NEW OPTIMAL PROCESS OF MAKING A GUITAR

Wenbo Zheng

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Title NEW OPTIMAL PROCESS OF MAKING A GUITAR
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Abstract The purpose of the thesis was to design a guitar life cycle, based on the situation of the Chinese market environment. Being a guitar player, and also a guitar maker is the reason for choosing this topic. I had an experience of making my own guitar in 2009. The process I experienced is almost the same as that in a guitar factory. I desired to utilize my understanding to improve the guitar making process and design. The main purpose of the thesis was to design and make a guitar which would be popular in China. The design was to penetrate the market. There was knowledge and reasons for choosing appropriate raw material. History and culture were considered in the design process. The other purpose of the study was to design an efficient factory layout. And the factory designed in the thesis was to be located in China. The ways of dealing with Chinese suppliers were studied in the work as well as the guitar delivery methods in China. And according to the Chinese instrument market status, the thesis evaluated the marketing for the virtual factory. In addition, hiring and training employees was studied. In summary, the goal of the thesis was to help to reveal the mystery of the Chinese guitar market.
Keywords Guitar, History, Design, Production, Marketing, Selling System, Transportation
Miscellaneous The bachelor's thesis is available in the library of JAMK University of Applied Sciences.

Contents

ABBREVIATIONS AND GLOSSARY

Les Paul	A standard guitar shape, which was designed by Ted McCarty in the 50’s.
Strat	A model of electric guitar designed by Leo Fender, George Fullerton, and Freddie Tavares in 1954, and manufactured continuously by the Fender Musical Instruments Corporation to the present.
Portamento	A musical term originated from Italian primarily denoting a vocal slide between two pitches. For guitar, it is the endurance of sound.
Tele	The Fender Telecaster, colloquially known as the Tele, is typically a dual-pickup, solid-body electric guitar made by Fender.

1 INTRODUCTION

1.1 Motivation

A guitar is the most popular musical instrument all over the world. A slap-up guitar is a kind of culture and not only a product. I learned to play the guitar in 1998. Since then, the guitar has been an inseparable part of my life. Last year, I made two guitars for the first time. During the three months, I improved my understanding of making a guitar. Some good ideas about guitar production have remained in me. I desired to implement my ideas through this bachelor thesis. A perfect guitar is every guitar player's dream. It has been my intention to design a "perfect" guitar for the Chinese market for a long time. So the design and production of a guitar have been combined in this thesis.

1.2 Goals

The aim of the study was to improve the process of guitar production. It especially concerned the layout of a guitar factory. Improving the efficiency of guitar production was the most significant issue. A good factory layout saves time of transporting semi-manufactured goods, decreases the work load and improves the operation performance. The other aim of the thesis was to design a new guitar type. The new design was to be suitable for the Chinese

music culture and guitar players. The guitar type designed was to be at least theoretically within the reach of the customers of the Chinese market. To achieve the two aims in practice, there has been created a simulated factory located in China, established after intense observations. It is uniquely designed to produce the new type of guitar. The simulated business is a case study, which follows the life cycle of guitar production.

First of all, getting a Chinese supplier is necessary. The goal is to find economical suppliers. And the quality of raw materials has to be reliable. Secondly, the employees have to be well trained. The arrangement of the time-tables for workers could optimize the benefit of the factory (tasks, shifts, and holidays). Through the labor costs, the proper balance between the performance and investment level could be achieved. The third challenge is building a selling system. It should be able to integrate a variety of sales methods. The selling system should cover most of guitar consumers. It should spread information widely and smartly. The final element is the transportation from the factory to customers. The aim is to design low-cost packaging with low damage rates keeping the short lead time.

1.3 Research Methods

The implementation of the thesis combined the use of the Internet, articles and practical experience. The Internet represented the lion’s share of the resource material, including records of visiting famous guitar factory. Because this is a qualitative research, theory plays the biggest part. The precise data could not be found through any channel. But the author’s skills in Chinese

were an advantage in seeking information. There is a lot of information that could only be found in Chinese. The basic structure and theory is based on article reference. And in addition, the experience of making a guitar gave the author an idea of making a guitar. All the details of making guitars are in the author's mind. And one of the author's friends is a professional of musical instruments. I was taught everything about the guitar. He could be used as a source of knowledge.

2 GENERAL INFORMATION

2.1. Brief History of Guitar Development

Guitar ancestors can be traced back three thousand years BC, before the Egyptian Nefer, the ancient Babylon, and the ancient Persia, a variety of ancient plucked string instrument. Archaeologists found the oldest stringed instruments, bowl harps and tanburs.

FIGURE 1 Bowl harp

The raw materials are quite simple. Tortoise shells and calabashes are used to make resonators. A bent stick is used for a neck and one or more gut or silk are strings. Around 2500 – 2000 BC more advanced harps, such as the opulently carved 11-stringed instrument with gold decoration was found in Queen Shub-Ad's tomb, started to appear. (Paul Guy. 2001. A brief history of the guitar)

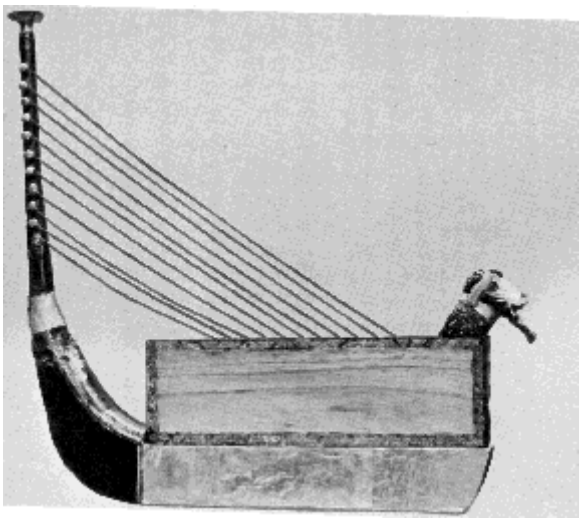

FIGURE 2 "Queen Shub-Ad's harp" (from the Royal Cemetery in Ur)

The oldest preserved guitar-like instrument belonged to the Egyptian singer Har-Mose. It is a 3500-year-old ultimate vintage guitar. (Paul Guy. 2001. A brief history of the guitar)

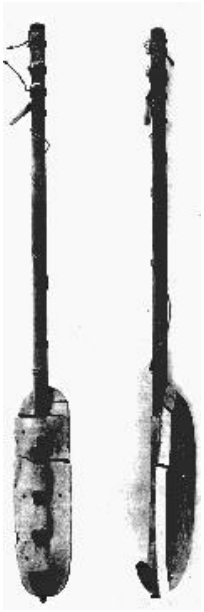

FIGURE 3 3500-year-old Ultimate Vintage Guitar

In early time, the Moors brought the oud to Spain. The Europeans developed the oud by adding frets and called the advanced oud as a “lute”. The other branch of development is in the Arabian counties. They changed its proportions of different components and remained fretless necks. (Paul Guy. 2001. A brief history of the guitar)

FIGURE 4 Lute

Guitars were defined as having “a long, fretted neck, flat wooden soundboard, ribs, and a flat back, most often with incurved sides” by Dr. Kasha. The name “guitar” comes from the ancient Sanskrit word for “string” – “tar”. So many stringed folk instruments that existed have names that end in “tar”, with a prefix indicating the number of strings:

Two = Sanskrit “dvi” – modern Persian “do” – dotar, two-string instrument found in Turkestan.

