THE AUSTRALIAN SCHOOL OF LUTHERIE: ORIGINS AND ACHIEVEMENTS

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ABSTRACT:

The acoustic guitar is the most popular instrument in the world because of its price, size and ubiquitous presence in popular music in the media and on the Internet. Most beginners purchase Asian-made instruments at the start, graduating to better guitars as they become more advanced. One possibility is obtaining an Australian instrument, either factory-made or hand-made. The Australian guitar industry is very small compared to overseas markets, and the custom industry is even smaller. Many Australians eschew the home grown product in favour of an exotic import, but in the classical guitar world, Australian guitars have become highly desirable and very expensive due to the original construction technique of using lattice bracing and carbon fibre. This paper discusses how this technique has created a relatively new school of Australian lutherie, which has finally come of age.

KEYWORDS: Australian guitar, design, carbon fibre, Nomex, lutherie

1.0 INTRODUCTION

Mention the word “guitar” to an orchestral violinist and they might look at you strangely shaking their heads and muttering sounds of disapprobation and negativity. Guitars are not serious instruments for many professional classically trained musicians (Somogyi, 2000). However, the guitar in all its guises is the most popular instrument in the world. Guitars come in a large variety of shapes and sizes to suit a range of playing styles and genres of music. There are steel string, nylon string, slide, resonator, gypsy, archtop, and electric guitars. They are used to play rock, pop, classical, jazz and folk styles. It is equally at home playing melodies and its ability to strum, or arpeggiate chords is unique to guitars and related string instruments. The accessories for guitars are many and varied: amplifiers, pickups, tuners, capos, plectrums, bottle slides, and effects boxes. There is but one piano, one flute, one trombone, but a multitude of guitars all of which are highly portable, relatively inexpensive and available (see Tyler & Sparks, 2002, for a history of the “immensely” popular guitar from the sixteenth century).

The beginner guitarist usually purchases a cheap Asian-made guitar, for less than perhaps a hundred dollars. Many beginners stay beginners, but a small number of guitarists progress to Japanese, Korean and American instruments. A few even yearn for Australian instruments. Many beginners learn on a nylon string guitar then move on to a “real” instrument with steel strings, electric or acoustic. A very small number of students learn to read music and learn to play from the classical guitar repertoire. Fifty years ago, these students would graduate to a high-end Spanish instrument, but more and more often, the intermediate/advanced classical guitarist desires to play a carbon-fibre, lattice braced guitar made by a custom Australian luthier, because of their reputation and the fact that so many concert guitarists play such instruments.

There certainly exists academic research about Spanish, American, Turkish, Italian, French and many other countries use of guitars and guitar-like instruments, but there has been very little interest in Australian guitar design and construction techniques. One exception is Atherton’s (1990) *Australian Made Australian Played* ground-breaking overview of Australian instruments, which highlighted the cultural and social capital that musical instrument makers have added to Australian life. This paper will hopefully extend on this previous research and encourage others to examine an area of expertise where Australians have excelled.

2.0 THE ORIGINS of AUSTRALIAN GUITAR MAKING

Australian guitars have had a relatively short life in Australia history. While the modern Spanish guitar has been credited to Antonio Torres in 1868, the steel string guitar started even earlier with American, C.F. Martin and claims an older pedigree from 1833. The Spanish guitar and the American acoustic guitar were not too dissimilar from the exterior, both had 6 strings, a feminine curvilinear body shape, and both used gut for strings, since monofilament nylon, and extruded steel wire had not been invented. Spanish guitars are essentially fan-braced below the sound-hole, while acoustic guitars are cross-braced across the entire soundboard area using a large X that intersects below the sound-hole. The resultant sounds are the result of the bracing style, soundboard material and the thickness of the wood. Backs and sides are essentially the same. Thus, nylon-string Spanish guitars utilise only the area under the braces, the lower half of the guitar, while larger, steel-string, acoustic guitars (with twice the string tension) utilise the entire soundboard area, making them louder, but also harsher sounding and also more prone to feedback when using a microphone.

There were no Australian guitars until after WW2. In 1946, Bill and Reg May founded the company, Maton Musical Instruments with Maton standing for May Tone. Bill was a jazz musician, teacher and custom luthier and Reg was a wood machinist. In the 40's, Maton produced high-end acoustic guitars for students and professionals and they used Australian woods with greater and lesser success (see Evans, 2006). In the 60's they started making electric instruments and also amplifiers under the name, Magnetone. In this post-war period Australian taxes on overseas guitars, and amplifiers made the Maton instruments more accessible to the buying public. The company became popular, and is now recognised around Australia as the iconic Aussie guitar, played by Tommy Emmanuel and many other celebrities around the world. In 2013, Maton sells mainly acoustic guitars, which account for 90% of their sales.

