists.

Guitarist Amplifier Uses and Playing Venues

To begin, it is important to broadly classify guitarists to understand why tube amps remain the tool of choice for many musicians. Electric guitarists may be classified by their preferred amp technique; as Clean, Distorted, Flex (switching between clean and distorted),

Pedal Platform, and Multi-effects. In Clean, Flex, and Distorted sounds, amps are specifically chosen for their pure sound without any pedals. Pedal Platform amps are amps used almost exclusively in conjunction with many pedals, and Multi-effects amps are amps used almost exclusively with their built-in effects.

Electric guitarists can be grouped by their main playing setting as follows: Performing, Bedroom, Recording, and Collector guitarists. Performing guitarists generally need an amplifier that is medium to high volume, has decent sound quality, and is reliable and portable. This group includes professional touring guitarists and casual players who perform at local performance venues, bars, and churches. Bedroom guitarists are players who spend most of their time playing in private for their own enjoyment, and who often need an amp that can play at low volume, usually with a compromise in sound quality. Recording musicians are a smaller group who mostly need amps that work well in a studio setting, meaning they are medium to high volume with great sound quality. Lastly, Collectors are guitarists who own multiple amps and use different amps for different purposes. For Collectors, it is assumed that money, space, and convenience are not concerns, and they will not represent many guitarists in the general population.

Premier Guitar's Rig Rundown Review

To get data on which amplifiers are used by professional guitarists, a study of *Premier Guitar's* recurring Rig Rundown interviews was completed, consisting of 44 interviews from February 2019-February 2020 (Bohlinger, 2019-20). From each artist and interview, the following data were collected: Genre, Amp Role, Use of Pedals, Amp Type, Amp Used, Words used to describe amp, and Qualities of the Amp. The genres that all artists were classified into

were: Rock, Country/Americana/Blues, Metal, Alternative, Punk, and Progressive/Math/Post Rock. There were no interviews with jazz, classical, reggae, or funk artists, and most groups' self-classifications of genre had to be somewhat simplified to allow for grouping with other artists. Only the most recent interviews (as of writing this paper) were included in this study, and no interviews were added based on any other criteria, such as artist, genre, or amp type. The results from this study are somewhat limited due to the small sample size and limited diversity of interview participants, but are useful in illustrating the extent to which tube amps are used by professional Performing and Recording guitarists. If there were multiple guitarists in the interview, only the first one appearing in the interview was used in the study to allow for a more diverse sampling base.

Of all the musicians in this study (N=44), 36 used tube amplifiers, 7 used modeling amplifiers, and 1 used a solid state amplifier. The results show a split among artists by genre, with artists in Rock, Punk, and Country/Americana/Blues playing exclusively tube amplifiers. All Alternative rock musicians used solid state or modelling amplifiers, and the Metal guitarists were roughly split between tube and modelling amps. Interestingly, not a single musician used a hybrid amplifier that uses both tubes and transistors as active components.

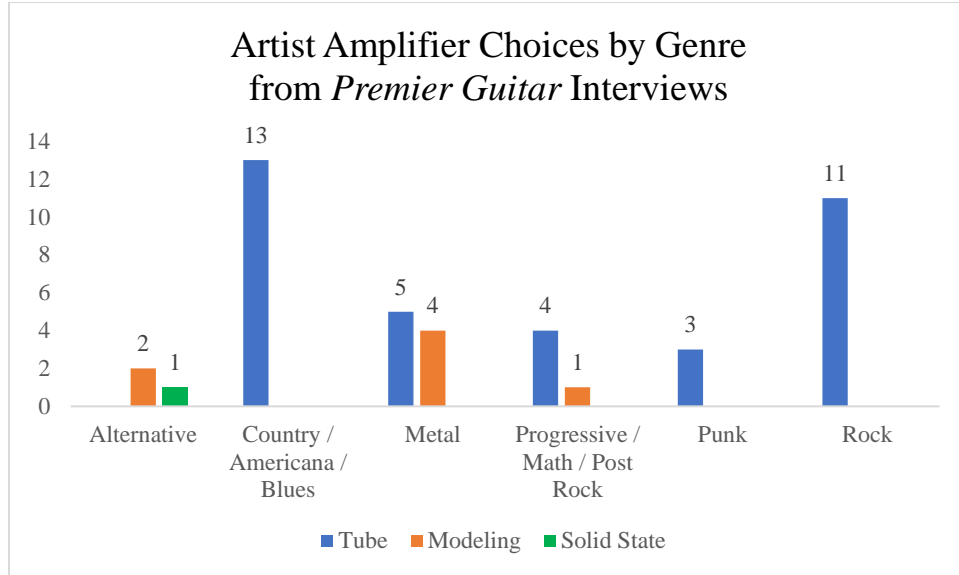


Fig. 1: Artists' amplifier choices from *Premier Guitar*'s Rig Rundown sorted by genre and amplifier type.