Three = Sanskrit “tri” – modern Persian “se” – setar, 3-string instrument, found in Persia (Iran)

Four = Sanskrit “chatur” – modern Persian “char” – chartar, 4-string instrument. Persia

Five = Sanskrit “pancha” – modern Persian “panj” – panchatar, 5 strings, Afghanistan

By the beginning of the Renaissance, the four-course guitar had become dominant, at least in most of Europe. The five-course guitarra battente (below) first appeared in Italy in around the 16th century. (Paul Guy. 2001. A brief history of the guitar)

FIGURE 5 Five-course Guitarra Battente

After that, the emergence of the model of the modern guitar is in the 19th Century. In around 1850, Antonio Torres, which is a Spanish guitar maker, expanded the body size, adjusted the proportions of different components, and invented the revolutionary “fan” top bracing pattern. It formed the modern “classical” guitar. (Paul Guy. 2001. A brief history of the guitar)

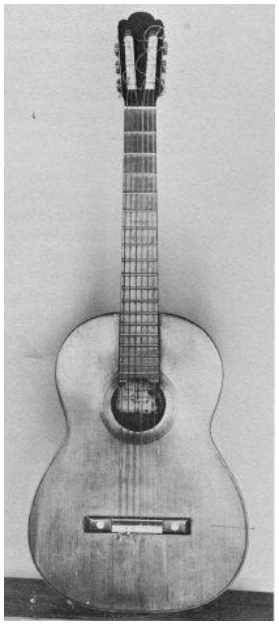

FIGURE 6 Guitar by Antonio Torres Jurado, 1859

In around 1900, Torres started making his breakthrough fan-braced guitars. After this new type had moved to the USA, steel strings first became widely available, because of X-braced tops. At the end of the 19th century Orville Gibson was building arch top guitars with oval sound holes. In the early 1920's, the designer Lloyd Loar joined Gibson, and refined the archtop "jazz" guitar (f-holes, floating bridge and cello-type tailpiece). Later on, between 1920 and 1940, electric guitars, amplifications and solid-body guitars sequence appear. (Paul Guy. 2001. A brief history of the guitar)

2.2. Types of a Modern Guitar

Classical guitar

The classical guitar is known, along the piano and violin as the one of the world's three most popular instruments. The junction between the neck and the body is usually located at the 12th fret on the fingerboard, which is wider than the others. Nylon strings make the classical guitar sound simple and honest. It is mainly used for playing classical music. There are strict requirement from the playing position to the fingers and intensive skill. The classical guitar is the highest form of guitar art. (Yun Xiyu. 2008. Guitar Classification)

Folk guitar

In the guitar family, the folk guitar is pervasive. Different from the classical guitar, the junction between the neck and body is usually located at the 14th

fret on the fingerboard, which is narrow. And the folk guitar uses steel strings and sounds crisp and bright. It is mainly used for an accompaniment to the country singer, folk and modern music. The form of performance is more relaxed and casual. And the folk guitar with a missing angle is a modern improved form. The electric folk guitar which has emerged in the recent years has brought great convenience to the stage. (Yun Xiyu. 2008. Guitar Classification)

Flamenco guitar

The flamenco guitar is the Spanish national instrument. The external appearance is basically the same as in the classical guitar. But there is a retaining plate on the panel. Flamenco is a nylon string guitar, which sounds harder and more brittle than the classical guitar. This guitar is especially for playing the Spanish folk music, with complex rhythm and rich skills. It has spread throughout the world and become a distinctive style. (Yun Xiyu. 2008. Guitar Classification)

Hawaiian guitar

The shape of a traditional Hawaiian guitar is similar to classical guitar. It uses steel strings. The position of plying Hawaiian guitar is flat on the leg, a hand-held metal slide bar pressing the strings, the other hand plucked with fingertip. The tone is gorgeous and good at melody performance. (Yun Xiyu. 2008. Guitar Classification)

Jazz guitar

As well as the electric guitar and folk guitar, jazz guitars are generally electric guitar with a resonance box. This type can be specially adjusted to produce a heavy soft effect. (Yun Xiyu. 2008. Guitar Classification)

Electric guitar

Electric guitars can have a solid body or a hollow body in accordance with the performance requirements. The neck is similar to folk guitar. Steel strings and magnetic pickups are used. It uses the speaker amplification audible acoustics signals, according to the principal of conversing string vibrations to electro-acoustic. Through the effects a variety of colourful sounds may be issued. It is now essential for pop music or rock music. There is plenty of peripheral equipment, for example, effects, amplifiers and so on. Through the decorating of peripheral equipment, electric guitars rise to various different types of sounds, which could figure according to personal interests. And the tools (picks, slide bar and others) could create more effect. (Yun Xiyu. 2008. Guitar Classification)

2.3. General Structure of an Electric guitar

The basic construction of an electric guitar is shown the figure below.

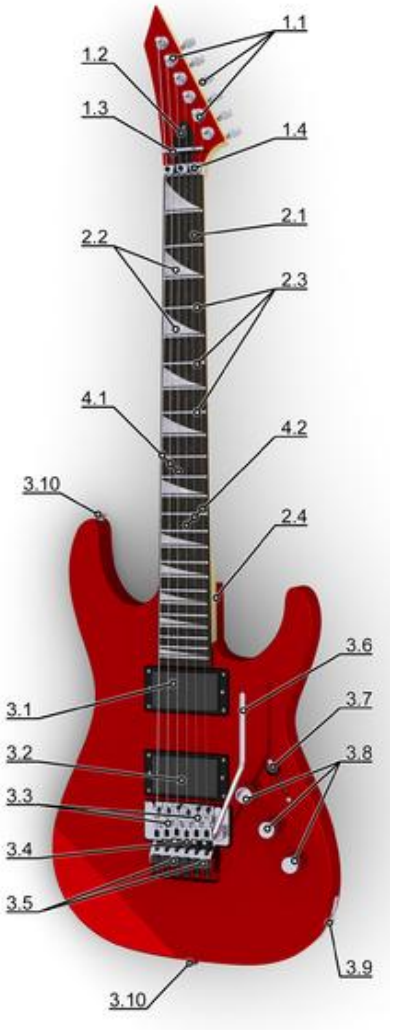

FIGURE 7 Guitar Structure

Controlling the figure 2.7, the name of each component is as follow.

1. Headstock: 1.1 Tuner; 1.2 truss rod cover; 1.3 string guide; 1.4 nut.

2. Neck: 2.1 fingerboard; 2.2 inlay fret markers; 2.3 frets; 2.4 neck joint.

3. Body; 3.1 "neck" pickup; 3.2 "bridge" pickup; 3.3 saddles; 3.4 bridge; 3.5 fine tuners; 3.6 tremolo arm; 3.7 pickup selector switch; 3.8 volume and tone control knobs; 3.9 output connector; 3.10 strap buttons.

4. Strings: 4.1 bass strings 4.2 treble strings. (Wikipedia. 2007. Electric guitar)

2.4 Guitar Shapes

The major innovation in guitar history, created a lot of classical shape. With the increasing demands of guitar players, a variety of different models has been improved continuously until now. (See Appendix 1 and 2)

3 MARKETING

In this chapter, a rough image of a guitar will appear by marketing the portion of different types of guitar. The analysis is based on the rank of customer concern degree.

And in the case, the location of the virtual factory is decided by the analysis of the regional structure of the production.

3.1. Current Trend

The chart below is a rank of electric guitar, based on the degree of concern.

TABLE 1 Chinayq Ranking List (Chinayq. 2010. Chinayq Ranking list)

Rank		Brand	Type	Price (Chinese yuan)
1		I-Ibanez	Ibanez AT300	¥12,400
2		I-Ibanez	Ibanez AT100CL Andy Timm	¥14,800
3		G-Gibson	Gibson Les Paul Classic	¥18,800
4		G-Gibson	Gibson ES－345	¥33,500
5		E-Epiphone	Epiphone B.B.King Lucill	¥4,450
6		E-Epiphone	Epiphone 1958 Korina Ex	¥3,600
7		G-Guina	Guina Metal Wing	¥0 (Not stable)
8		C-CORT	CORT M200	¥1,900
9		C-CORT	Cort Z22	¥1,700
10		C-CORT	Cort Z42	¥1,750

This figure shows the trend of popularity of the guitars in China, which is helpful in designing a new model especially for Chinese guitar players.

From the rank we can see that the “Soloist” possesses the highest degree of interest, because 4 out of 10 in the rank are Soloist.

In the rank, Ibanez AT 300 presents the most popular guitar characteristics. It is mahogany body, maple neck, and rosewood fingerboard, with S-S-H type ‘DiMarzio’ pickups and tremolos bridge.