3.0 AUSTRALIAN CUSTOM LUTHIERS

Following the Vietnam War era of the 1960's, and the growing popularity of the acoustic guitar in folk, blues and pop music, a small coterie of Australian custom luthiers began making guitars in the 1970's. Individual guitar makers included Teen Goh, Graeme Caldersmith, Robin Moyes, Jim Williams, Gerard Gilet and Greg Smallman. Some were trained overseas by attending American, Charles Fox's Guitar Research and Design school, some were self-taught evolving their own style of making guitars through trial and error. Given the lack of scholarly interest in luthery at that time, instrument making was developed mainly through word of mouth and individual experimentation. The skills involved were highly refined woodworking and acoustical skills with measurement tolerances in fractions of millimetres using materials that were highly susceptible to climatic conditions, especially humidity. The making of a guitar involves a multitude of tools and jigs, and dozens of separate processes, all of which must be mastered in order for the instrument to be constructed. Thus, the custom luthier truly became a master of their art (Bailey, 2007).

It is worth noting that the word, "hand-made" is often used to distinguish the commercial, factory-built instrument from the boutique custom ones. The myth surrounding the hand-made guitar is that it is entirely made with the use of old- fashioned hand tools and lovingly crafted by a single luthier in a small workshop (Shaw, 2008). The fact is, that the vast majority of 21st century luthiers employ power tools and modern technologies, which allow them to build instruments more efficiently and consistently. Apart from a few exceptions, contemporary custom makers will prefer to use power tools, which have higher tolerances and perform a better job, than simpler, traditional tools (Solondz, 2000). The myths surrounding old-fashioned glues, finishes, and traditional woods, similarly need to be dispelled.

One of the distinguishing characteristics of the custom luthier is the ability to be able to customise any aspect of the guitar according to the choice of the client. The wood species, the grade of the timber, the final finish, the shape of the neck and body, the width of the fingerboard, the scale length and the size of the frets can all be changed. Maton currently offers around 25 different styles of guitars, some of which can also be customised, but soundboard bracing patterns remain tried and

true traditional designs, whereas custom luthiers offer a large choice of bracing styles, bridge shapes and materials employed (see King, 2010). For example the traditional shape of the acoustic guitar bridge is either pyramidal, or the typical bellied rectangle of the Martin guitar. Typical classical guitar bridges are usually simple rectangles. The custom luthier can change the shape, dimensions, weights and materials of the bridge in order to maximise the sound output, or colour the sound of the instrument.

Forty years ago there were only a handful of dedicated Australian professional guitar makers. Many of these pioneering luthiers had to work at other jobs, or sell other products in order to make a living. In 2013, the number of professional, semi-professional or serious amateur Australian guitar makers figures in the high hundreds. This remarkable surge of interest has come about for two main reasons: 1. the large numbers of guitar making students who have progressed through one of dozens of guitar-making courses available in Australian capital cities and regional towns, and 2. the availability of technical information in the form of instructional materials found in books and on the Internet. Exactly the same explosion of interest has occurred in other countries, especially the USA, which continues to develop steel-string acoustic instruments, in the Martin and Gibson style (Russ, 2011).

Guitar-making tuition has existed in Australia for at least 30 years. Jim Williams started a school at Brookvale, Sydney in the early 1980's. However, the first tuition in lutherie was that offered by Gerard Gilet in Sydney, at his workshop in Balgowlah, and later Botany. Gilet Guitars has produced acoustic and classical guitars, which were essentially hand-made instruments since 1976. Gilet Guitars also sold tonewoods and lutherie supplies and has had a constant stream of lutherie students since 1980. These students spent about 21 non-consecutive days constructing their own instrument, and were individually mentored in every stage of the guitar making process and taught how to use a range of jigs and specialty tools. Today, there are dozens of other guitar building courses located around Australia, including government level registered programs, various apprenticeships, and individual schools dedicated to only tuition.

While there are no associations of Australian guitar makers, there is an active community found on various Web forums such as the Australian and New Zealand Luthiers' Forum (http://www.anzlf.com). Australians have also written instructional books on guitar making (e.g. Williams, 1987), and received Australian government grants in order to further understanding of this hidden art (see Caldersmith, 1982). A recent two-volume book, *Contemporary Guitar Design and Build* (2010) by Australians, Trevor Gore and Gerard Gilet is regarded as one of the most advanced books on the subject, embracing both acoustical theory and practical instructions.