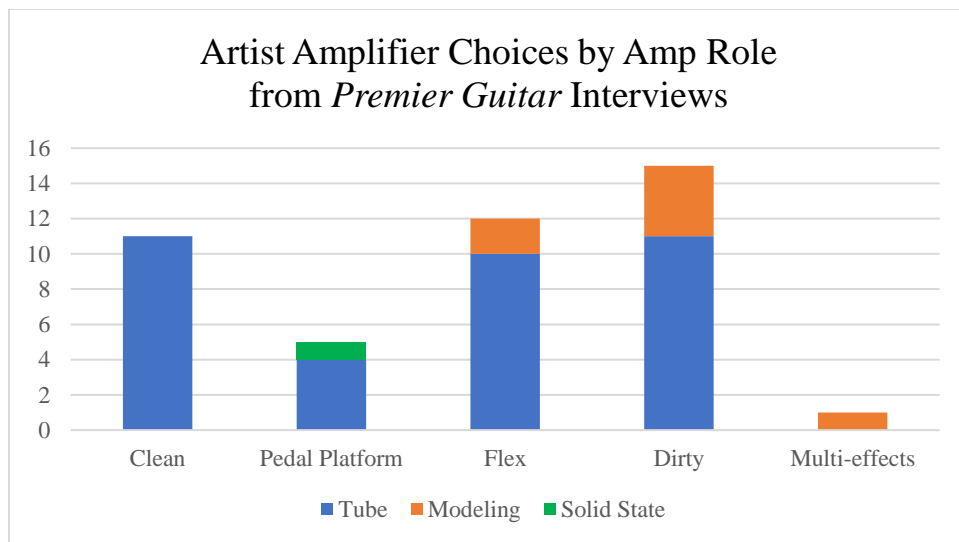


Fig. 2: Artists' amplifier choices from *Premier Guitar*'s Rig Rundown sorted by amplifier role.

Discussion of *Premier Guitar* Data

From the small study, 82% of musicians chose tube amplifiers to play on tour, making up a significant majority despite the abundance of other products available that are cheaper, lighter, and more reliable. These results align with Herbst's findings that tube amps continue to dominate the market of guitar players (Herbst, 2019). The musicians who were in the Country/Americana/Blues, Punk, and Rock genre categories exclusively played tube amplifiers, which is especially remarkable considering that the categories with the most musicians were Country/Americana/Blues and Rock. In the case of these performing musicians, there are two main factors that determine which amplifier they use: the influence of authenticity by the community of their genre, and the required or appropriate sounds produced by the amplifier.

Artists who prioritize authenticity in their sound and stage appearance tend to use tube amps, and genres that are closely associated with authenticity as part of their image are Punk, Rock, Blues, and Americana (Atton, 2019, Cogan, 2003). Musicians performing in genres that are less associated with authenticity or tradition, such as Alternative or Metal, are more likely to use alternatives to tube amplifiers. The survey data shows that 100% of musicians performing in Punk, Rock, Blues, or Americana in this study used tube amps, compared to 42% in Metal and Alternative genres combined.

The amount of distortion required from the amplifier is another factor in determining which artists chose to use tube amps, with tube amps generally appealing most to musicians who want mild to moderate distortion effects. This is because the aural properties of high and odd order harmonic content make digital and transistor replicants sound close to heavily overdriven tubes, while lightly clipping tubes are more subtle and harder to reproduce digitally. The results from the *Premier Guitar* interviews show that as the distortion preferred by the artist increases,

they are more likely to use a modeling amplifier. Nearly all players who used their amplifiers for guitar sounds with no distortion used tube amps, even if the amp was primarily used with pedals. This also fits with the genre data, showing that Metal players using high distortion are much more likely to choose modeling amplifiers over tube amplifiers. However, many of the desirable effects from tube amps, such as compression and power sag, do not occur when the amp is running without distortion. This implies that there are other draws to tube amps besides sound and feel alone, which will be discussed in the next section.