3.2. State of the Chinese Musical Instrument Industry

In recent years, there has been a rapid development in the Chinese music industry. China has become the world’s third largest musical instruments producer, second only to the United States and Japan, including piano, guitar, violin, wind instruments, harmonica and other products. To the twenty-first century, China’s musical instrument industry has become to include a full range of a species supporting a complete industrial system of instruments, as the world’s largest musical instrument producer and seller. The Chinese guitar market is constructed by some foreign-owned, joint ventures, collective, township, private and individual economic ownerships. Out of 200 strong foreign instrument companies, 30% of their branches have settled in China. Because the low fixed cost and labour resources, it is a giant advantage to settle a guitar factory in China. Since 2005, musical instrument industry operation has turned from the extensive production towards intensive management. Through the foreign, state–owned, and private instrument

manufacturers benefiting each other, the overall level of our instruments has a relatively big increase in the corporate image and internal management. At present, the chain of instrumental industry in China is quite intact.

From January to May 2009, the value of the output of 316 manufacturers in the Chinese musical instrument industry was 6,130,000,000 Yuan, increased by 1.03%; the total industrial sales output value was 6.079 billion Yuan, risen by 1.83%; the total output value of new products was 369 million Yuan with an increase of 32.90%; the total export delivery value was 1.937 billion Yuan, down by 20.49%. Different types of musical instruments from January to May 2009, industrial output value of 444 million in musical instruments, increased by 9.37%, export delivery value of 150 million Yuan, down by 11.09 percent; west music industry 3.61 billion Yuan output value, down by 1.76%, export delivery value of 1.12 billion Yuan, down by 21.28%; 1.04 billion Yuan industrial output value of electronic musical instruments, risen by 0.52%, export delivery value of 498 million Yuan, down by 18.59%; instrument parts industrial output value 1.035 billion Yuan, increased by 8.78%, export delivery value of 168 million Yuan, down by 27.52 percent. (China Market research Network. 2009. 2009-2012 electric guitar competition in the industry structure and investment strategy research and consulting reports.) These data reveal the increasing domestic consumption, the increasing demands of new products, and the declined export amount.

4 CHOOSING RAW MATERIALS

4.1. General Categories and Properties of Guitar Woods

Alder

Alder wood is widely used for the production of a guitar body, because of its relatively light weight. A standard strat body which is made from alder wood should be 1.9 kilograms. The original colour is reddish. And it has a very full sound, which reflects very well in every frequency range. The wood surface lines are closed style, which means very smooth (See Appendix 3). So it is easy to be painted. Fender has used alder guitar body for many years. Sunset or pure paint is classical for alder. (Finefly. 2010. Wood property)

Ash

Ash is divided into two: one is the northern hard ash (hard ash); the other is southern soft ash, also called swamp ash. Northern hard ash wood is very hard, dense, and heavy (Strat hard ash guitar bodies are at least 2.25 kilograms). Because of its high density, its sound is sharp, resonant and with long portamento. The property of the sound makes hard ash also very popular. The general color for hard ash is cream. Swamp ash is also a very popular species, it is strong musical wood. It goes through different frequency ranges, from resonant to warm, very average. Its weight is light compared with hard ash (Strat swamp ash guitar bodies weigh less than 2.25 kilogram). Many of the early Fenders adopted swamp ash for guitar bodies. Its lines are open

style, which are very suitable for sunset color or varnishes. (as shown in Appendix 3) (Finefly. 2010. Wood property)

Basswood

Basswood, linden wood, first of all is a very light wood; the weight of a basswood strat guitar body is less than 1.8 kilograms. The main colour is white, but often there will be some ugly dark green stripes (See Appendix 3). But if you are lucky, you may find shiny tiger stripes as well. Basswood is identified for its cork, soft texture, wide gamut, and warmer and more beautiful tone. Lines are closed type, but will absorb a lot of paint, not for the light-coloured or transparent paint. Ibanez bass bodies have thicker and more non-transparent paint, because Ibanez prefers to use basswood for guitar bodies. (Finefly. 2010. Wood property)

Bubinga

Bubinga has a very high hardness (See Appendix 3), which is commonly used in bass neck or veneer. Rickenbacker (Company) uses bubinga for producing fret boards; Warwick (Company) uses it for manufacturing bodies. Bubinga has a relatively brighter medium frequency, generous and clear low-frequency. (Finefly. 2010. Wood property)

Koa

Koa, this very beautiful wood from Hawaii islands, is very rare. It is famous for beautiful wood lines. Upmarket lines appeal flamed, but the difference between flamed maples is that the lines of flames maples are horizontal, while the fire lines of figured koa are vertical (See Appendix 3). United States strictly controls cutting koa. Koa weight varies, but generally is toward biased wood. It

sounds perfect as a bass body. It is warm, thick, similar to mahogany, but more outstanding high-frequency than mahogany. Primary colour paint is most suitable for koa to highlight the beautiful wood lines. (Finefly. 2010. Wood property)

Korina

Korina produced in Africa, divided into black and white korina. Black korina weight is moderate, but light korina is usually used for guitar body. Its tone is similar with mahogany, showing a very nice olive colour. As well as koa, it sounds perfect for bass body. Tough of this wood is very smooth and delicate. Primary colour paint is more appropriate. The late 50's Gibson and Flying V used korina as raw material. White korina is basically the same, except the weight. White korina is biased towards moderate weight. (See appendix 3) (Finefly. 2010. Wood property)

Lace wood

Lace wood is mainly in Astralia, medium weight, lines are open, and the wood crack shape varies from small to big, like the retile's spot (See appendix 3). It is beautiful as a thin veneer; it sounds similar with alder as guitar body. (Finefly. 2010. Wood property)

Maple

Maple is often divided into two kinds of maple, Eastern hard maple (hard maple) and Western soft maple (soft maple).

Eastern hard maple (hard maple), hard maple is very hard, heavy, high density. It is usually used to produce guitar neck. The wood lines are closed

style. Sound is very bright, with long sustain, and there is a “bomb, stab” feeling. Varnish and gradient paint are suitable for it. (See appendix 3)

Western soft maple (soft maple), soft maple is found mainly in Western Washington Continent. It usually weight much lighter than hard maple, but sounds similar with hard maple has a strong impact. The flexibility is very good. Flamed maple and quilted maple belong to the Western soft maple, while birdseye maple belongs to the Eastern hard maple. (See appendix 3)

(Finefly. 2010. Wood property)

Mahogany

Mahogany is a widely distributed wood. The majority is in Africa. Best mahogany is from Honduras, Central America, is commonly used Gibson wood. It weights biased moderate. Lines are beautiful, and also very easy to paint. Sound is warm and full with good sustain. Varnish and gradual red are most suitable paint for mahogany. (See appendix 3) (Finefly. 2010. Wood property)

Padouk

Padouk is produced in Africa. Original colour is clear orange. After cutting and processing, padouk will turn to purple into brown side because of oxidation. The texture is smooth and soft. But like rose wood, padouk has the same opened-style lines (See appendix 3). And the tone is similar to maple, which is strongly stable. In addition, it did not fit any paint. (Finefly. 2010. Wood property)

Poplar

Poplar is another widely used wood with gray green colour (See appendix 3), which only used in pure paint. The weight is 0.75 KG heavier than alder. And the sound is similar with alder. (Finefly. 2010. Wood property)

Rosewood

Rosewood is a heavy timber, often used to make fret board. The sound for guitar body is warmer than maple.

Brazilian rosewood is particularly beautiful wood. The wood lines are wider than ordinary rose wood, and sometimes there are loading pretty volatile vortex line (See appendix 3). It is suitable to make fret boards and body surfaces. But it is very expensive, because Brazilian rosewood is protected by the united states as same as the koa. (Finefly. 2010. Wood property)

Walnut

Walnut has high weight, but lighter than hard maple. Sound is similar with hard maple, but be a little more warmth. Nice texture is open lines for the original paint.

