Gibson vs. Fender: Innovation paths in the early Electric Guitar Industry (1945–1984)

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Résumé :

This article investigates the two radically different innovation paths chosen by Gibson and Fender, the two major electric guitar manufacturers, during the period 1945–1984. The beginning of this period corresponds both to the entrance of Fender in a market then dominated by Gibson and to the birth of the electric guitar. The article shows that the period 1945–1958 is one of intensive innovation, albeit of a different type, from both manufacturers. Fender's innovation was inspired by engineering and electronics, while Gibson's was rooted in craftsmanship and tradition. These very few years, which defined what electric guitar is, were then followed by a period of innovation deadlock (1958–1984). This article demonstrates that this was not due to a lack of innovative activities, but, instead, to a growing misunderstanding of consumer needs and to sterile attempts to capture each other's market share.

Mots-clés : radical innovation, market entry, engineering, craftsmanship, trajectories

INTRODUCTION

Although electric guitar has, arguably, been for more than half a century the most famous icon of popular music and companies manufacturing them have demonstrated a rather unusual longevity and leadership (Gibson, one of the two market leaders was founded in 1894), little attention (if any) has been given in the literature to this industry. Yet, the electric guitar industry is certainly worthy of study as it displays a singular combination of innovation and inertia, of technology and tradition, of mechanisation and craft.

Innovation, as a research topic, has attracted a lot of attention over the past decades. While, at first, mainly focused on high-tech industries, the research perspective has grown to encompass what is commonly referred to as "Low-tech or medium tech industries", or LMT (von Tunzelmann and Acha, 2005). Such industries, for instance the oil industry (Gulli, 1995), food and drink industry (Martinez and Briz, 2000; Menrad, 2004) or retailing (Brown, 1990; Keh, 1998; Tamilia and Reid, 2007), are generally mature industries with little change in technologies and market conditions (von Tunzelmann and Acha, 2005). Yet, the electric guitar industry belongs to neither and could instead be seen as a middle ground where strong conservatism and high-tech constantly oppose one another.

The recent trends in this industry provide a good illustration of this continuous battle. Indeed, over in the past decade the market leaders have, simultaneously, invested vast amounts of money to develop methods enabling to recreate, to the smallest detail (including artificial ageing of new instruments look like they have been bought decades ago and played on stage every night ever since), electric guitars the way they used to be in the early 1960s and engaged in intensive R&D to develop embedded electronic systems (very much alike miniaturised computers) to overcome the limitations inherent to stringed instruments.

In fact, the origin of this competition dates back to the very birth of 'modern' electric guitar, when the long established incumbent, Gibson, was challenged by Fender, a company that was not only a newcomer but also an outsider (Fender had no prior experience of instrument manufacturing and, originally, produced amplifiers). At the time, the two companies' background, knowledge and skills and approach to guitar manufacturing could not have been more different. As a consequence, they both chose radically different technological paths.

Gibson, bearer of the tradition, reluctantly introduced a dose of modernity in trusted designs and processes, while Fender, starting from a blank slate, almost entirely reinvented the instrument.

In a rather surprising outcome, the Gibson Les Paul and the Fender Stratocaster, each a perfect representation of the different technological path chosen by each company, have both become the essence of what electric guitar is. The paradox is, of course, that these two models could not have been less similar.

The history of business is full of examples of incumbents replaced by technologically more advanced entrants (Utterback, 1996; Lucas Jr. and Goh, 2009; Rayna et al., 2009; Jacobsen, 2010) or of incumbents achieving to deter newcomers in spite of a technological disadvantage (Bettis and Weeks, 1987; Lieberman and Montgomery, 1988; Rayna and Striukova, 2009; Rayna et al., 2009). However, examples where both win and share the market are not very common (Bevan, 1974). The electric guitar industry is one of them.

Understanding why this is the case requires a thorough analysis of the early technological path chosen by each firm, as well as the rationale behind these choices. This is what this article aims to do by the means of two detailed case studies of Gibson and Fender. Section 1 provides a brief overview of the history of the electric guitar. Section is devoted to the analysis of the innovation trajectories chosen by the two companies during the early years of electric guitar manufacturing (1948–1958), during which both firms were very successful in introducing innovations to the market. Section 3 is devoted to the period 1958–1984, during which both firms, despite important efforts and investments, were unable to foster adoption of their new products. Finally, Section 4 aims to confirm the results obtained in the previous sections by conducting a patent analysis.

1. AN ABRIDGED HISTORY OF THE ELECTRIC GUITAR

Although the guitar, as an instrument, evolved to its definitive shape in the beginning of the nineteenth century, it remained, until the mid twentieth century, in the shadow of other more popular instruments, such as mandolin or banjo. While the characteristics of the instrument

were appreciated (it would, otherwise, have disappeared as many other instruments did), its weak sound output confined it to solo work or voice accompaniment and prevented it from being used in orchestras.

Guitar had some advantages, though. In comparison to other instruments, it was cheap to produce, easy to learn and to carry around; all the ingredients to make it a popular instrument. It is thus not surprising that the growing success of guitar happened simultaneously with the democratisation of music that began during the start of the twentieth century. Although a growing usage of guitars among jazz, blues and folk players put guitar in the spotlight, its lack of loudness was still a major obstacle to a large adoption. Starting from the 1920s, attempts were made to solve this issue by the means of electric amplification. However, it rapidly became clear to the early inventors that a different technology had to be used in the case of guitars and that simply using existing technologies, such as the one used to amplify voice, would not be sufficient (Beauchamp, 1937; Hart, 1937).

Before World War II, only a handful of electric guitar models had been successfully produced (among them, the famous Gibson ES-150 'Charlie Christian' model). However, most of these models were, in fact, nothing more than standard acoustic guitar models on which a magnetic pickup had been fitted (Fuller, 1942). These early models of electric guitars had serious shortcomings. They were very sensitive to feedback, which meant that the volume of guitar amplifiers had to be kept low. Furthermore, the opposite vibrations of the strings and the pickups (placed on the guitar soundboard) did not allow for efficient amplification to take place. Shortly after the war, attempts were made to correct these two issues. The hollowness of the guitar body was identified as the root of both issues and, since hollowness was no longer needed (because amplification occurs through an external amplifier and no longer through the body), the idea of a 'solid body' guitar came to mind to several inventors (among them, Les Paul, a famous guitar player, who built an early prototype of solid-body in 1940).

However, despite the maturity of the guitar industry at that time, the first mass-produced solid-body guitar was not released by any of the major players, but by a newcomer instead. Fender, a company formerly producing electronics, released the Telecaster model (then known as 'Broadcaster') in 1950 (Fender, 1951b). The success, though, was far from being immediate

(the Telecaster looked radically different from any other guitar and was, at first, mockingly nicknamed ‘canoe paddle’ or ‘snow shovel’). Nonetheless, eventually, it became obvious that a solid body was the last missing ingredient for guitars to become the most popular instrument. Since the hollow body is the part that requires the most craftsmanship, replacing it with a ‘plank of wood’ made solid-body guitars particularly fit for machine industrial mass production and, hence, cheap to produce. Furthermore, the body is also one of the most fragile parts of the instrument so replacing it by a block of solid wood made guitars very resistant and durable.

Gibson, market leader at the time, released its first solid-body (the Gibson Les Paul) in 1951. Three years later, Fender released its most successful model to this day, the Stratocaster, which has been so successful that it actually identifies what an electric guitar ought to be. By the mid 1960s, solid-body electric guitars had taken over almost the entire guitar market and electric guitar became an icon of rock music, of consumer society, and, by extension, of popular music.

