Design, Construction, and Integration of an
Electrical Generator Product for Bicycles
(Technical Paper)

That Tube Sound: Technology and Users of
Electric Guitar Amplifiers
(STS Paper)

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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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General Research Problem

How is modern technology applied to niche markets in the United States?

Given the increasing population, improved standard of living, and advance of technology in the United States, the market for niche products for common hobbyists and enthusiasts has increased significantly. The specific interests of these hobbyists vary widely, and my research problems will look deeper into two different product types in two markets. The two markets my research will be looking into will be bicycle products for my technical project, and electric guitar amplifiers for my research paper. Both markets are significantly influenced by new technological changes in unique ways, and there are similarities and differences that will become evident to the reader of this prospectus and the eventual paper.

Design, Construction, and Integration of an Electrical Generator Product for Bicycles

How can an effective, multipurpose electric generator attachment to a bicycle be designed and created?

My team's technical research challenge is to create a convenient, practical product that outdoors enthusiasts and casual bicycle riders can put on their bike in order to charge their cell phones and a battery pack. Over the past 20 years, the development of cell phones has greatly changed the way most people communicate, navigate, and go about their daily lives. For many, cell phones have quickly become nearly essential to everyday life, with many adults spending two to four hours on them each day. However, a certain common drawback and factor in many cell phone users' interests is the battery life of their cell phones. When the battery runs out of charge, the cell phone is useless if the user is not near a charging device or plug.

This problem of poor battery performance of cell phones has led to many products that aim to amend that problem, a common one being an external battery called a power bank. Cell phone designers and manufacturers also generally aim to try to improve the battery performance of their products. That being said, all phones need to be recharged frequently to some degree, and this can be an inconvenience for their users.

To present a solution to this problem, our team will be designing and creating a product for attachment to bicycles that will use the energy of the bicycle wheel turning to charge a battery pack and a cell phone. This product will be designed to be practical, easy to use, and user friendly, with some compromises being made in efficiency and size in order to make a more accessible and useful product. The general design of this product will involve two sections: a generator section which will have a wheel in contact with the rear wheel of the bicycle to generate electricity, and a battery and power-filtering section on the handlebars, which will take the raw electrical power signal and convert it to a useable direct current supply for charging the battery pack and the cell phone. Additionally, the battery pack will be designed to be detachable, so the user can continue to charge their phone without having to remain on the bicycle.

To design this product, we will largely use the CAD software Solidworks to create a three-dimensional model of the product before the actual construction will begin. Our team will be using our team member Michael's bicycle to test the product, although we will be designing the product for use on as broad a range of bicycles as possible. Once again, the main goal of this project is to create a useable and flexible product that can easily be mass produced, rather than making one specific generator for use only on our team member's bicycle.

The end goal is a working product prototype and an exact model in Solidworks that could later be produced on a mass scale. The product designed should effectively charge the cell phone, be fairly easy to attach to the bicycle, be able to be put on a variety of bicycles, and be durable enough for regular use by both commuters and mountain bikers out on the trail. This end product, should it be mass produced, would be useful to a range of bicycle riders, especially those who need to charge their cell phones away from conventional power sources.

That Tube Sound: Technology and Users of Electric Guitar Amplifiers

What are modern technological trends in electric guitar amplifiers, and how are they mutually shaped by the market for such products?

Introduction

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 creating the sound appropriate for the music. What makes electric guitar amplifiers such a unique topic is the role of sound, image, and logical and nonlogical factors in why electric guitarists choose one amplifier over another. The purpose of the research paper is to document how amplifier preferences among guitar players are linked to the scientific qualities of amplifiers, and to ultimately understand to what extent factual evidence plays a role in musician preferences in amplifiers. Understanding the scientific and subjective qualities in certain guitar amplifiers that makes them successful in the current market is critical information for guitar amplifier manufacturers, and provides a unique case study anthropologically.

Generally, guitarists prefer vacuum tube amplifiers, despite transistors replacing tubes in nearly all other technical fields. Vacuum tubes (referred to throughout this paper as tubes) are much less reliable than transistors, and require bigger, heavier amplifier construction, an inconvenience to most guitar players. Despite these setbacks, tube amplifiers dominate the market of guitar amplifiers, and remain highly sought after by the guitar players who use them. This presents a unique and interesting community to study, where old electronic technology from the 60's and earlier is often considered superior to modern technology. This goes against the general conception that advanced technology is more valuable, unlike many other fields dealing with electronics.

Background and Theoretical Framework

The electric guitar has been a staple of American music for over 60 years, and a critical component of the sound of the electric guitar is the electric guitar amplifier. Most conventional acoustic instruments do not require amplification in their general use, but electric guitars vary because of their intrinsic need for external amplification. An expensive electric guitar with poor amplification can sound terrible, and many musicians who play electric guitar find that the amplifier plays just as much, if not more, of a role as the guitar itself in getting them a desirable sound.