Figured walnut is commonly used for veneer. The sense of wood lines is guite rough (See appendix 3). (Finefly. 2010. Wood property)

Zebrawood

This is a relatively heavy wood. The colours mixed in straight wood lines construct an obvious contrasting and make a strong sense of visual impact (See Appendix 3). And the sound is familiar with hard maple. (Finefly. 2010. Wood property)

The table below shows the usage for different woods.

TABLE 2 Wood Applicability (Finefly. 2010. Wood property)

	Veneer	Body	Neck	Finger board
Alder	O	O	X	X
Ash	O	O	X	X
Basswood	X	O	X	X
Bubinga	O	O (few)	O	O (few)
Koa	O	O	O	X
Black korina	O	O	X	X
White korina	O	O	O	X
lacewood	O	O	O	X
Hard maple	O	O	O	O
Soft maple	O	O	X	X
Mahogany	O	O	O	X
Padouk	O	O	O	X
Poplar	O	O	X	X
Rosewood	O (few)	O (few)	O (few)	O
Walnut	O	O	O	X
Wenge	O	O	O	O
Zebrawood	O	O	O	O

Based on the property and marketing data, maple made necks and stock heads, ebony fingerboard and basswood or mahogany body can fulfil the market demand best.

4.2. Pickup

Pickup is the soul of a guitar, responsible for the sound of the electric guitar. The basic structure of pickups is magnets surrounded by a coil of wire. When

the guitar string moves through the magnetic field of the magnet, the variations in the field cause the coil to generate a small amount of AC electricity. This electricity is a signal that will be transferred to the guitar amplifier. Variations in the magnet strength, shape and composition as well as the number of wire windings, wire gauge and composition make for a variety of tones and power output strength. (Alan Ratcliffe. 1998. Electric guitar pickups)

The simplest type of pickup is a single-coil pickup, which is with one wire coil surrounding the magnet structure. It is commonly seen on the Fender Stratocaster and similar guitars. This type of pickup generally has a more trebly sound with more “snap” and “punch”. Generally it has a lower power output. It tends to be susceptible to pick up “hum” from transformers or computer monitors. (Alan Ratcliffe. 1998. Electric guitar pickups)

The Humbucker type is a relatively complex pickup. Humbuckers have two coils and set of magnets in a clever arrangement which could cancel out most of the hum picked up by coils. It is a more powerful type compared with single coil pickups. Humbuckers have more bass and a smoother sound. And humbuckers give a variety of wiring because of tow coils and four wires are within. (Alan Ratcliffe. 1998. Electric guitar pickups)

Side by side with humbuckers there are other versions of humbuckers. These are humbuckers which are of the same size as a single coil. They are usually more powerful than standard single coils. The sound is more ‘snap’ series in phase which would give them very thin unusable sounds. (Alan Ratcliffe. 1998. Electric guitar pickups)

Stacked Humbuckers are made to look and sound very similar to a songle coil. They consist of two coils on the same magnet.

It is also usual to combine two or three pickups on one guitar. The combinations of guitar could dictate the range of sound available from the instrument. The three most common combinations are showed below.

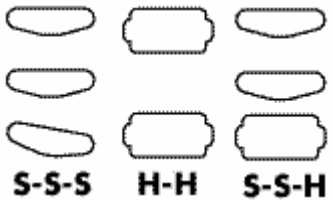

FIGURE 8 Combinations of Pickups (Alan Ratcliffe. 1998. Electric guitar pickups)

The ‘S’ means single coils, while the ‘H’ means humbuckers. The first combination (Three single coils) is quite flexible with a good range of five sounds. Two humbuckers is less flexible, but higher powered sound. Combination of two single-coils and one humbucker is the most flexible all-rounder. (Alan Ratcliffe. 1998. Solid Body Electric Guitars)

Based on the marketing section, author decides choose S-S-H type pickups with using brand DiMarzio.

4.3. Bridge

The basic usage of the bridge is to support strings. But today, it is more functional and are three modes for electric guitar developed, which are fixed bridges, tremolos and locking tremolos separately.

Fixed bridges are unmovable fixed directly onto the body without cavity routed out below. This means they have more sustain and tone with more stable tuning. The strings need to go through the body, rather than terminate at the bridge itself. (Alan Ratcliffe. 1998. Solid Body Electric Guitars)

Tremolos are designed movable. They can change the pitch of the notes played. But Because of strings would stick at the nut or bridge itself, the tune will go out of standard when tremolos aggressively are used. (Alan Ratcliffe. 1998. Solid Body Electric Guitars)

Locking tremolos is similar to standard tremolos. The difference is the strings are locked in place, so that tuning is very stable, regardless of how aggressively they are used. Tremolos are usually also fitted with a locking nut to further enhance tuning stability. Based on the stability this type of bridge has lots of space to lower or pullback. In the other hand, they make it is very difficult to change strings and tune before locking. Also, if a string breaks while playing, the rest of the strings go far out of tune. (Alan Ratcliffe. 1998. Solid Body Electric Guitars)

Which considering the function differences, marketing result, and special situation of supplier (See details in chapter 6), author uses Floyd Rose locking tremolos as raw material.

4.4. Truss Rods

A truss rod is used to stabilize the guitar neck and adjust the lengthwise forward curvature. Usually it is a steel rod that runs inside the neck and a bolt

that can be used to adjust its tension. Some guitars come with dual truss rods that are more stable and not affected by seasonal climate changes. These two different styles of truss rods are called “standard” and “bi-flex” truss rods. (Fender Support. 2010. Stratocaster Setup guide)

Standard truss rods have in turn two types: one that adjusts at the neck heel and one that adjusts at the headstock. They can counteract concave curvature in a neck that too much relief. (Fender Support. 2010. Stratocaster Setup guide)

The bi-flex truss rod system can only correct a neck that is too concave (under-bowed). It can compensate concave or convex (over-bowed) curvature by generating a correcting force in either direction as needed. (Fender Support. 2010. Stratocaster Setup guide) The price of Korean bi-flex truss rod is 15 Yuan per unit.

4.5. Fretwire

A fret is a raised portion on the guitar neck, which extends generally across the full width of the neck. Fret wire is made in a variety of crown heights, so after installing and levelling, they could lose from 0.1mm to 0.3mm in height. High fretwire has a crown height of 1mm or more. It may offer more note sustain due to its slightly greater mass, and more fret dressings are possible between refrettings. Low fret is often useful for partial refret jobs. And there are different dimensions for width. For distinguishing, the width from 1.35mm to 2.03mm is narrow fretwire; from 2.03mm to 2.41mm is medium fretwire;

from 2.54mm to 2.79mm is wide fret. (See appendix 4) (Stewart-MacDonald. 2007. Fretting supplies)

The applicability of different dimension can be illustrated by the table below.

TABLE 3 Applicability of Different Fret Dimension

	Narrow	Medium	Wide
Low	For modern standard mandolin		For electric guitar
Medium	For Martin guitar or pre-war banjo	For acoustic or electric guitar	For electric guitar or bass
High		For acoustic or electric guitar	For electric guitar or bass
Higher		For acoustic or electric guitar	
Pyramid			For electric guitar or bass
Highest		For acoustic or electric guitar	For electric guitar or bass

And it is obviously that medium fret is the optimal type for this case, after combining the introduction and marketing. This type is 350 Yuan per 20 meter.

4.6. Hardware

Tuning Head

Tuning heads are the part of a stringed instrument adjoined to the end of the neck, where the strings are wound. (Farlex Free Dictionary. 2010. Tuning Head Definition) They are responsible for adjusting the tone of guitar. The basic standard figure of tuning heads is the gearing varieties. The variety is the ratio of rotating speed between the handles and the axes. So the higher the variety is the better accuracy tuner has. During the installing, “3 left 3 right” and 6-in-line are the two options. It would affect the guitar design and visual effect.

Knob

The significant difference between different knobs is the appearance and material. The knobs will be used on adjusting the tone, volume or switching pickups.