However, in spite of its popularity, electric guitar never completely replaced acoustic guitar. Apart from the obvious reason that the latter do not require electricity to function, which is, sometimes, more convenient, the actual reason is that these are, in fact, two different instruments. Electric guitars were meant to produce the same sound as acoustic guitars, but louder. Technological limitations were such, however, that the sound produced by electric guitars was quite different from the acoustic sound. Because they enabled to create entirely new sounds (such as distortion, long sustain, etc.), these technological limitations were pivotal in the success of electric guitars.

By failing to accurately reproduce the sound of acoustic guitars, electric guitar became an instrument in its own right.

2. EARLY TECHNOLOGICAL TRAJECTORIES IN THE ELECTRIC GUITAR INDUSTRY (1948–1958)

Gibson and Fender have been the market-leading brands of electric (solid-body[1]) guitars since their introduction in the late 1940s. The Fender Stratocaster and Gibson Les Paul are the most famous electric guitars, so famous, in fact, that almost everybody (sometimes unconsciously) is familiar with their shape. These two companies not only led (although they did not initiate it) the innovation surrounding the electric guitar, they actually shaped the electric guitar industry (and the instrument itself). They did so to such extent that most of the electric guitars produced since are a, more or less, close copy of either of these two models or of another of the other successful models of these two companies (Fender Telecaster, Fender Precision, Gibson ES-335, Gibson Explorer, etc.).

Although the electric guitar industry has been largely dominated by these two companies, the number of guitar manufacturers remains, in comparison to other highly oligopolistic industries, rather large. First of all, a niche market of custom and 'boutique' electric guitars produced by independent luthier or small companies has survived to this day in the shadow of the mass-market electric guitar. In addition, although many of Gibson's and Fender's mass-market competitors have either disappeared or have been bought out (Epiphone by Gibson; Gretsch and Guild by Fender), a large number of new companies, most of them of Asian origin, appeared during the second half of the 1970s. Some of these companies, such as Ibanez, Yamaha or PRS, are still very successful. None of them, however, was able to erode Gibson's and Fender's dominance.

[1] Since hollow-body electric guitars only represent a small niche in the electric guitar market, the term 'solid-body' will be omitted in the remainder of this article. Although they are, technically, slightly different from solid-body guitars, semi-hollow-body guitars, such as the famous Gibson ES-335, are assimilated to solid-body electric guitars.

2.1. TWO COMPETITORS FROM A DIFFERENT BACKGROUND

Gibson was founded in 1894 by Orville H. Gibson, a luthier specialised in the manufacture of stringed instruments. Orville Gibson's first and only patent (Gibson, 1898), related to the use of solid carved top on mandolins and guitars, was so innovative that it led five investors to purchase, in 1902, the exclusive right of usage of the patent and set up a limited company[2] aiming to produce instruments based on Gibson's groundbreaking design (Carter, 2003).
Though Orville Gibson left soon after the company that bore his name, he was rapidly replaced by other radical innovators (Lloyd Loar, in the early 1920s, Walter Fuller in the 1930s, Ted McCarthy in the 1940s) which enabled the company to stay ahead of the incumbents and to quickly gain market share.

Gibson's initial success was due to innovative designs, advanced craftsmanship and cautious embracing of industrialisation (machines were only used for repetitive and dangerous tasks, while the actual building of the instruments, which requires human touch, was left to skilful luthiers) (Martin, 1998). Though Gibson is best known for its guitar manufacturing, it first became successful because of its mandolins, a very popular instrument at the time. The mandolin fashion in the U.S. eventually faded in the late 1910s and banjo became the must-have instrument. Gibson was able to adapt to the new fad and became a successful banjo manufacturer. Finally, in the 1930s, the popularity of guitar began to increase. Once again, Gibson was able to adapt and became a successful guitar manufacturer. Gibson's ability to accommodate three major shifts in consumer tastes is quite unique and very few manufacturers were able, at the time, to make even one transition successfully, let alone two.
Between the two World Wars, because of numerous product innovations, the very good reputation of its product and its ability to foresee the growing importance of the guitar, Gibson progressively became market leader. It retained this rank throughout the 1950s and cemented further its position by buying out its main competitor, Epiphone, in 1957. However in the 1960s, the rapid growth of a newcomer, Fender, started to undermine Gibson's market dominance.

Fender Manufacturing was founded in 1946 by Clarence Leonidas 'Leo' Fender. Unlike Orville Gibson, Leo Fender was neither a luthier nor a musician (though he studied piano and

[2] Gibson Mandolin Guitar Manufacturing Company Limited

saxophone as a child). He was an accountant and self-taught electrical engineer. In 1939, he opened Fender Radio Service, an electronics retail and repair shop. The expertise he gained repairing guitar amplifiers led him to found in 1945 a company named K&F (for Kauffman and Fender) with Doc Kauffman, a musician-inventor. Together, they began manufacturing electrical lap steel guitars (also known as "hawaiian" guitars) and amplifiers. Kauffman, however, subsequently left shortly after and Fender carried on his own.

In 1945, he co-founded a company named K&F (for Kauffman and Fender) which manufactured lap steels[3] and amplifiers. After his business partner, Doc Kauffman, decided to leave and sold his share to him, Leo Fender carried on producing lap steels and amplifiers under his own name. However, it quickly became obvious to Leo Fender that the innovations he had introduced for his lap steels could also be adapted to standard electric 'Spanish' guitars.

2.2. THE NEWCOMER: FENDER OR THE ENGINEERING PATH

Despite being a late entrant in the guitar market, Fender was able to immediately radically innovate and had a highly disruptive and long-lasting effect on the industry. The three main sources of Fender's innovation were its limited access to traditional resources (knowledge of instrument manufacturing, access to skilled labour), its use of concept in techniques from other industries and its use of consumer input.

Fender first started by manufacturing electric lap steel "Hawaiian" guitars. Though such guitars were still in fashion in the 1940s (Hawaiian music has been extremely popular in the 1930s), this was probably only incidental in the decision of Fender to manufacture this kind of instrument. Indeed, unlike regular ("Spanish") guitars, lap steel guitars are played by sliding a metal tube along the strings. Because the hands of the player are not in contact with the neck of the instrument, its quality is of little importance and the construction can be greatly simplified. Furthermore, by amplifying the instrument electrically, Fender was able to replace the hollow body of the guitar (which requires significant skills to manufacture) by a solid piece of wood.

[3] Lap steels are special guitars that are played placed on the musician's lap with a metallic instrument that slides on the strings. These guitars usually do not have hollow chambers and, since the hands of the player are only in contact with the strings, their shape or finish is much less important than for a regular guitar. Consequently, these guitars were the first to be (successfully) fitted with electronics and to be industrially manufactured.

Hence, electric lap steel guitars could be designed and manufactured without, almost, any craftsmanship. This starting point was highly instrumental in the technological trajectory subsequently chosen by Fender.

2.2.1. Telecaster (1950): a diamond in the rough for local constraints

Indeed, the approach Fender adopted a few years later to build its first electric "Spanish" guitar was very much influenced by the methods used to manufacture lap steel guitars, as it relied a lot on engineering and very little on craftsmanship. Although this was a totally new approach to guitar manufacturing, this fitted perfectly the capabilities and constraints of Fender and, hence, was made by necessity rather than by deliberate choice. Leo Fender himself had no knowledge of instrument-making (besides some related engineering knowledge). Also, unlike Gibson, which was located in a region rich in instrument manufacturing companies, Fender had simply no access to qualified labour. Consequently, Fender's approach to guitar making necessarily had to be based more on machines than on manual craft.

As noted by Maskell (1998), in low-tech industries specific competencies are generally not easily copied by competitors because they are often embedded within the company (e.g. its social system) or its environment. More than Fender's lack of guitar manufacturing skills, it is, in fact, its inability to access qualified labour (located several thousand miles away) that made it impossible for Fender to adopt the same technological trajectory as Gibson. Fender had to approach the problem from a different angle and find its own way to respond to specific local constraints.