4.0 CARBON FIBRE and LATTICE BRACING

Arguably the most significant contemporary development in the history of the acoustic guitar occurred due to the use of thin strands of carbon fibre glued with epoxy resin in order to support a lattice of lightweight braces under a very thin soundboard (Okuda & Ono, 2008). This technique was pioneered by Australian luthier, Greg Smallman, who was also a keen model boat and airplane maker, hence the use of high-tech, lightweight materials (see Caldersmith & Williams, 1986). Carbon fibre is easily obtainable in the form of a woven webbed fabric usually obtained from boating supplies stores (see Fig. 1). Thousands of individual strands are spun to form filaments, which are then woven together to create sheets of carbon fibre fabric. By unweaving the fabric, an individual filament may be isolated and placed on the surface of diagonal braces made from light balsa wood. The resulting lattice is very rigid but also very lightweight providing a suitable base for supporting a 1.2mm (or less) thick soundboard typically made from Western Red Cedar (see Figs. 2 and 3).

The use of carbon fibre as an engineering material is not new. Thomas Edison in the late 19th century used thin strands in his first light bulbs, but it was not until the 1950's that extremely thin high-tensile strength carbon fibres could be manufactured. Modern carbon fibre is stronger than steel, lighter than wood, and powerfully resists stretching if it is glued with epoxy resin glues to create a composite material (Manders & Bader, 1981). Thus, a lattice-braced soundboard is thinner, lighter and able to vibrate better than its traditional counterpart. The material should not be confused with graphite,

which is also made from carbon. Carbon fibre reinforced materials are currently used on airplanes, spacecraft, motor vehicles, snow-boards, tripods, golf clubs, and tennis racquets (Loud, 1998). Carbon fibre is typically thought to make braces, and hence soundboards stiffer, but in reality it still bends, with its primary function being to limit the elasticity of the soundboard where it acts as a safeguard to the constant pull of the strings.

Since the 1980's, the guitar experiments of Greg Smallman were encouraged by Australian guitarist, John Williams, with lattice-braced guitars becoming the mainstay of the majority of concert classical guitarist in the world today. Carbon fibre reinforced guitars are considerably louder than most traditionally constructed instruments, but this volume comes at a price – they do not sound like traditional guitars. Lattice-braced guitars have a very strong fundamental tone, with individual notes sounding "dry", without harmonic complexity and richness, a recognised feature of good Spanish guitars. Thus, a typical carbon fibre guitar may not sound that impressive in the home of a practising musician, or the recording studio, but may sound wonderful in a large, acoustically suitable concert hall, where the harmonic richness can be provided by the walls and ceiling of the room.

The typical dry sound of the carbon fibre guitar can be minimised by judicious use of materials and brace design. For example, classical guitars made by Gerard Gilet, Peter Villaume and others in the last ten years have shown that the lattice braces need not be consistently straight pieces of reinforced wood typical of most standard lattices. American acoustic guitar braces need to be scalloped (shaved) in order that the soundboard vibrates to particular patterns. By scalloping the braces of the carbon fibre lattice a similar effect can be obtained, and the dryness of the carbon fibre tone minimised. Also using an all-balsa wood lattice creates an equally stiff and rigid structure, albeit lightweight. By using alternating balsa, and another slightly heavier wood such as spruce, cedar or pawlonia[1] the lattice itself can be tuned to be less stiff in certain areas, allowing the soundboard more movement and harmonic content. Unfortunately, many concert guitarists and intermediate level musicians have little understanding of carbon fibre construction. The mere mention of the words, "carbon fibre" can function as a marketing ruse for unsuspecting, cashed-up guitarists, with a variety of Smallman-type instruments now fetching many thousands of dollars all over the world. The method of construction however, remains an Australian invention, creating for the first time an Australian School of guitar making.

5.0 NOMEX and OTHER TECHNIQUES

The somewhat misnamed "double-top" guitar refers to the use of Nomex as a lightweight laminate core between two extremely thin sheets of wood. Nomex is a paper-based, honeycomb fabric soaked in resin, which is predominantly used in fire retardant clothes and internal panels in aircraft. In 1995, Matthias Damman, a German luthier is credited with the innovation of using a Nomex sandwich to produce guitars, which not only sound almost as loud as lattice-braced instruments, but also sound like real classical guitars. By using a thin 1.5mm Nomex core, two 0.6mm skins of wood can be glued above and underneath to create a lightweight soundboard (see Fig. 4). When used on a guitar, the laminated soundboard posseses a very fast attack and vibrates to produce a loud, articulate tone that resembles solid wood, without any loss of sound anywhere on the fretboard. Nomex guitars have become very popular in Europe and America, and the construction technique lends itself to a wide range of instruments including acoustic steel-string guitars, as well as mandolas, citterns, and ukuleles.