Jack Plate

Jack plates are the frame of sockets, which used to connect pickups and amplifiers. The table below will illustrate the general situation of jack plates in current market. (Best Guitar Parts. 2004. Jack Plate)

TABLE 4 Jack Plate Market Situation

Price	Chrome	Silver	Black	Gold
Electro Socket Jack plate for Tele		$12.00	$12.75	$13.50

Cup Jack plate for Tele	$3.50		$4.00	$4.50
Jack plate for Strat	$5.00		$8.00	$9.00
Football Jack plate for side mount	$4.00		$5.00	$6.50
Square Metal Jack plate	$4.50		$5.00	$6.00
Discount Football Jack plate for Side Mount		$2.00		$2.00

4.7. Inlay

Guitar necks have marks on the 3rd, 5th, 7th, 9th, 12th, 15th, 17th, 19th and 21th frets. It usual inlays some images on the finger boards or the edge-on necks. The raw materials of inlay have three categories that distinguished by shape, blanks, pre-cut inlays and purfling.

Inlays are almost made by pearl and Abalone, but a small minority is made by plastics. The colours include in white pearl, figured white pearl, gold pearl, black pearl and green abalone.

FIGURE 9 Inlays

5 NEW FACTORY LAYOUT AND WORK FLOW

5.1. Machines

5.1.1. Machinery

Multi-functional Sliding Table Saw

This table costs 1890 Yuan/unit. The primary processing needs the table for shaping wood. It can also be used as a carving machine table.

The nominal parameter is 200V, 50Hz, 1800W, 4500Rpm. The blade size is Φ254xΦ15.9x2.8mmx40Z. The blade tilt range is from 0 degree to 45 degree. The normal blade cutting depth is 0mm to 65mm, while the maximum cutting ability is 65mm when it is 90 degrees and 47mm when it is 45 degrees separately. 650mm x 520mm (1334mm when an extension table is equipped) is the size of table. The scope of the left side sliding table is 840mm, while the right side sliding table is 210mm. The total weight is 52 kilograms. (Taobao E-Commerce Platform. 2009. Information Provision - Multi-functional sliding table saw)

FIGURE 10 Multi-functional Sliding Table Saw (Taobao E-Commerce Platform. 2009. Information Provision - Multi-functional sliding table saw)

MP-550 Automatic Programming CNC Milling Machine

CNC stands for Computer Numerical Control. The first benefit offered by all forms of CNC machine tools is improved automation. The operator intervention related to producing work pieces can be reduced or eliminated. The second major benefit of CNC technology is consistent and accurate work pieces. And the third benefit is flexibility. Since these machines are run from programs, running a different work piece is almost as easy as loading a different program. Once a program has been verified and executed for one production run, it can be easily recalled the next time the work piece is to be run. (CNC Concepts, INC. 2007. The Basics of Computer Numerical Control)

This type, MP-550, is very suitable for guitar production. Here is the main parameter: the table size is 690mm x 320mm, while T-slot size is 14mm; table can load maximum 300kilogram; the travel size is 550mm for X axis, 320mm for Y axis and 350mm for Z axis; the spindle centre to column distance is

330mm; door width 620mm; spindle taper is BT30; standard spindle speed is 1500/3000 rpm; the standard power of spindle motor is 3000w, while three-axis servo motor is 1000/1500w; power and pressure requirement are 7.5kw and 6 to 7 kilogram/ com; weight is 1400kg; position accuracy is 0.012mm, while repeat position accuracy is 0.01mm. And the price for one unit is 78500Yuan. (China CNC Machine Tool Network. 2010. Information Provision - MP-550 Automatic Programming CNC Milling Machine)

R-RP1300-1 Wide Belt Sander

A sander is a power tool used to smooth wood and automotive or wood finishes by abrasion with sandpaper. (Wikipedia. 2008. Sander) For model R-RP1300-1, the technical specification includes: maximum working width is 1300mm, while thickness is 2.5 to 1200mm; number 1 abrasive belt speed is 20m/s, number 2 abrasive belt speed is 18m/s; abrasive belt size is 1330mm x 2200mm; speed of conveyor is 6 to 38 meter/minute; total motor power is 56.7kw; working pressure is 0.55mpa; consumption of compressor air is 1.5 cube meter per minute; average speed of sucked air is 25-30m/s; overall dimension is 2700mm x 2100mm x 2000mm; and net mass is 3500kg. This China-made machine is approximate half cheaper than a normal one with powerful function, which is 30000 Yuan. (Woodworking Machinery Website. China Timber. 2010. Information Provision - Wide Belt Sander)

FIGURE 11 R-RP1300-1 Wide Belt Sander (Woodworking Machinery Website. China Timber. 2010. Information Provision - Wide Belt Sander)

Gang Drill

A gang-drill machine consists of several individual columns, drilling heads, and spindles mounted on a single base and utilizing a common table. Various numbers of spindles may be used, but four or six are common (Britannica Website. 2010. Gang Drill Definition). In this study, this machine is used to drill guitar stock heads. Considering the function is quite simple, the author decides to choose the cheapest and simplest type, which is only 4500 Yuan per unit. (Huicong E-Commerce Platform. 2010. Information Provision - Gang drill)

Buffing machine

Low speed 1100rpm buffing machine is ideally suited for polishing wood, acrylic, lacquered surfaces and plastics and so on. The kit costs 1500 Yuan, which, includes:

- 1100RPM, 3/4 HP Buffing Machine

- 6 x 12" diameter acrylic buffing wheels
- 1 x Plastic Buffing Compound (Fine)
- 1 x Plastic-Glo Buffing Compound (Ultra-Fine)
- 5 each 120, 240, 400 and 600 grit Wet and Dry Paper

The buffing machine features large diameter, extended shafts, allowing easy access of larger parts. Heavy duty cast iron formed the base and frame. Motor figures are below (Casewell, INC. 2006. Information Provision - Wood and Acrylic Polishing Kit):

- 3/4 HP, 115V, 60 Hz, 7.8 amps
- Rotation speed: 1100 RPM
- Spindle thread: 3/4" x 12 TPI
- Spindle length: 2-5/16"
- Base: 8"L x 5-3/4"
- Overall length of shaft: 30"
- Height of shaft center from bottom of base: 6.5"
- 12 month warranty

FIGURE 12 Buffing Machine (Casewell, INC. 2006. Information Provision - Wood and Acrylic Polishing Kit)

Band Saw (Metabo BAS 505G WNB)

A band saw is a power tool which uses a blade consisting of a continuous band of metal with teeth along one edge to cut various guitar work piece (Wikipedia. 2009. Band Saw).

The author chooses model BAS 505G WNB of brand Metabo. This is a well-known German brand. But the price is much cheaper in China, which is 19700 Yuan (including transportation fee). The detailed specification is below. (Taobao E-commerce Platform. 2010. Information Provision - Metabo Band Saw BAS 505G WNB)

- Dimension: 834mm (length) x 639mm (width) x 1860mm (height)
- Table size: 536mm x 640mm
- Height without bracket: 925mm
- Blade tilt range: 0 to 20 degree
- Cutting thickness: 280mm

- Cutting speed: 68m or 176m or 375m or 967m per minute
- Blade length: 3380mm
- Blade width: 6 to 25mm
- Input power: 1.5kw
- Output power: 1.1kw
- Weight: 146kg
- Voltage: 220V

FIGURE 13 Band Saw (Taobao E-commerce Platform. 2010. Information Provision - Metabo Band Saw BAS 505G WNB)

Curtain paint room

Curtain paint room consists of the room, groove system, curtain-like layer, sprayer system, steam water separation system, slag removal system and air exhaust system. The features are the use of curtain-like layer of water flowing to collect and remove paint mist; exhaust system guarantees that no paint

mist will escape. It maintain a good working environment. Basic theory is that sets a smooth stainless steel curtain board at the positive direction of the chamber. The water will be pumped up to the top of the overflow tank. The overflow will form a waterfall curtain. The flying painting mist will be absorbed by the water curtain once they encountered, and fall down to the bottom of accumulation tank. The painting mist without impact is guided by the fan and filter through spray-type water filter. Then paint will separate to gas and water by gas-water separator, and complete the whole process. Curtain paint room is also equipped a slag device, which can automatically clean out the sink in the paint residue. The operator could simply refresh the groove by the alarm system. And the rice is 50000 Yuan. (Chinese Manufacturing Network. 2010. Curtain painting room)

FIGURE 14 Curtain Painting Room (Chinese Manufacturing Network. 2010. Curtain painting room)

Ω Disk-type coating machine

Compared with traditional operation, this machine is able to save 30% to 60% paint. It recommends going together with curtain painting room, which can dramatically decrease pollution. The performance of painting is fine, uniform and stable quality, which can greatly reducing the manual spray supplement. The discharge amount can be adjusted accurately by the precision gear pump.