Fender's first electric guitar, Telecaster, was a perfect answer to the constraints faced by Fender at the time. It was clearly designed with a 'what is convenient to produce' and 'what is not essential and can be removed' mindset. The latter point is particularly obvious when comparing early Telecasters with other guitars manufactured at the time. Whereas guitars were usually richly ornamented (pearl inlays on the fret board, binding[4] on the neck and body, golden-plated hardware, etc.), Telecaster looked, in comparison, plain. It had none of the usual refinements and its 'blond' yellowish body finish was yet another aesthetic departure from the canons at the

[4] Decorative strip of plastic, wood or fibre.

time (most guitars had a 'sunburst' finish consisting of a gradation of two or three colours). Likewise, whereas three or more types of wood (such as mahogany, maple, rosewood or ebony) were traditionally involved in the production of guitars, only two were used for the Telecaster (ash for the body and maple for the neck).

The neck of the Telecaster was particularly representative of this minimalist approach. While competitors' necks were generally made of two or three pieces of wood (often mahogany or maple) with a glued fingerboard (generally rosewood or ebony), the neck of the Telecaster was made of a single piece of maple. Both neck and body were, thus, produced out of one single piece of wood each, which could be cut by machines and rapidly finished by hand. In addition, the neck was not glued to the body, but was instead attached with four bolts (Fender, 1951b).

The latter point is of significant importance, as gluing is a critical process in guitar manufacturing. At the time, synthetic glues were not available and it took special skills to master the preparation and application of animal hide glue. Such skills were critical as multiple gluing operations were normally required for each single part of the instrument and the durability and reliability of the instrument depended on the quality of the gluing process. Yet, manufacturing a Telecaster did not involve a single gluing operation.

Leo Fender mentioned on many occasions that this was done so that guitars would be 'serviceable', with replacement parts shipped directly to the consumer (concepts taken from the electronics/automobile realm, but entirely new in the music instrument industry). However, the fact that it enabled to use a totally unskilled labour force was certainly a key determinant. In any case, Fender would simply not have been able to use a different approach.
All these differences enabled Fender to dramatically reduce the cost of production and to be competitive from the very beginning, even while still experiencing a steep learning curve. Although competitiveness, which eventually enabled consumers to gain access to cheap (but well-built) instruments, was later often mentioned as key driver for the changes made by Fender, the actual reason was more straightforward: all the features that were removed corresponded to areas of knowledge that Fender did not have and could not obtain due to the lack of qualified labour force available locally.

With this unique method of guitar manufacturing, Fender established some very clever and novel ways to adapt the production process to local constraints. Hirsch-Kreinsen et al. (2006) state that companies are characterised by the specific combination they make of more or less special and rare resources and, in particular, knowledge of various forms. In this sense, Fender, in its early years, was characterised by a combination of abundant unskilled labour with a rare knowledge of engineering and problem solving (part of which was supplied by local musicians).

However, this should not hide the fact that Leo Fender was an inventor and certainly did not intend to produce a cheap, stripped down, guitar, but instead a very innovative instrument. The fact that the Telecaster had a solid body was *intrinsically* an innovation, as it solved many of the shortcomings of hollow-body electric guitars[5]. It introduced, furthermore, a significant number of other innovations.

These innovations, whether product or process related, arose because Fender used a perspective normally used for electric appliances. Fender saw the guitar very much like a radio, with electronics on one side and wood work on the other[6]. Unlike other manufacturers, who installed the circuitry inside the guitar, a tedious and labour-intensive job, Fender fitted all the electronics of Telecaster[7] on a single metallic plate which was then screwed to the body of the guitar (Fender, 1951b, 1957b). Using a different perspective enabled Fender to be much more open-minded and innovative than traditional luthiers, whose thinking was constrained by decades of routines and tradition. Interestingly, many of the novel concepts and techniques used by Fender had been in use for many years in other industries. Though these techniques and concepts were new for the instrument industry, they were not *intrinsically* new. However, innovation based on existing knowledge and which provide solutions to practical problems is often more important than the creation of new knowledge (Hirsch-Kreinsen et al., 2006). The example of Fender in its early years clearly exemplifies this.

[5] See section **Error! Reference source not found.**.

[6] At the time, the casing of radios and televisions was made of wood.

[7] Except the pickups – the sensors which transform the vibration of the strings and transform it into electric current (Fender, 1957a, 1961).

A last source of innovation for Fender was its customers. Interestingly, in contrast to what generally happens in low-tech industry, where firms typically innovate through suppliers (Pavitt, 1984), a major source of inspiration for Leo Fender was his frequent interactions with local professional musicians. For instance, at their request, the tuners (machine heads) were all placed in line on the same side of the neck for a more convenient access (Fender, 1951b) and the bridge[8] of the guitar was fitted with adjustable saddles that enabled to adjust the intonation of the guitar[9] (Fender, 1951a).

Local professional musicians hence played the role of lead users (von Hippel, 1986). As early adopters of electric guitars, they felt needs that the rest of the population only felt months or years afterwards. Some of them, who adopted the Telecaster at a stage where it was closer to prototype than finished product (using software development terminology, at 'alpha' or 'beta' stage) encountered problems long before mainstream customers did. Many of them shared ideas with Fender in hopes Fender would improve the product or even produce a new one. As professionals, they had an extended knowledge of musical instruments. This way, Fender was able to offset the relative lack of knowledge in musical instruments of the company by using the knowledge of its early customers. User innovation certainly was instrumental in the success of Fender guitars. In fact, long before the concept was introduced in the literature, Leo Fender was using "external ideas as well as internal ideas" Chesbrough (2003) and therefore applied what was, decades later, coined as 'open innovation'.

The Telecaster[10] was released in 1950 at a retail price of $169.95 (equivalent to $1,470 now). At the time, Gibson's—then market leader—line consisted of seven electric hollow-body guitars priced between $97.50 (equivalent to $843 now) and $375 (equivalent to $3,244 now). Telecaster was initially frowned upon by most professional musicians who disliked its cheap and unrefined look. As noted in Utterback (1996), "[when] an invading technology first appears, the established technology generally offers better performance or cost than does the challenger,

[8] The bridge is the part on the top of the guitar on which the strings rest.

[9] Before that, a guitar with faulty intonation had to have its bridge replaced. Since the bridge was often glued to the top, this was a difficult operation.

[10] Originally released as 'Broadcaster', the guitar was renamed as 'Telecaster' following a lawsuit threat.

which is still unperfected". Telecaster was, by all means, unperfected, but was nonetheless rapidly adopted by many musicians and, as such, became an invading technology.

Indeed, in spite of obvious flaws, the product innovations embedded in Telecaster progressively convinced musicians of its worth. After an initial success amongst West Coast country music players, the adoption of Telecaster grew rapidly in the U.S. What had been originally dismissed by many as just a gadget proved to be, in fact, a radical innovation.

2.2.2. Stratocaster (1954): user innovation full throttle

Fender's engineering approach to guitar making was developed further for its next model of guitar, the Stratocaster (Fender, 1956). For this model, the 'electronic appliance' paradigm was used to an even fuller extent. This time, all the electronic components (even the pickups) were mounted on a white plastic pick-guard which was screwed to the body. Production was thus rationalised in two distinct processes: woodwork and electronics. Furthermore, all the main parts (neck, body, electronics) could be produced separately and were only assembled at the latest stage of production, which provided great flexibility in terms of operations management.