Musicians on Amplifiers

There is a consensus among the guitar community that tube amplifiers are the best choice for many musicians, and each artist has a different opinion regarding what will work best for their needs. On electric guitar internet forums, there are constant debates over the advantages of tube amps over the modern alternatives of solid state and modeling amplifiers, which provide insight into the reasoning behind how players choose their amplifiers.

In favor of tube amps, Reddit user superwrong states that “tube amps are more responsive to picking and strumming dynamics which makes for a livelier, more ‘organic’ sound” (superwrong, 2015). Here, the user’s opinion aligns with Murphy’s quotation in Santo’s publication – that the harmonics of the tube amp change in response to the player’s picking dynamics, giving the impression of a more “lively” or “organic” sound (Santo, 1994). Another post by superwrong argues “Only the best solid state amps can suitably mimic the growl of a cranked tube amp, and none yet (that I’ve played through) can mimic ‘edge of breakup’ dynamics of merely a ‘decent’ tube amp” (superwrong, 2017). “Edge of breakup” is slang among guitarists describing a sound that is achieved by an amp that is barely overdriven. This user’s argument can

likely be explained by Keeports' data, where even order harmonics were emphasized at low distortion levels in tube amps. Another forum post by user JustABluesGuy says "I can't stand the sound of a DS-1 [a common distortion pedal] into a clean, solid state amp. It sounds like a plastic buzz saw. With a tube amp on the edge of breakup, I can get creamy sustain, and I prefer that" (JustABluesGuy, 2017). The user's argument here is that the soft clipping from tube amps reacts with the distortion pedals in a favorable way, and that solid state amps emphasize the harsher sounds and higher harmonics of the pedal. This could also be in part to the high negative feedback found in most solid state amps, which can cause undesirable distortion artifacts that sound harsh and unpleasant (Atwood in Barbour, 1998).

Many guitarists on forums also describe attractions to tube amps that are not as firmly based on the scientific properties of the amps. Reddit user Dr_Strang3l0v3 argues that "A big part of why people love tube amps is the romanticized notion of them... That idea that you're plugging into a piece of raw, austere technology and feeling the satisfaction that you get from playing with them is more than enough for most guitar players to like them," (Dr_Strang3l0v3, 2017). The user goes on to state that the modeling amps that he has used in the past sound "amazing" and "much more 'pristine,'" but that they prefer "that satisfaction of knowing that I'm working crude tube technology like a farm animal... it's just what feels 'right' to me as a musician." Reddit user NayOfThunder also shares their emotional excitement of tubes, saying "it's really cool to know that im [sic] plugging into a pure, raw sound machine. Pushing the hell out of tubes is cool as (expletive) to me," (NayOfThunder, 2017). The user goes on to describe how they hear "more dynamics, more complexities, and more growl," and that they love how tube amps are "just absolutely loud as (expletive)." Clearly, these guitarists are passionate about tube amps because of a fascination with them. Tubes glow yellow as their filaments heat, and

have other primitive aspects that draw guitarists to them – the very same aspects that caused their obsolescence in most other electronic fields. The fascination with tubes is likely also a reason why many Bedroom guitarists use tube amps at extremely low volumes. TDPRI forum user jvin248 also suggests that “Belief/Religion/Tradition” play a role in drawing new guitarists to old technology, asserting that “New players seek to match the tools of the Old Masters,” (jvin248, 2016). Given many musicians’ emotional connection to their tube amplifiers and their music, it makes sense that many may choose to use similar gear to their favorite guitarists.

Some guitarists are also willing to offer some middle ground, such as TDPRI user Tele-beeb, who asserts the advantages of using tube alternatives for Performing guitarists. They generalize: “I think, down deep, we’d all like to go solid state for price, weight and convenience. However, tube types, arguably, have advantages in feel and sound... if the songlist [sic] has some of my favorites... I lug the big iron and glass,” (Tele-beeb, 2016). Here, the user establishes a strong emotional connection and preference with tube amplifiers, stating that they will only compromise for the sake of convenience, only performing with tube amplifiers when they want to especially enjoy the performance. Reddit user Amplifiedsoul argues that it is difficult to tell the difference between the tube and solid state sounds, and argues that it won’t make a difference to “98% of an audience,” (Amplifiedsoul, 2017). They then continue to describe that they “can hear the difference but it’s not important enough to me anymore [to use tube amps].” This musician implies that because the audience will not likely show a preference for tube amps, the performer should not worry as much about choosing a tube amp for its sonic differences.