For employees, it is easy to operate after simple training. The lift system adopts PLC programmable computer control. The system can increase the dead-end rate. In aspect of security, the static electricity generator is made in Taiwan or the German original. There are automatic protections of leakage current, over voltage, and over current. And author assumes the price is around 30000 Yuan. (China Business Network. 2010. Coating machine)

Fret Press System

Pressing frets into place is a time-saving and accurate method widely used in guitar production. (Stewart-MacDonald. 2007. Fretting supplies) The price is around 1200 Yuan per unit.

FIGURE 15 Fret Press System (Stewart-MacDonald. 2007. Fretting supplies)

The dimensions of the machine are illustrated in the figure below.

Dimensions	
Base	9-1/2" x 4" x 2" high (241.30mm x 101.60mm x 50.80mm)
Overall height minus the ram	10-1/2" (266.70mm)
Ram length	7-1/2" (190.50mm) and 3/4" (19.05mm) square
Handle diameter	1/2" (12.70mm)
Handle length	11-3/4" (298.45mm)
Maximum vertical opening	4-1/2" (114.30mm)
Throat depth	4-3/4" (120.65mm)

FIGURE 16 Fret Press System Dimensions (Stewart-MacDonald. 2007. Fretting supplies)

Large drying room

This equipment can dry paint in 15 second by infrared rays.

Functions of the drying room include:

- Heating methods containing heating tube, infrared ray, oil, coal, steam.
- Automatic heating, automatic sleep timer
- Automatic temperature
- Low voltage automatic protection
- Automatically opening security gate when automatic anti-pressure device has indicated too large pressure
- Unique design of efficient heat exchanger, which could meet the requirement within 20 minutes.

The external dimensions of the room are 5000mm, 5000mm and 5000mm for length, weight and height, while the internal volume of the room is 4880mm, 4880mm and 4200mm for length, weight and height. For more figures, the

wind speed in the room during working is approximate from 0.3m/s to 0.5m/s; ventilation rate is 150 times/hour; operation temperature is between 20℃ and 80℃; diesel consumption 8 liters each time (diesel can be replaced by waste wood); requested electric power is 380V (three phases and four wires); the maximum temperature is up to 500 Celsius degrees; and hot air circulation is equipped. (Alibaba E-Commerce Platform. 2009. Information Provision - Large Drying Room)

The market price is 2800 Yuan/unit.

5.1.2. Hand Tools

Beside the machineries, some carpenter tools are also essential. Author following lists most of them. They are Strap buckle, glue, paint, fixture, screwdriver, laser range measurer, electric hand drill, fret slot saw and shaft, clamp, hammer, file, ruler, foot arc detector, and intonation tester.

5.2. Block Diagram

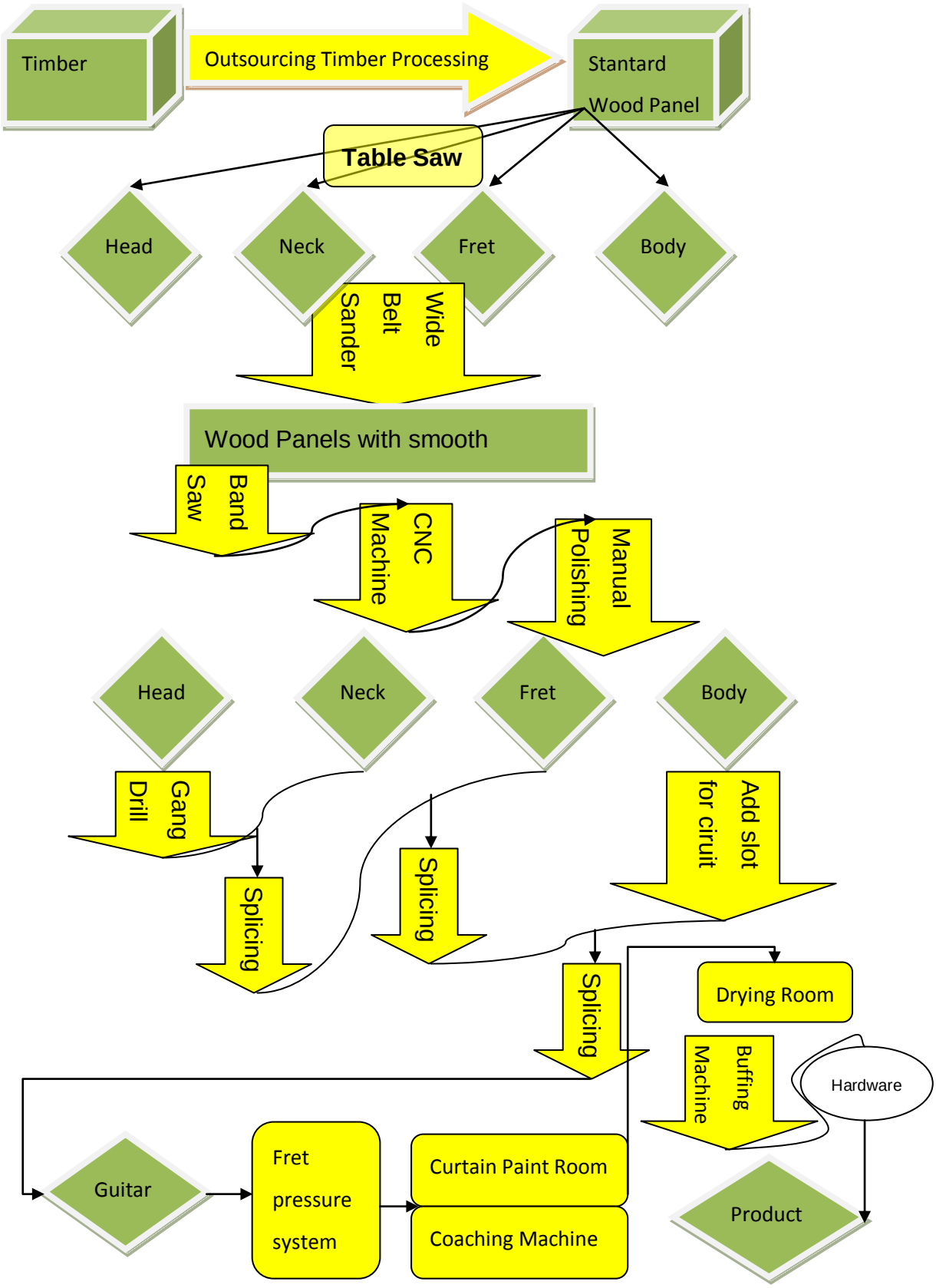

FIGURE 17 Block Diagram

First of all, the original woods are processed into standard wood panels. Then workers use table saws to cut wood panels into four different dimensions, which are suitable to make heads, necks, fingerboards and bodies. All the different panels go through a wide belt sander to have a smooth surface. After that an automatically programmed CNC milling machine can shape them. Then, workers need to polish those parts manually to make them fulfil the requirement of splicing. But there is a branch before they go splicing, which is using a gang drill to process 6 holes on head stock. During the splicing process, the head stocks are spliced with the necks first and following with fingerboards and bodies one by one. The rough guitar will dress on frets by fret pressure system, then go to curtain paint room and be painted by disk-type coating machine. Now drying room can dry paint. After drying process, workers use buffing machine to polish semi-finished guitar. Then in the final step, hardware includes pickups, switches, circuits, and knots are installed.