While Telecaster was about 'what is convenient to produce', Stratocaster was about 'what is convenient to use'. For Stratocaster, user innovation was used in its fullest extent. Leo Fender involved even more local guitarists in the design of the guitar and key innovations resulted from this collaboration. Stratocaster was the first guitar with 'body contouring'. The edges of the guitar, instead of being straight, were bevelled ergonomically to fit with the body of the player (Fender, 1959, 1960), so that the edges of the guitar would not hurt the player ribcage or forearm. It was also the first guitar to have a bridge that allowed full fine-tuning of intonation (with six individual saddles instead of one per pair of strings for the Telecaster). More importantly, the Stratocaster included one key radical innovation: it had a self-contained vibrato unit (an adjustable bridge, a tailpiece, and a vibrato system, all integrated in one component), that achieved what so many guitar makers had attempted but failed to obtain (Fender, 1956). This vibrato unit could be used without getting the guitar out of tune and could both raise and lower the pitch of notes. It has been, since, become an industry standard, copied countless times, marginally improved, but never surpassed. Stratocaster was released in 1954, at a retail price of $249.50 (equivalent to $1,934 now). It had, like the Telecaster, a one-piece maple neck and

an ash or alder body. The finish, though, had been upgraded to a two-tone sunburst paint. Though, as with Telecaster, adoption was originally slow, Stratocaster had become, by the early 1960s, one of the most successful guitar models and has remained so to this day[11].

Over the years, minor improvements were made to the Stratocaster. In 1959, the neck was upgraded with a glued rosewood fingerboard and the finish was changed to a three-tone sunburst (just like Gibson's models). A few months later, Fender was the first manufacturer to introduce 'custom colour' finishes, such as 'Candy Apple Red', 'Sonic Blue', 'Foam Green', all based on DuPont paints, originally used in the car industry. This caused quite a stir in the conservative world of musical instrument-making: Fender was building instruments that looked more like Cadillacs than guitars.

2.2.3. Process vs product innovation

Hence, the first Fender guitar models embedded both process and product innovations. According to Heidenreich (2009), process innovation is much more important in low and medium tech industries than in high-tech industries. At first, this may seem the case for Fender, since its 'electronic appliance paradigm' has indeed revolutionised guitar manufacturing by making it fit for mass production. Nonetheless, it is important to note that, while process innovation was indeed needed to lower the cost of production (Utterback, 1996)—Fender would not have been able to compete, had it used the traditional methods of guitar manufacturing—and make up for the local lack of knowledge and skills, it was not as critical as product innovation. The most crucial innovations introduced by Fender at that time did not stem from the need to lower production costs, but, instead, to what Leo Fender thought was convenient for musicians.

Even in the case of the Telecaster, where process innovation might have seemed more crucial than product innovation, the latter was, in fact, more important. This is demonstrated by the fact that Telecaster products innovations have been maintained and developed further, while most of the process innovations (e.g. guitar made of two woods, one-piece neck) were

[11] These two models are part of the very few models of guitars whose production has never been interrupted since their initial release.

subsequently dropped and replaced by more costly (and more traditional) manufacturing processes (e.g. maple neck with glued rosewood fingerboard). Actually, many of the process innovations (e.g. bolted neck, electronics attached to the pick-guard), were considered by Leo Fender as product improvements, made for the convenience of customers (who could easily replace faulty parts).

Overall, in spite of his lack of knowledge in instrument building, Leo Fender's creativity has led him to develop radical innovations that have defined what electric guitar is. As noted by Hirsch-Kreinsen et al. (2006), professional creativity tends to matter more than the existence of a science base when it comes to conquering a market.

2.3. THE INCUMBENT: GIBSON OR THE TRADITIONAL PATH

During the early years of electric guitar, Gibson's approach was simply the opposite of Fender's. While the latter embraced the solid-body concept and was the first to promote it, Gibson, at first, simply did not believe in it. This is not very surprising, though, as established firms often ignore radical innovation when it first appears, simply because, in the initial stages, it is far from obvious that the radical innovation will have any impact at all (Utterback, 1996). Thus, when famous guitarist Les Paul visited Gibson headquarters in 1946 to demonstrate a prototype of a solid-body guitar he had built, Gibson's executive laughed at him.

However, as noted in Utterback (1996), "radical technological innovation can emerge and successfully invade—and eventually overwhelm—the established technology in almost any circumstance." As the sales of Fender Telecaster began to grow significantly, Gibson was forced to join the movement.

In 1951, Gibson started to design its own version of a solid-body. To ensure an immediate success, they asked Les Paul (the same they turned down five years before) to endorse the new guitar which was released under the name 'Gibson Les Paul'. Gibson's approach to solid-body guitar building was also diametrically opposite to Fender's. Whereas Fender's guitars looked like no other guitar, Gibson's solid-body guitar simply looked like any other. In fact, it looked just like a slightly smaller version of Gibson's hollow-body electric guitars.

Gibson's strategy at the time provides a good example of a shortcoming that many incumbents have: when established companies try to fight back newcomers, they often choose easier solutions and, instead of using bottom-up approach, they often only amend their product slightly (Utterback, 1996). In contrast to Fender Telecaster, the Les Paul has all the Gibson usual aesthetic refinements (pearl inlays, binding around the body). The neck, glued to the body, was made of mahogany with a glued rosewood fingerboard. The headstock had the same shape as any other Gibson guitars. In fact, the only visual characteristic that separated the Les Paul from the rest of the Gibson's line was its smaller body.

Even so, even a closer look at the body makes it still difficult to notice any significant difference. It is, obviously, devoid of sound holes but the top of the body even retains the usual Gibson carved 'arch-top' shape. Although its influence on the sound in a solid-body guitar is more than arguable, the carved top of the Les Paul is very important.

Gibson's initial success in the instrument-making industry was in a large part caused by their ability to adapt the concept of arch-top, originating from the violin manufacturing, to mandolins and guitars. Building carved top requires much more craftsmanship than for a flat top. This is for this very reason that Gibson decided to fit one on the new Les Paul: they knew that Fender had neither the tooling, nor the knowledge to do the same with their guitars.
A further distinction with Fender guitars, whose body is made of one piece of ash or alder: the Les Paul body is made of one piece of mahogany (for the back) and one piece of maple (for the carved top) glued together. The combination of these two different woods gives the Les Paul a unique sonic signature.

The downside of making the Les Paul body similar to a 'real' guitar is that it is significantly thicker than the Fender's (more than 5.5 cm for the Les Paul vs. less than 4.5 cm for the Telecaster and Stratocaster). It is also significantly heavier (around 4.5 kg for the Les Paul vs. 3.5 kg for the Stratocaster and 3 kg for the Telecaster), to a point that it may be challenging to play standing for a long time. The guitar is also imperfectly balanced, which makes it difficult to be played seated. In contrast, Fender guitars are known for being light and perfectly balanced in both seated and standing position.

In order to keep the dual-layer design of the body hidden and to emphasise the luxurious design of the instrument, the Les Paul was originally supplied with a 'gold-top' finish: the top of the instrument was painted in gold, while the back and the neck used the usual brown colour. It was fitted with two pickups and with a combined 'trapeze' bridge and tailpiece which not only did not allow any intonation adjustment, but also had an inadequate design and was incorrectly fitted during the initial production run.

It might seem surprising that the first solid-body guitar produced by a company which had been at the cutting edge of innovation for five decades and which aimed to compete with the radically innovative Fender guitars did not embed any actual innovations. Utterback (1996) shows that firms that have gained industrial leadership through innovation often fail to shift to newer technologies. Incumbents have many reasons not to devote resources to developing radical innovations as they have significantly invested in the current technology, which creates inertia in the decision process. To compete with Fender, skilled labour and advanced tooling were not required, only practical thinking and common sense were. However, this was not what Gibson had invested in.