Australian guitar makers have embraced these high-tech materials, and a few Australian luthiers are now building guitars using Nomex laminates. Jim Redgate's double-tops are particularly highly regarded being played by many concert guitarists around the world. His own newly invented "wave" soundboard design combines aspects of Maccaferi /Selmer gypsy guitar design with the Nomex, lattice-braced and traditional techniques.

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[1] Pawlonia is a species of wood native to China and Vietnam, which is extremely lightweight but stronger and more warp-resistant than balsa wood.

The author's own experiments with Nomex have identified several misconceptions, which need further explanation. The scant information found on the Internet regarding Nomex construction methods declares that the Nomex laminate soundboard is lighter and thus more responsive than a traditional solid wood soundboard. Careful measurement of constructed Nomex soundboards shows that they are in fact heavier than a similar soundboard made from solid wood. The three plates together with epoxy glue actually increases the weight of the soundboard to about 200g, around 20-30g heavier than solid timber. Another issue with using Nomex is that the soundboard is not nearly as stiff as solid wood and has to be stiffened by other means in order to compete with solid wood. The fact that a Nomex, double-top guitar is louder is thus due the vibration of the outermost plate of wood, which certainly is thinner and lighter than a typical 2.2mm solid wood soundboard.

Innovative Australian luthiers have embraced Nomex construction and are using a variety of methods of bracing the soundboard. Traditional Spanish fan bracing, lattice/carbon fibre, steel-string X braces and curvilinear, falcate bracing have all been used in order to improve the sound of acoustic and classical guitars. The use of a curved bracing pattern is a feature of Gore and Gilet's research and described in detail in their book. By utilising lightweight laminated timbers, a curvilinear X can be created that smooths out acoustic inconsistencies due to unequal spacing of straight braces. Falcate braces can be adjusted to the overall shape of the guitar and designed to minimise the unevenness of traditional X bracing. Falcate braces can also be made from any material, not just wood. A recent acoustic guitar of Gilet Guitars combined extruded foam with carbon fibre for falcate bracing under a lightweight spruce soundboard with outstanding success.

6.0 CONCLUSIONS

One of the major problems plaguing not just Australian luthiers, but all instrument makers and players is that there is no accepted standard by which a guitar, a violin or even a set of drums can be said to sound good. There is no consensus on how to evaluate sound quality apart from subjective ratings. In the guitar world there are specific measurements in terms of the vibrational harmonic modes that can be assessed from the back, the soundboard and the air cavity. A simple tone generator can identify certain frequencies that are known to be useful to produce a quality tone, but these frequencies cover a fairly large range and are primitive tools, which are employed after an instrument is already constructed. Unfortunately, a tone generator cannot measure string attack, sustain, evenness, timbre or a number of other desirable acoustic qualities.

Probably the single most desirable quality in acoustic guitars is acoustic efficiency or more simply, volume (Moschioni & Saggin, 2004). If a guitar is loud then the importance of all other characteristics seems to diminish in comparison. This is where Australian guitars have had the most success. The lattice-carbon fibre method of construction utilises a thinner soundboard than other instruments - it approaches the thickness of the skin of a drum. When a string is plucked the transmitted energy is not impeded by the mass of the soundboard, nor dissipated into the sides of the instrument. The volume heard by the listener is noticeably louder allowing the performer a greater range of dynamics, and thus musical expression. There does exist a community of conservative dissidents who yearn for traditional instruments, but this group represents a small minority compared to the resounding success of lattice-carbon fibre guitars.

For the past 20 years Australian classical (and acoustic) guitars have steadily become more desirable as their reputation has grown. Greg Smallman never patented his method of construction preferring to share his knowledge with his peers, and so many Australian luthiers have copied and modified the lattice-carbon fibre technique. Various experiments have been tried with lattice size, orientation, different woods, and angles of connection, some with great success. Greg Smallman is now joined by Kim Lissarague, Graeme Caldersmith, Jim Redgate, Simon Marty, Gerard Gilet, Tony Morrison, Dan Kellaway, Peter Villaume, and many other luthiers around the country. Their guitars are sold by some of the world's most prestigious guitar salons, and played by some of the world's best players. The Australian School of Lutherie, which was born in the 1970's has finally matured and is enjoying worldwide independence and success.