5.3. Layout Design

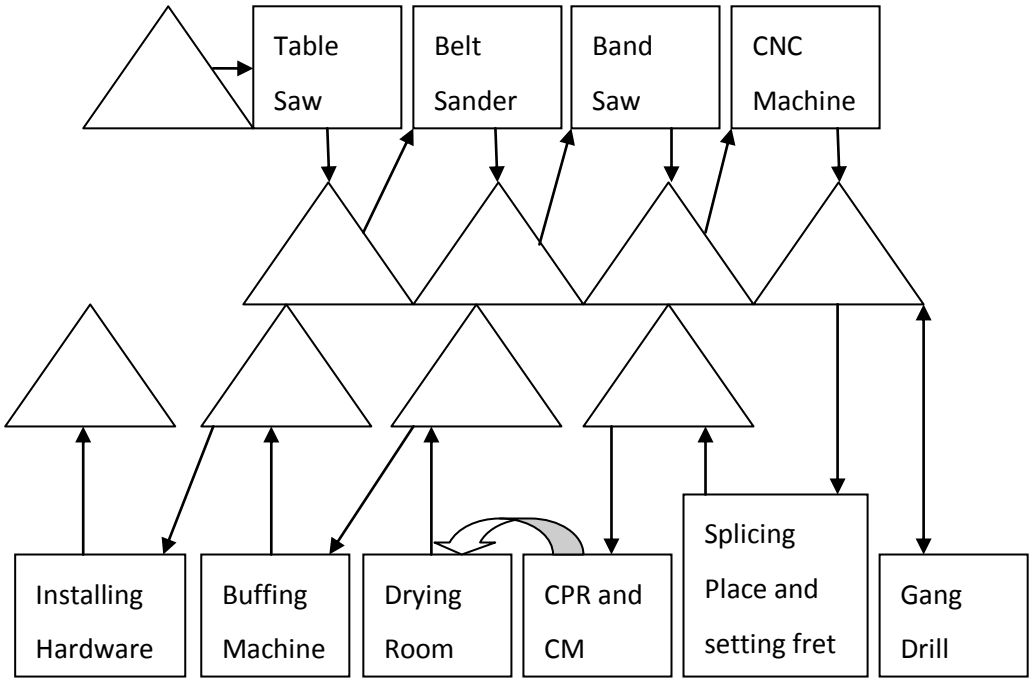

FIGURE 18 Factory Layout

In figure 18, triangle stands for shelves of storing different semi-finished products. And the arrows are the flow of semi-finished products. It goes from standard wood panels in the beginning to completed guitar at the end.

6 SUPPLY CHAIN

6.1. Main Suppliers

China is famous for cheap raw materials. In this chapter, the author will introduce the cheapest raw materials with a good quality that are found in China.

6.1.1. Timber

Maple

The supplier for maple timber is Wood Co., Ltd. Shanghai Tian Qi. The author found the company by a famous wood industry website called China Wood Industry Network. When using the Baidu search engine by inputting ‘timber’ in Chinese, the China Wood Industry Network would display on the 5th column. The price is competitive, 8000 Yuan per cubic meter. (Wood Co., Ltd. Shanghai Tian Qi. 2002)

Basswood, Mahogany and Ebony

The supplier of basswood timber, ebony timber and mahogany big block is Wood Industry Development Co., Ltd. Shanghai Senlian. The method of finding the company was also via the Internet. The author used the Baidu search engine as well and finally found the company via the Alibaba. The Alibaba is the second most popular Chinese E-commerce platform which is only second to Taobao. The status is the same as eBay and Amazon in Europe. The prices of basswood timber, ebony timber and mahogany big block are 2600 Yuan/cubic meter, 5200 Yuan/cubic meter and 3700 Yuan/cubic meter, accordingly. (Wood Industry Development Co., Ltd. Shanghai Senlian. 2007)

6.1.2. Bridge

According to the planning of the guitar factory dedicated to produce a high-end guitar, while the bridge is an essential guitar part, a good quality bridge is very significant. Under the current conditions, precise bridges are basically produced in Europe or the United States. However, accidentally, on a website related to the Shanghai instrument exhibition, the author found that famous bridge brand “Floyd Rose” production of which is authorized right to Korean manufacturer BOO HEUNG. And its factory is in the south of China. It is a rare chance to purchase high-end bridges domestically in China, which could greatly reduce the costs associated with logistics. So in this bachelor’s thesis, the author assumes BOO HEUNG is the bridge supplier.

6.1.3. Pickup

As DiMarzio is the target brand, the author visited its official website, and found out that there is one and only one dealer who cooperation with DiMarzio in China. It is a company called MusicGW (Music Great Wall. 2007), which is located in Guangzhou. So Music Great Wall is the only option for a supplier.

6.2. Outsourcing

In the case, some of the raw materials are original woods. Author decides processing the original wood to usable wood panel, which has the optimal dimensions for factory processing.

The Dongguan Xiangnan Mill is a wood product enterprise, which has integrated research, design and manufacturing. The author outsources original wood processing for this enterprise. (Dongguan Xiangnan Mill. 2006)

6.3. Location

Factory location has a long-term impact on the supply chain and must be part of the business strategy. Dr. Kasra Ferdows suggests several useful location strategy roles for this case (Peter Jurkat. Logistics and Facility Location):

1. Offshore factory - low cost investment and labour costs.
2. Contributor factory - firm involved in product development, production planning, procurement decisions, and developing suppliers.
3. Outpost factory - embedded network of suppliers, competitors, research facilities for materials, components and products.
4. Lead factory - firm is source of product and process innovation and competitive advantage of the entire organization.

In this case, the factory possesses the characteristics of offshore factory, contributor factory and outpost factory. And the decision is made by considering the elements of the business climate, host community(Logistics and Facility Location, File type ppt, Peter Jurkat), access and proximity to

markets, customers, access to suppliers and cost, and labour issues, (Peter Jurkat. Logistics and Facility Location).

Guangzhou is the capital of the Guangdong Province, the province's political, economic and cultural centre, which is located in the southeast of the Guangdong Province, the northern margin of the Pearl River Delta. This makes possible convenient transportation and perfect business environment. Based on the data, by the end of 2006, the city's registered population was 7.6 million, while permanent population was more than 10 million. Such a huge population can guarantee sufficient customers. Guangzhou is also a well-known hometown of immigrates, it has the first ranking of number of immigrates in big cities. According to statistics, 1.06 million overseas Chinese and 877.2 thousands Hong Kong and Macao compatriots are living in Guangzhou. The high prevalence of English makes it a highly efficient host community. And the good education system provides high quality labourers. (Guangzhou Government Website) In addition, the final raw material comes from the outsourcing company, which is located in Dongguang. In the Figure 19, "A" stands for Guangzhou (Pickup suppliers' location), "B" stands for Shanghai (Timber supplier's location), and "C" stands for Dongguan (Outsourcing supplier's location). It illustrates the optimal location of accessing suppliers in Guangzhou.

FIGURE 19 Location Distribution

7 SELLING SYSTEM

7.1. Internet

7.1.1. Advantages

Network marketing can expand the scope of the store's distribution, and impact to a broader area. In an online store, customers can search more promotional information and pictures of guitars, resulting in the purchasing desire, when the local store cannot satisfy customers. This network effect breaks the restrictions of real geographical situation. Except dramatically expanded sales channels, the Internet also helps to promote inventory sales

to cross-regional groups, which speeds up the inventory turnover rate, thereby enhancing the purchasing amount. It can eventually form a perfect virtuous circle.

7.1.2. Action Plan

First of all, the author plans to design a business website providing an online purchasing system, product information and contact information. Customers can always find products by a search engine. But that information listed on the top of the websites are always those famous instrument shops or advertisements. A key challenge is to improve the product visibility. So large trading platforms are significant for increasing sales

For foreign customers, eBay and Amazon are the most famous trade platforms with a very good reputation. The Chinese Customers, they use Taobao and Alibaba. The author also recommends using “Baidu Promotion”. Baidu is the most often used search engine in China, as well as Google. Baidu promotion is a pay-for-promotion network outreach. It charges money according to the amount of accesses by potential enterprises or customers. It is very flexible for the factory to control promotion investment. (Baidu Promotion. 2007)

7.2. Salesman

In China, a salesman is a very important business channel. It could be a typical Chinese characteristic, because of the unsound business system. Recruiting salesman is a very common phenomenon. It even forms an industry, a typical Chinese industry.