The Les Paul was launched in 1952, at a retail price of $210 (equivalent to $1,652 now), $20 more than the Telecaster's price at the time. Such a small difference in price is quite surprising: not only the Les Paul is more expensive to produce (more labour intensive, more expensive wood, etc.) but the brand power of Gibson was, at the time, significantly stronger than Fender's. This could reflect the fact that Telecaster was priced, not in relation to its cost of production, but, instead, in relation to what Fender estimated the willingness to pay for such an instrument would be. Furthermore, Fender was a very young company and had not reached yet the level of output enabling economies of scale. Although Telecaster is, theoretically, much cheaper to produce than the Les Paul, the respective situation of both companies at the time may have led to the production costs of both guitars to be very similar.

Some minor improvements were brought to the Les Paul over the next few years after its initial release. In 1953, the faulty trapeze bridge/tailpiece was replaced by another combined bridge/tailpiece that corrected the previous issues but was still not adjustable. In 1955, a fully adjustable bridge, with six individual saddles, was finally introduced. Two major upgrades, a radical one and an aesthetic one, were subsequently brought about. All the guitar pickups used

at the time had a common shortcoming: they were extremely sensitive to electrical interferences. In particular, they would all, more or less loudly, produce a 60 Hz hum, characteristic of the alternative current. By attempting to build hum-free pickups, Gibson came up with a radical innovation that profoundly changed the electric guitar industry. Gibson's 'humbucking' pickup used two magnetic coils (previous guitar pickups only used a single coil) of opposite polarity wired together. However, Gibson's invention went further than just creating a hum-free guitar: it created a new sound. Humbucking pickups have more output than single coil pickups and have a 'rawer' sound. Starting from 1957, these new pickups were soon fitted on all Gibson's line and became a crucial part of Gibson's sonic signature.

Although the sales of the Les Paul were, at first, encouraging, they had by 1958 started to decline. The golden finish was pointed out as the likely culprit and the finish of the guitar was changed to a, more traditional, cherry sunburst. The release retail price, in 1959, of the new version was $280. The sales, after reaching a peak in 1959, started to slump again.

The Les Paul models were discontinued in 1960 and replaced by a completely redesigned line, known under the name 'SG', which bore no resemblance at all to its predecessor. Whereas the original Les Paul model was clearly inspired by the traditional arch-top electric guitars, the new model undoubtedly took after Fender's Stratocaster. The SG had a small, thin and lightweight one-piece mahogany body with contoured edges. Like the Stratocaster it had two cutaways. It was released in 1961 at a retail price of $300 (equivalent to $2,000 now). Although this model sold relatively well, it had little, if any, impact on both Fender's growth and Gibson's decline.

Meanwhile, several rock stars, such as Eric Clapton, Jimmy Page, Keith Richard, had purchased second-hand Les Paul guitars and made them their instrument of choice. This sudden media exposure led to a steep price increase (reaching up to $1,000, equivalent to almost $6,000 now) on the second-hand market. The Les Paul was, eventually, reintroduced to the market by Gibson in 1968 at a retail price of $395 (equivalent to $2,366 now). The production of the Gibson Les Paul has, since, been uninterrupted.

In 1958, Gibson released a new line of guitars: the ES-3xx, also known as thin-line hollow-body. This new line was particular for two reasons: first of all, these were not truly solid-body guitars and, secondly, this new range was the last range of new instruments released after 1957

to be immediately and durably successful. The ES-335 is, together with the Gibson SG, the only Gibson electric guitar whose production has never been interrupted.

These guitars were the first semi-hollow-body[12] guitars to be mass-produced. In principle, they combine the qualities of both solid-body and hollow-body guitars. The body is hollow but has a central solid piece of wood on which the neck is glued and the pickups are fitted. In practice, they tend, instead, to have both the drawbacks of hollow-body (feedback at high volume) and solid-body (not loud enough to be played acoustically). However, their familiar and yet distinctive look may have convinced the most conservative guitarists to finally embrace the electric revolution.

3. THE INNOVATION DEADLOCK (1958–1984)

After the release of their initial and successful models, both Gibson and Fender continued innovating. First of all, they made improvements to the existing models, but very quickly also released new models.

3.1. FENDER: TECHNOLOGICAL FAILURE

Between 1958 and 1978, Fender released eight new upscale regular electric guitars[13]. Looking at Table 2, it is possible to identify two trends. The first one, which lasted until 1965 is an actual innovation trend: new models included innovations. The second trend, which started in 1965 and ended in 1978, is an expansion trend: new models did not include any actual innovation, but instead features usually associated with Gibson.

The Jazzmaster and Jaguar were meant to be top-of-the-range models. With these guitars (and later on, the entry-level model Mustang), Fender continued the path of innovation and improvements that had been very successful with the two previous models. The Jazzmaster and the Jaguar embedded a new innovative electronic system allowing to pre-programme a rhythm and lead sound. These models also included a new vibrato system, this time consisting of a

[12] Except the ES-330 which has a thin, but totally hollow body.

[13] These were supplemented by a large number of entry-level guitars and special guitars, such as 12 strings guitars, bass guitars, etc.

separate bridge and tailpiece. The new vibrato system could be locked, thereby enabling the guitar to stay in tune even when a string breaks. A further 'improvement' of this vibrato system, in the form of a spring-loaded string mute, was inaugurated with the release of the Jaguar. These new guitars were based on a patented 'offset-waist' shape allowing the guitarist to play more comfortably while seated.

In parallel with these improvements, Fender started to explicitly target Gibson's market. In order to make the Fender guitars look more traditional, the one-piece maple neck was replaced by a maple neck with a glued rosewood fingerboard (the neck looks brownish, like most guitars, instead of looking yellowish). Special 'Jazz' pickups (with a mellower tone) were developed for the Jazzmaster in order to lure professional players. These new single-coil pickups were much bigger than the ones used by Fender before and looked very much like Gibson's own single-coil pickups, the P-90. For the Jaguar, Fender went back to its traditional small pickups, but added some extra shielding (the Jazzmaster had been heavily criticised for its ability to pick up interferences). In addition, the Jaguar was equipped with a shorter neck, which was a Gibson usual features.

In contrast to the innovations developed for the Stratocaster, most of which became over the years industry standards, the new technologies embedded in the subsequent models were almost complete failures. The new vibrato proved to be far less efficient than the previous one and would even lead to strings getting dislodged from the bridge if the guitarist applied a little more strength than usual. Its only advantage was to stay in tune if a string broke, however, only if the player had thought about engaging the lock before the breakage occurred.

Nevertheless, the biggest failure was certainly the string mute switch introduced with the Jaguar. This failed innovation is, in fact, crucial, since it reveals the rift that had grown between Fender and the guitarists and Leo Fender's increasing misunderstanding of the guitarists' needs. Since the initial release of the Telecaster, Fender guitars had been supplied, for aesthetic reasons, with a metallic bridge cover. Because this cover prevented guitarists from muting the strings with their hand, these covers were most of the time discarded by musicians (hence their 'ashtray' nickname). Fender was aware of this, but instead of simply removing this part, it continued to supply it on the new models and designed a spring-loaded string mute which was

totally impractical. This lack of understanding led to further problems, since one of the main sources of instability of the new bridge was, precisely, that guitarists continued removing the bridge covers on their guitars. While the bridge cover was a completely inessential part of the Stratocaster vibrato, which could function normally without the cover, it was, by design, a fundamental element of the new vibrato system.

The growing gap between Fender and the guitarists is further revealed by the development of the new 'offset-waist' body, which was expected to increase the comfort of guitarist when playing seated. Unfortunately, the new body shape was introduced at the time when most performers, at least those most likely to choose Fender, where playing standing. Furthermore, this made the body longer and heavier, which was a nuisance when playing in a standing position. Likewise, the new electronic circuit, although it was, indeed an improvement, was considered by many guitarists as too complicated to operate. Whereas the Stratocaster had one switch and three controls, the Jazzmaster had four switches and two controls and the Jaguar six switches and two controls (this was the first time in the history of guitars that players had to read a manual in order to be able to operate their instrument).