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8.0 FIGURES

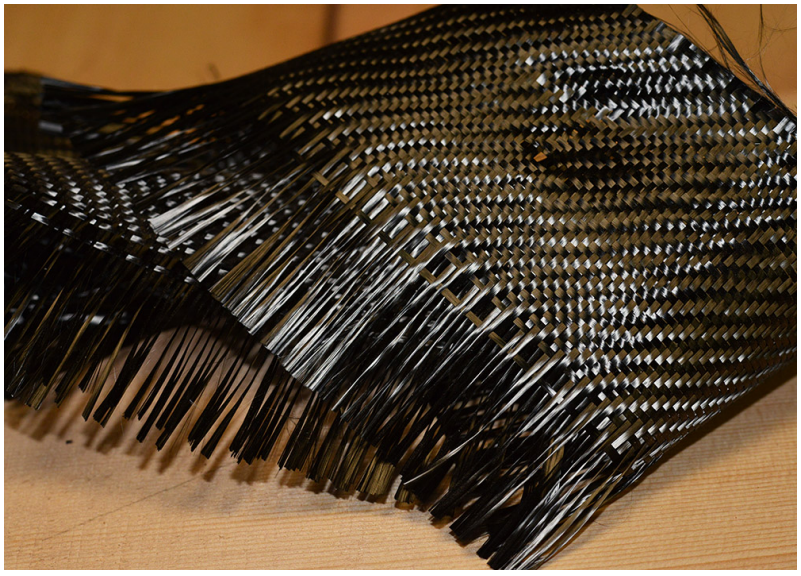

Fig. 1: *Carbon fibre woven fabric*

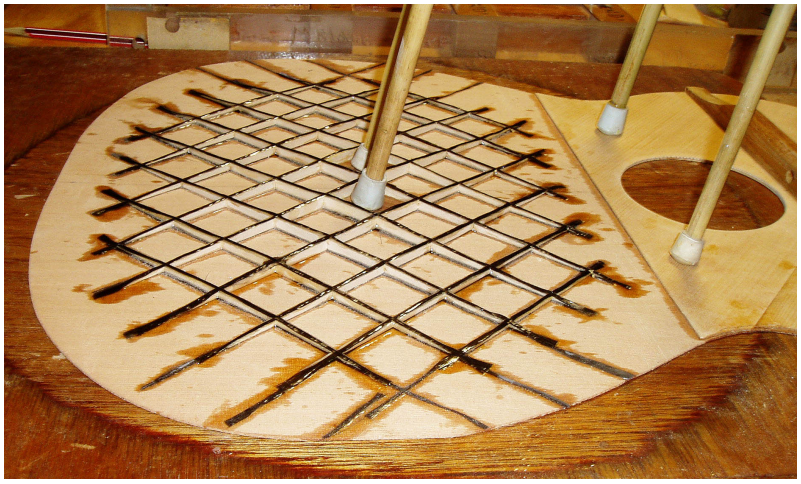

Fig. 2: *Soundboard with carbon fibre reinforced lattice*

Fig. 3: *Guitar carcass, showing laminated skeleton reinforcement for the sides.*

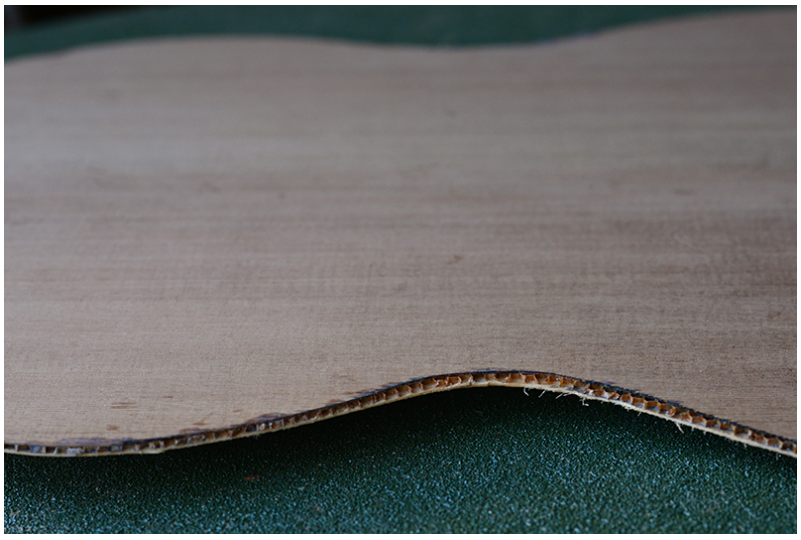

Fig. 4: *Laminate soundboard of Nomex core and solid wood 'skins'*