In the late 1940s and early 1950s, as electric guitars began to enter the market, the only available active electric amplification component available was the vacuum tube. Vacuum tubes were used in the first computers, radios, and other electric devices, until transistors became cheap enough to use in most electronics. Transistors were smaller, more reliable, cheaper, lighter, and generally more desirable than tubes in almost all uses, and quickly replaced tubes as the active amplification method of choice in nearly all electronics. But today, tube amplification is still used in electric guitar amplifiers, an outlier in a world where they have been entirely eliminated from most other practical forms of electronics. For example, in 2019, 31 of Fender's 45 combo amplifier models for electric guitar used tube technology in some form. Despite their popularity, tube amps are expensive and need to be serviced regularly, and are usually much bulkier and heavier than their transistor (solid state) counterparts.

There are many reasons behind guitarists' attraction to tube amplifiers, and we can roughly consider them as intrinsic and extrinsic factors. Intrinsic factors are solid physical or scientific attributes of an amplifier that the user takes into consideration. Some examples of intrinsic factors include amplifier size, weight, and loudness. Extrinsic factors are attributes assigned to the amplifier by the player or guitar community that are not based on the physical or scientific qualities of the amp. These factors include branding, identity, and perceived sound and "feel" of the amplifiers. Some of these extrinsic factors may be based on scientific fact, and part of the research paper will consist of proving or disproving common conceptions about these amplifiers. The extrinsic factors also will allow us to draw parallels with other markets where a consumer's emotions play a large role in their decision making.

Tubes are coveted by the guitar community, and there are common intrinsic and extrinsic factors associated with them. Known intrinsic factors that draw players to tube amplifiers are that they distort in a softer, more musical way than transistor amplifiers, and are generally louder per watt of power used (Hamm, 1973). Intrinsic factors against tube amplifiers tend to be that they are expensive, unreliable, heavy, and more delicate than their transistor counterparts. Extrinsic factors in favor of tubes are vary with each guitarist, but range from favorable "feel"/response to playing, to pride and satisfaction in using the same components or models that were used by popular or historic guitarists.

Evidence and Data Collection

In this study, there are two major foci of research: the first is the amplifiers, and the second is the musicians who play the amplifiers. The research on the amplifiers will involve a study of the fundamental science behind guitar amplifiers, as well as analysis of the current trends in popular guitar amplifiers. The research focused on the musicians will focus on why they chose the amplifier they use, and what qualities about the amplifier that are appealing to them.

There is certainly evidence that certain components of both tube amps in general and vintage amps as a whole cause sonic effects that guitar players may find desirable (Barbour, 1998; Keeports, 2017; Siegle, 2002). Some of the desirable qualities of tube amplifiers are based in fact, like the soft clipping qualities of overdriven tubes. However, other qualities are perceived by guitarists in tube amplifiers (especially tube compression and soft attack at low volumes) that have no basis in scientific evidence. Determining the extent of misinformation in the electric guitar community will rely on the findings of the second part of the research focused on the guitar players themselves.

Doing research by analyzing the most popular amplifiers on the market today (Orkin, 2018) and more specific interviews with professional musicians (Bohlinger, 2008-2019) will serve as starters to get data on the reasons behind musician preferences in amplifiers. In the interviews, I will be looking for positive descriptors of the amp by the player, and will document these qualities as either intrinsic or extrinsic factors, for both tube and transistor amplifiers. Another useful resource for additional data is guitar forums, where guitarists review and compare amplifiers. Once the data is collected, I will look for trends in the preferences, paying special attention to common conceptions and extrinsic factors regarding tubes. Then I will determine which of these conceptions are based in scientific fact, and which are attributes made up by guitar players.

Given how valued tubes are in the guitar community, and their seemingly mythical status, I expect that there will be a gap between guitar players' understanding of their amplifiers and the scientific evidence of tube circuits. Understanding this gap provides us insight into the extent that emotional reasoning and misconceptions play in guitarists' decisions. This data is especially useful for amplifier and guitar pedal companies, who can use the information to determine how to use new technology to make products that will be embraced by the guitar community. If cheap transistor amps or pedals can convincingly emulate tube amplification, the guitar community may embrace them and eventually make tubes completely obsolete.

Conclusion

If there is a trend with modern technology for guitar amplifiers, it is not away from tubes, but instead towards small size, low volumes, and convenience. This has gone to the extent where some modern boutique amplifiers include built in attenuators designed to replicate the load of the speaker, allowing the whole amplifier to be pushed into distortion at reduced volume. These unique technologies in a niche market of hobbyists are similar to my technical project, whose specific audience is bicycle riders looking for power on the go. Looking into these two distantly related topics will give us more information about the American recreationalist and hobbyist, and how modern technology affects their interests. This will not just be useful data for companies in those markets, but also for general anthropological documentation, which may overlook these critical elements of American life.

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