Both the Jazzmaster and the Jaguar enjoyed a burst of popularity after their release, but the interest in these models faded quickly and sales remained much lower than those of the Stratocaster and the (by then almost 15 years old) Telecaster. This is particularly ironic when one considers that Fender did not aim, at first, at market segmentation but thought that the Stratocaster would supplant the Telecaster and would, in turn, be replaced by the Jazzmaster. After 1965, none of these new "improvements" (besides the rosewood fingerboard) were used for new models. The subsequent models released by Fender did not embed any actual innovation and were clearly targeted at capturing Gibson's market. In 1966, Fender released a thin hollow-body, the Coronado, which was very much like the then very successful Gibson ES-335, except that it did not have a central solid block (which is surprising since this block was a key element in the success of the ES-355) and had the traditional Fender bolt-on neck (which, unfortunately, gave a 'cheap' appearance to the instrument). This was followed by the release of the first Fender full-bodied arch-top hollow-body (this type of guitar was the quintessence of Gibson's craftsmanship) guitar, the Montego, which also had a bolt-on neck.

The production of these guitars was plagued with craftsmanship problems. As opposed to Gibson's, Fender's workers were insufficiently skilled to handle the labour-intensive tasks that the production of such guitars required. Furthermore, Fender, as a firm, did not have the know-how required. These models sold very little and were quickly discontinued. Nonetheless, Fender pursued this trend and released two semi-hollow-body guitars, in 1968 (Thinline Telecaster) and in 1976 (Starcaster), both of which had, at the time, little success. Also, since Gibson guitars were renowned for their humbucking pickups, Fender decided to introduce, in 1971, similar pickups for some of its models.

Yet by 1981, all Fender's 'Gibson-like' models had been discontinued. It is also important to note that none of these developments were conducted in-house, due to a lack of knowledge, and that Fender had to hire Roger Rossmeisl, a renowned luthier, and Seth Lover, the designer of the Gibson humbucker, to pursue these lines of development.

3.2. GIBSON: DESIGN FAILURE

Table 3 shows that, after the release of the Les Paul, Gibson seldom introduced technological innovations. The stereo output (which allowed to amplify each pickup separately) and the Varitone (a mid-range tone cutter), introduced in 1958, were only used for a handful of models and, eventually, were discontinued. Mini-humbuckers, introduced in 1963, were disliked by most players because they failed to produce the same sound as regular humbuckers. Gibson's multiple unsuccessful attempts to push consumers to adopt low impedance pickups also reveal a misunderstanding of the market. Low impedance enables guitars to be recorded without an amplifier, thereby producing a very pure sound. However, most guitarists consider amplifiers and the sound distortion they bring about, as a key element of their personal sound signature. Gibson, apparently, had not yet realised at that time that the industry's original failure to produce high fidelity electric guitars led to the birth of a totally new instrument to which most guitarists were more attached than to 'pure' acoustic sound.

In 1977, Gibson released the RD model, which was the first Gibson model fitted with active electronics[14]. This was not, however, a real innovation. Leo Fender (who had, in the meantime, left Fender and founded another company) was the first to successfully bring this technology to the market with the Music Man guitars in 1976.

The rest of Gibson's innovations in the 1960s and 1970s mostly relate to design. Starting in 1958, Gibson tried to attract a younger public, which was the core of Fender customers, by releasing models with highly unusual shapes (Flying V and Explorer). These models were, indeed, futuristic and undoubtedly too modern for their time. Both models were discontinued after barely a year of production and only a few units were sold. Nonetheless, they enjoyed a posthumous success (Flying V was reintroduced in 1965 and the Explorer in 1975). A similar situation occurred with the multiple variants of the Firebird which all had been discontinued by 1969.

It is important to note that, in contrast to Fender whose highly innovative shapes had little to do with design, but with ergonomics instead, Gibson's new models only aimed at looking modern and were unergonomic (for instance, because of its v-shape, Flying V cannot be played easily while seated).

Gibson's attempt to capture Fender's market becomes even more obvious during the 1970s. The L-6S (1973) was fitted with a new electronic circuit that could (supposedly) emulate Fender Stratocaster and Telecaster sounds and also had, a first for Gibson, a bolted neck. The Marauder (1975) also had a bolted neck and combined one humbucker (traditional for Gibson) with a small-sized single-coil (traditional for Fender). With the S-1 (1976), Gibson borrowed even more from Fender, since it was the first Gibson to have the usual Fender three single-coil pickups arrangement.

3.3. THE ROOTS OF THE INNOVATION DEADLOCK: UNSUCCESSFUL INNOVATION AND CONQUEST WARS

[14] An on-board pre-amplifier is fitted on the Guitar to prevent the quality of the signal from decaying while going through the lead cables.

The second half of the 1970s was for, both companies, low in terms of innovation. While many models were discontinued, no new models were introduced (besides some entry-level products) and only a few minor changes were made to the remaining models. This non-innovative period lasted until 1985, when both companies, which had been both bought out during the mid-1960s by large conglomerates, regained their independence.

Having a look at the product range of both Gibson and Fender in 1984, it is striking how little the range and the models have changed in comparison to 1958. Almost all the models that survived were introduced before 1958 and, although they may have evolved between 1958 and 1984, most models were back, at the end of this period, to having characteristics very close to their original ones. In contrast to the early years of electric guitars, the 1958–1984 years were, thus, a period of stagnation with regard to innovation.

Quite interestingly, this did not occur because firms did not innovate at all (a large number of new models were launched), but rather because innovation was hill-targeted. At first, large amounts spent in R&D produced technologies that were not adopted by consumers. Later on, Gibson and Fender engaged in a sterile attempt to capture each other's markets (Gibson by producing futuristic solid-body guitars and Fender by producing hollow-body guitars). The marginal improvements made to their competitors' products did not offset their lack of know-how in the competitor's domain.

4. EARLY INNOVATION IN THE ELECTRIC GUITAR INDUSTRY: A PATENT ANALYSIS

4.1. METHODOLOGY

We used USTPO patent databases to construct a database listing the patents registered by Gibson and Fender. The resulting database comprises 224 patents granted in 1890–2007. As the focus of this research has been put on the early years of electric guitar, only patents granted during the period starting from 1945 (when Fender was created) to 1984 are analysed. The patents of Leo Fender after his departure from the Fender company (in 1970) are excluded. The new database included 58 patents.

4.2. HYPOTHESIS

Based on the case studies detailed in the previous sections, the following hypothesis were developed:

1. Relationship between innovation and patents:
   (a) The evolution of the rate of innovation is reflected in the patent statistics.
   (b) Fender was overall more innovative between 1945 and 1984 and should have more patents than Gibson during this period.
   (c) Between 1945 and 1984, Gibson innovated mostly in design. Its ratio of design patents for the period should be higher than Fender's.
2. Relationship between innovation and patent citations
   (a) Gibson was founded 50 years before Fender, thus Fender should, overall, cite Gibson more than Gibson cites Fender.
   (b) Fender was overall more innovative between 1945 and 1984 so Fender patents for this period should be cited more than Gibson's.
   (c) The number of patent cross-citations reflects the efforts of companies to copy each other.

4.3. ANALYSIS

Table 4 presents the number of patents obtained by Gibson between 1945 and 1984. Table 5 shows, for both companies, the number of utility and design patents. This data is used in the sections below to validate the hypothesis developed in the previous section.

4.3.1. The evolution of the rate of innovation is reflected in the patent statistics

The Fender case study reveals a very high innovation period for Fender between 1945 and 1966. This highly innovative trend was then followed by a low innovation period during which Fender mostly aimed at Gibson's market share. These two trends are well reflected in the patent statistics: the number of patents obtained by Fender continuously increases in each five-year period and reaches a peak of 13 patents for the 1960–1964 period, after which the number of patents quickly drops and remains null for 10 years, between 1975 and 1984.