There are also cases of misinformation about both tube and transistor amplifiers that play a role in a user’s decision. TDPRI user otterhound states “Tubes utilize a continuous electrical flow path...Transistors/solid state paths are on/off switches. There is no in-between. Tubes play

the sounds between the notes while solid state is either on or off,” (otterhound, 2016). Here, the user is mistaking the digital use of transistors with using transistors as audio amplifiers – the difference that they are hearing is likely due to tube clipping and frequency manipulation by the transformer, not a digitized versus analog guitar signal. There are other common misconceptions (such as hand wired amps or point to point circuit boards producing a better sound) that contribute to the misinformation surrounding guitar amplification (Hunter, 2015).

An interesting common theme is using creative descriptive language to describe the sounds from tube amps. Rather than explaining scientifically, guitarists use language that might be hard to interpret without proper context and understanding of playing the guitar. Some of these include: ““vocal, squishy, chunky, tight” (Bohlinger, 2019-20) and “woody, barking, greasy” (Gee, 2017). All of the listed adjectives are used to positively describe the sound and feel of tube amplifiers, adding to the concept that playing through a tube amplifier is a romanticized experience firmly attached to the guitar community. TDPRI user Tele-beeb’s slang “iron and glass” (referring to the transformer and tubes in the amp, respectively) is another example of unique descriptive language showing the emotional connection to tube amplifiers.

Modern Manufacturers’ Response to Tube Popularity

Manufacturers have gone to extensive lengths to keep tube technology competitive in a marketplace where digital modelling amplifiers are beginning to become more popular. The primary challenge for modern guitar amplifier and pedal companies that continue to use tube technology is to make a product that can reproduce the sound and feel of cranked tube amplifiers at low volumes. Audio manufacturers created attenuators that lower the volume of the distorted signal going to the speaker while also loading the power section of the amplifier to create power

sag – emulating a pushed amp at lower volumes. Some companies such as Tone King even offer their attenuator built into their tube amplifier, to increase the amplifier’s functionality (Fleming, 2015). However, load bearing attenuators even have limitations, as expressed in the Tone King Ironman II Attenuator manual. These include no speaker compression, perceived lack of bass frequencies, and a different human-instrument connection at low volume (Fleming, 2019). Other strange tube-based guitar products exist, including a ½ watt mini tube amplifier and guitar pedals with tubes as an active distortion component (Vex, 2013, Wolfert, 2014). These tube products designed for low volume output are especially appealing to Bedroom and Recording guitarists who are not able to play at high volumes.

To compete with the changing market of tube amplification equipment, manufacturers of modelling amps and pedals are continuing to create new products that are specifically aimed to cater to guitarists’ affiliation towards tube sounds and the emotional connection with tube amps. In 2019 Fender, one of the most popular guitar and amplifier companies in the US, released the Tone Master modeling amp line, which are based on popular Fender amplifiers designed in the mid-1960’s. The amps are aesthetically identical to the originals that use tubes and are designed to sound and behave identically while offering additional digital functionality and a lighter weight (Fender Musical Instruments, 2019). While the original tube amplifiers mostly appealed to Performing musicians for their loud clean tone, the Tone Master amplifiers include a built-in attenuator and speaker simulator to appeal to Bedroom and Recording musicians, respectively. Regarding effects pedals, the Catalinbread Formula 55 is an overdrive pedal using JFET transistors in place of tubes and has circuitry that mimics the equalization and response of vintage Fender amplifiers. The pedal’s cover art features a graphic of a vacuum tube, and the pedal claims to be able to emulate tube distortion and power sag, although the latter is not

possible without an actual tube (Gee, 2017). This example shows that even pedals that do not use tubes both contribute to and draw from the guitarists' general affinity towards tube amplification and distortion.

Conclusion

Guitarists remain attracted to tubes and tube amplifiers in modern times due primarily to extrinsic traits assigned to tubes by guitarists with intrinsic traits of the amplifiers being a secondary factor. While the majority of evidence points to amps achieving unique and desirable aural properties at moderate distortion levels, artists who perform with minimal amp distortion are more likely to use tube amps to achieve their sound. Evidence from internet discussion boards and interviews with guitarists shows that there are romanticized nonlogical elements of fascination, authenticity, and tradition associated with tube amps contributing to their general appeal. Modern manufacturers cater to guitarists' attachment to tubes by making products with modern technology that aim to reproduce the experience of playing through loud, distorted tube amps, perpetuating guitarists' attraction and connection to tubes. Combined, these form a significant cultural appeal that began due to serendipitous chance that tube amplifiers were the amplification method of choice during the popularization of the electric guitar.

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