The Gibson case study shows that, after lagging behind Fender, in terms of innovation, in the late 1940s and early 1950s, Gibson, then, had a very innovative period until the end of the 1950s. Afterwards, Gibson did not innovate much, except in the second half of the 1960s (when,

for example, low impedance pickups were introduced). These various rates of innovations are empirically confirmed by the patent statistics. In relation to electric guitars, Gibson starts patenting after Fender, but the number of patent increases steadily until 1959. The next five years show a lower rate of innovation whereas the 1965–1969 period, with 5 patents granted, confirms a slight resurgence of innovation in the second half of the 1960s. Subsequently, the number of patents abruptly drops and only one patent in the next 15-year period is obtained by Gibson.

4.3.2. Fender was overall more innovative between 1945 and 1984 and should have more patents than Gibson during this period

This hypothesis is confirmed empirically. The patent statistics show that during the 1945–1984 period, Fender obtained, overall, almost twice as many patents as Gibson (38 vs. 20), that is, on average, nearly one more patent more than Gibson each year. The only five-year period when Gibson obtained more patents than Fender is 1954–1959, during the other periods Gibson patented much less than Fender.

4.3.3. Between 1945 and 1984, Gibson innovated mostly in design. Its ratio of design patents for the period should be higher than Fender's

The case study shows that, in particular starting from 1958, Gibson innovates mostly in terms of shape of guitars. Fender, in contrasts, repeatedly uses similar shape (e.g. the "off-waist" shape) for its guitars, but innovates a lot in terms of technology. Consequently, it is expected that the ratio of design patents should be higher for Gibson than for Fender. The data confirms this hypothesis, since, over the 1945–1964 period, 15% of Gibson patents are design patents, whereas only 10% of Fender patents are design patents.

4.3.4. Gibson was founded 50 years before Fender, thus Fender should, overall, cite Gibson more than Gibson cites Fender

Basically citations include previous patents that describe the relevant technology which was publicly known. Griliches (1990), Jaffe et al. (1993), Hall et al. (2000) discuss fully the advantages and disadvantages of using patent citations. Patent citations only capture the transfer of tacit knowledge. Another disadvantage is that the patent examiner can add citations he/she believes are applicable and the inventor might even not be aware of this previous invention. By

studying patents that cite a particular invention it is possible to identify the size of the technological impact of the cited patent (Hall et al., 2000). Jaffe et al. (2000) reported, however, that half of the citations did not correspond to any kind of knowledge flow. We will therefore use patent citations only as an indication of knowledge exchange between Fender, Gibson and the other companies.

Table 6 confirms, indeed, that Fender cites, overall, Gibson more than Gibson cites Fender. The fact that Gibson was founded more than 50 years could be a reasonable explanation for that, however, the statistics show that Fender's patent granted between 1945 and 1984 only cite 5 of Gibson's patent obtained before Fender was founded. Furthermore, the ratio of citation per patent is significantly higher for Fender in both own-citations (Fender patents cite on average 0.66 Fender patents, whereas Gibson patents cite on average 0.3 Gibson patents) and cross-citations (0.42 for Fender vs. 0.3 for Gibson).

This demonstrates that Fender is more constant in following development path while Gibson tends to make unrelated innovations without pursuing a particular trajectory, as confirmed in the case studies.

4.3.5. The number of patent cross-citations reflects the efforts of companies to copy each other

Table 8 shows the number and ratios of cross-citations per year. It empirically confirms the hypothesis that the number of cross-citations reflect the efforts of companies to copy each other. The case studies show that Gibson was the first to initiate this trend starting from 1958. This is reflected in the statistics by the peak in Gibson's cross-citations in the 1955–1959 period.

Fender started to explicitly copy Gibson in 1966. However, attempts to lure Gibson customers started as early as 1962. This is confirmed by the data. The number of Fender cross-citations grows steadily during the whole 1960s and reaches a peak during the 1960–1965 period. Furthermore, Fender copied Gibson's hollowbody models that started to be introduced before World War II. This is reflected by the number of cross-citations related to patents that were granted to Gibson before 1945. Fender cited four of them during the 1960–1965 period.

The copying trend continued until 1984. However, since no patents were applied for by either of the two companies between 1975 and 1984, this is not reflected in the patent statistics.

4.3.6. Fender was overall more innovative between 1945 and 1984 so Fender patents for this period should be cited more than Gibson's

Table 9 shows the number of citations of Gibson and Fender patents obtained between 1945 and 1984. The fact that Fender was more innovative than Gibson between 1945 and 1984 is clearly reflected in the patent statistics. At the time of this writing, Fender's patents are cited more than twice more than Gibson's (508 vs. 223). Furthermore, when considering the number of citations per patent, it is evident that the higher number of citations for Fender is not only due to its higher number of patents obtained by Fender during the period but also due to the fact that Fender's patents were more innovative and are, on average, more often cited than Gibson's (11.2 citations per patents for Gibson vs. 13.4 citations per patents for Fender).

CONCLUSION

What was demonstrated in the past sections is that the period of radical innovation that shaped the electric guitar as an instrument was, in fact, rather short. It lasted from 1945 to 1958, 13 intensive years that defined what most of electric guitars are still nowadays. The following years, from 1959 to 1984, were a period of innovation stalemate. Such a discontinuity is not, intrinsically, surprising. In most markets, long periods of continuity, when innovation is infrequent and incremental, are followed by periods of discontinuity when radical process of product innovations occur (Utterback, 1996). However, in the case of these two companies, this article has shown that continuity was not due to a lack of innovative activities, but instead to the fact that R&D was not well targeted and inventions it resulted in were not adopted.

While both companies had their share of successful and failed innovation, Leo Fender is often credited for having been a visionary and the 'true father' of electric guitar. It is undeniable that Fender has been far more radically innovative over the period and Leo Fender's open-mindedness and engineering approach to guitar manufacturing is clearly to be recognised as having enabled mass production (and subsequent mass adoption) of electric guitars. His use of user innovation was both clever and unorthodox and led both to inventions that responded to an actual need and provided Fender with a strong competitive advantage.

Compared with Fender, Gibson's successes appear almost accidental. Undoubtedly, the power of the brand, as well as the quality of its craftsmanship, enabled Gibson to succeed where other companies, with similar products, would have failed. Nonetheless, Gibson should not be blamed for not doing as well as Fender. It was, at the time a well-established and large corporation and it would have taken a lot of courage and leadership to switch resources from a tried and tested profit making type of product to an entirely new one with a totally uncertain future. To their credit, Gibson did try to innovate. However, using a totally top-down approach, without any user involvement, led them to fail more often.

Gibson still managed to survive, certainly partially because Leo Fender began to think he knew better than guitarists what guitarists needed and, abandoning user innovation, started to become as mistaken as Gibson. Another reason for this survival is the unique pool of skills that Gibson had and that Fender, despite numerous attempts, never managed to match. Hence, Gibson retained the advantage of being the sole able to mass-produce luxurious guitars. Access to skilled labour, thus, remained one of the competitive advantages of Gibson.

Another, more unexpected reason for which Gibson was not completely defeated is that its failed products, for which there was, originally, no market, eventually created their own. Years after being discontinued, models, such as Explorer or Flying V, were reintroduced, due to a high demand.

This last point relates to one of the surprising findings of this study. While Fender Stratocaster and Gibson Les Paul are both icons of Rock'n'roll music and while this very music led to the very high demand for these products, none of them were designed with Rock'n'roll players in mind (Fender targeted Country Music players and Gibson Jazz players). That these instruments revealed themselves perfectly fit for this new and incredibly popular music is, thus, a sort of accident that neither Fender nor Gibson had anticipated (or targeted). More surprising, both firms remained for years oblivious to the growing success of this new music and continued targeting traditional musical genres, in spite of the high demand that arose due to Rock'n'roll.

Gibson was the first to break this trend, by designing the avant-gardist Explorer and Flying V. But because they did not involve users in the design, these were initially unsuccessful and their posthumous success is also an accident.

In this respect, it is interesting to note that the renewed success of these two brands, from 1985 onwards, is largely due to the creation of 'custom shops' departments enabling users to design their own instruments. Part of the work of these teams is to mass-produce 'pro models' who are designed and endorsed by famous Rock guitar players (e.g. Eric Clapton, Jimmy Page, Jeff Beck, Slash). Thus, user innovation was a key element in the birth of the electric guitar. Acknowledging it would maybe have enabled Fender and Gibson to avoid 25 years of unsuccessful innovation.

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ANNEXES

Model	Telecaster	Les Paul	Stratocaster	SG
Manufacturer	Fender	Gibson	Fender	Gibson
Released	1950	1952	1954	1962
Discontinued	–	1961-1968	–	–
Launch Price	$169.95	$210	$249.50	$300
Equiv. Price[a]	$1,470	$1,652	$1,934	$2,212
Body	One-piece ash	Maple (top) Mahogany (back)	One-piece ash/alder	One-piece mahogany
Neck	One-piece maple — Maple and rosewood fingerboard (1959-)*[b]	Mahogany and rosewood fingerboard*	One-piece maple — Maple and rosewood fingerboard (1959-)*	Mahogany and rosewood fingerboard*
Body/neck joint	Bolt-on (screwed)	Set (glued)	Bolt-on (screwed)	Set (glued)
Pickups	2	2*	3	2*
Pickup type	Single coil	Humbucker (1957-)	Single coil	Humbucker
Adjustable intonation	Yes (by pair)	Yes (1955-)	Yes	Yes
Adjustable string height	Yes (by pair)	No	Yes	No
Finish	'Blond' (yellow) Custom colours (1959-)	Gold Sunburst (1958-)	Sunburst Custom colours (1959-)	Cherry
Cutaway	1	1	2	2
Body contour	No	No	Yes	Yes
Carved top	No	Yes	No	No
Binding	No	Yes	No	No
Inlays	No	Yes	No	Yes
Vibrato	No*	No*	Yes*	No*

Table 1: Gibson and Fender early solid-body electric guitars

[a] Current relative value in U.S. Dollar of the launch price.

[b] Items denoted with an (*) indicate a customisable option. For instance, Custom version of Gibson guitars were often fitted with three pickups; all non-vibrato guitars could be custom fitted with a vibrato unit; Stratocasters could be custom fitted with a 'hardtail' non-vibrato bridge.

Model	Released	Discontinued	Launch Price	Equiv. Price	Type	Novelties	Target
Jazzmaster	1958	1980	$329.50	$2,377	solid-body	Rosewood Fingerboard; two-part vibrato unit; 'Jazz' pickups; new electronic; offset-waist body shape	Jazz players (usually playing Gibson)
Jaguar	1962	1975	$379.50	$2,620	solid-body	New Stratocaster-type pickups; String mute; Shorter 'Gibson-like' neck and 22 frets	Own market and Gibson's customers
Coronado	1966	1971	$229.50	$1,477	Thinline hollow-body	First Fender hollow-body; new vibrato; binding; inlays	Gibson players
Montego	1968	1974	n/a	n/a	hollow-body	First Fender archtop hollow-body; first archtop with bolt-on neck	Gibson players
Thinline Telecaster	1968	1979	$332.50	$1,992	Semi-hollow-body	First Fender semi-hollow-body; two humbucker pickups (1971-)	Gibson players
Telecaster Deluxe	1972	1981	$440	$2,195		Two humbucker pickups	Gibson solid-body players
Starcaster	1976	1980	$850	$3,115	Semi-hollow-body	Semi-hollow-body; Two humbuckers	Gibson players

Table 2: Fender upscale models of electric guitars (1958–1978)

Model	Released	Discontinued	Launch Price	Equiv. Price	Type	Novelties	Main Target
ES-335	1958	–	$282.50	$2,038	Semi-hollow-body	First semi-hollow-body	Conservative players Own market
Explorer	1958	1959	$247.50	$1,786	solid-body	Futuristic design	Fender players
Flying V	1958	1959	$247.50	$1,786	solid-body	Futuristic design	Fender players
ES-345	1959	1982	$380	$2,723	Semi-hollow-body	Stereo output; 'Varitone'	Own market
SG	1962	–	$300	$2,072	solid-body	Contoured double cutaway design	Fender players
Firebird	1963	1969	$189	$1,288	solid-body	Neck-through design Futuristic design Mini humbuckers	Fender players
Crest	1969	1971	$895	$5,362	hollow-body	Entirely rosewood; golden hardware	Own market
Les Paul Personal/ Recording	1969 1971	1970 1979	$645 $625	$3,664 $3,217	solid-body solid-body	Low impedance pickups; new electronic circuit	Purists Session players Recording studios
Les Paul Signature	1973	1977	$610	$2,864	hollow-body	Thin hollow-body with low impedance pickups	Purists/Conservative Session players
L-5S	1973	1984	$895	$4,203	solid-body	Top-of-the line solid-body	Own market
L-6S	1973	1980	$495	$2,324	solid-body	New humbuckers; new electronic; 24-fret neck	Own market Fender players
Marauder	1975	1981	$349	$1,352	solid-body	Bolt-on neck, 1 humbucker and 1 'Fender-like' single-coil	Own market Fender players
S-1	1976	1979	$399	$1,462	solid-body	'Bolt-on' neck 3 single-coil pickups	Fender players
RD	1977	1981	$659	$2,267	solid-body	Futuristic design Solid-state active electronics Long 'Fender-like' neck	Own market Fender players
ES-347	1978	1985	n/a	n/a	Semi-hollow-body	New fine-tuning tailpiece	Own market

Table 3: Gibson upscale models of electric guitars (1958–1978)

Year	Fender	Gibson
1945-1949	1	0
1950-1954	3	2
1955-1959	6	9
1960-1964	13	3
1965-1969	11	5
1970-1974	4	1
1975-1979	0	0
1980-1984	0	0
Overall	38	20

Table 4: Number of patents, per year, obtained by Gibson and Fender

	Fender	Gibson
Utility	34	17
Design	4	3
Ratio	85%	90%

Table 5: Number of utility and design patents for Gibson and Fender (1945–1984)

Number of citations:	Gibson's patents	Fender's patents
– by Gibson	6	6
– by Fender	16 (5)	25

Table 6: Own and cross-citations of Gibson's and Fender's patents obtained before 1985 (in brackets: patents obtained before 1945)

Ratio of citations per patent:	Gibson's patents	Fender's patents
– by Gibson	0.3	0.3
– by Fender	0.42 (0.13)	0.66

Table 7: Ratios of own and cross-citations per patent of Gibson's and Fender's patents obtained before 1985 (in brackets: patents obtained before 1945)

Year	Fender cites Gibson	Ratio	Gibson cites Fender	Ratio
1945-1949	0	0	–	0
1950-1954	1 (1)	0.33	0	0
1955-1959	0	0	5	0.56
1960-1964	5	0.38	1	0.33
1965-1969	9 (4)	0.82	0	0
1970-1974	1	0.25	0	0
1975-1979	–	0	–	
1980-1984	–	0	–	
Overall	16	0.42	6	0.33

Table 8: Cross-citations between 1945 and 1984 (figures in brackets relates to patents obtained before 1945)

	Gibson Patents	Fender Patents
Number of citations	223	508
Ratio per patent	11.2	13.4

Table 9: Citations of Gibson and Fender patents, obtained between 1945–1984, to this date (2007)