Data collection is the beginning for a highly efficient salesman. The sources of data contain yellow pages, newspapers, magazines, outdoor advertising, the Internet, related industrial exhibitions, visiting related unknown companies and customer's customers. And during the data collection, the salesman cannot miss the following information: name of the target company, date of when it was established (This is a psychological tactics. Imagining what the customers' reaction was after hearing their own company's establishment date when they even cannot remember that themselves), main products and secondary products, product range, several success cases of the target company, address, phone number, legal representative of the contact person (It is very impressive if the salesman knows his/her birthday), and the customer's main competitors.

The data collection follows telephone interviews, visiting, signing contracts, receiving money, and after-sales service. After all the steps, the process will be repeated from visiting to making more and more contracts. In addition, in the aim of enhancing the enthusiasm of a salesman, the salary structure is formed by the basic wage and bonuses. (Manager Xie. 2007. Salesman work flow)

8 TRANSPORTATION AND DELIVERY

8.1 Packaging

A guitar is very easily damaged during transportation. So the guitar packaging material must be soft enough. The author found an optimal packaging box on the Internet (See Figure 20). One of his box costs 15 Yuan, which is very cheap. And considering the huge quantity of order, it is even cheaper to order from the plastic factory.

FIGURE 20 Plastic Package

8.2. Delivery Methods

According to the selling system (Chapter 7), there are two delivery methods. We can complete the orders from the Internet by the appointment of delivery firms. The cost of delivering is added to the product's online price. The

customer can also trace the goods online, by the delivery tracing system, check where the goods are at any time. The other way is delivering by our own truck or using a train or an airplane, depending on the distance and customer requirements. This method is for huge amounts of orders that are signed by salesmen.

9 EMPLOYEES

9.1. Staffing Arrangement

Following the work flow, the author hires two people in charge of managing the contact and cooperation with outsourcing company. For handling machines, each machine needs staffs to operate it, which means ten men are separately needed for the table saw, belt sander, band saw, CNC machine, gang drill, fret press system, curtain paint room, coating machine, drying room and buffing machine. And there are two steps, splicing and hardware installing, needing two workers. In addition, network marketing, including website maintenance, accepting online orders, requires one professional staff. In the end of the work flow, the author hires two persons for dealing with transportation and delivering issues. After adding 3 salesmen, the total number of employees is 20.

9.2. Training

9.2.1. Goals

Employee training is a very important long-term investment. It provides employees with accurate and relevant information on the company and jobs, and encourages new staff members' morale. They can learn work skills that are related to their jobs and get aware of the company's expectations. Training is also a good way to eliminate new employees' tension and make them to adapt to the company faster. They can feel welcome as well as a sense of belonging to something. During the training, it facilitates communication between employees, and virtually strengthens coordination with each other. Overall, the most fundamental purpose of training is to improve the staff's ability to solve problems individually and work efficiently.

9.2.2. Training Process

First of all, lectures are given during the first 5 days. They mainly concern total of five areas of contents:

- Security education
- Products property and work flow
- Operation skills and requirement
- Product quality control system

- Describing jobs, duties and importance of their position

The most significant section is the security education. The content includes the principles of national security education, tasks and significance of labour protection, production and safety management system, safety ban and common accident case analysis in the company level; department production features, working environment, hazardous area, equipment distribution, basic knowledge of security technology in the department level; working hours, condition of fire fighting devices, safe operation of his/her type of work and job responsibilities, and the practical safety demonstration in the team level. After lectures, employees will be trained in practice. Everyone has one to one skill training by one of the skilled employees. (Shanghaimart Human Resource Department. 2010. Orientation Program for New Shanghaimart)

During the training, retraining is very important. The author would arrange retraining three times separately on the day finishing the lecture training, one week after working and one month after working. The first time is for understanding staff character, personal career expectations, the overall impression of the factory and the knowledge of the work. The second time is for discussion of job duties and work problems. After solving the employees' problems, the teacher can give them several evaluations and recommendations. During the last time, employees get a comprehensive assessment from the company, which increase their motivation again. (Shanghaimart Human Resource Department. 2010. Orientation Program for New Shanghaimart)

10 FINANCIAL CALCULATIONS

Financial calculations can provide a common direction. The enterprise's business objectives can be decomposed into a series of specific economic indicators, so that production and business goals are more specific. It also can help companies to set production numbers, and target sales, and at the same time, help to control costs.

10.1. Expenses

Truck

The author chooses Dongfeng Xiaobawang. The rated load is 0.95 tons and the maximum load is 1.05 tons. The dimensions of the cargo compartment are 4.3m length, 1.8m width and 1.9m height. The maximum speed is 90km/h. The fuel consumption is about 13 litres per one hundred miles. These features can meet the needs of guitar transportation. And the price is very cheap, 58000 Yuan.

FIGURE 21 Dongfeng Xiaobawang

Rent

In Guangzhou, there are a lot of available factories. The area should be from 1000 square meters up to 200000 square meters. In this case, the author decides to rent a 2000-square-meter factory. The market price for the rent is 9 Yuan per square meter. So the cost of the rent is about 18000 Yuan per month. It is quite cheap compared with the price in Europe. The same price in Europe should be only enough to support a restaurant of less than 200 square meter.

Hand tools

These tools were strap buckle, glue, paint, fixture, screwdriver, laser range measurer, electric hand drill, fret slot saw and shaft, clamp, hammer, file, ruler, foot arc detector, and intonation tester. Author would like to assume the total price as 3000 Yuan.

Electricity

We can calculate the total power of the machinery by the features in chapter 5, which is about 72.5kw. Assuming that all the machines would work 8 hours

per day, 20 days per month, then the total electricity used in one month would be 12032 kilowatt-hours (KWH). And in Guangzhou, the price for industrial electricity is 1.4 Yuan/KWH. So the electricity fee would be about 17000 Yuan per month.

Employees

Based on the salaries of the Qin Dao instrument factory, the salary of an operator is 810 Yuan/month. And based on the interview of a friend, who worked in a similar position, the salary of a manager is about 3000, and the salary of a salesman is 1000 plus bonus money. The bonus money is an average 5% of contracts. For the programmer who takes care about the website the salary is at least 3000 Yuan/month. So the approximate labour cost is 22400 Yuan plus bonus money for salesmen.

Raw materials

In this section, author assumes the yield per month is 1500 guitars. Generally, one cubic meter of original wood can make 10 guitar bodies, 60 guitar heads, 60 fingerboards and 30 guitar necks. So the need for every month is 75 cubic meters of basswood, 75 cubic meters of mahogany, 25 cubic meters of ebony, and 75 cubic meters of maple, with 4500 pickups, 1500 suits tuning head, 1500 rod trusses, 4500 knobs, 1500 bridges, and 1500 jack plate. One guitar also needs 1.8 meters of fret wires and 10 square centimetres of pearl blank, totally 2700 meters of fret wires and 2 square meters of pearl blank.

Fuel

Because the fuel consumption is 13 litres per a hundred miles and now the fuel price in Guangdong is 6.3 Yuan per litre, the author uses 13104 Yuan/month in the condition of during 8 miles per working day.

The summary is listed below.

TABLE 5 Financial Sheet

Currency: Chinese Yuan; Time: one month		
Machinery	Multi-functional Sliding Table Saw	1980
	MP-550 Automatic Programming CNC Milling Machine	78500
	R-RP1300-1 Wide Belt Sander	30000
	Gang Drill	4500
	Buffing machine	1500
	Band Saw (Metabo BAS 505G WNB)	19700
	Curtain paint room	50000
	Ω Disk-type coating machine	30000
	Fret Press System	1200
	Large drying room	2800
Hand Tools	3000	
Truck	58000	
Rent	18000	
Electricity	17000	

Employees	22400 + push money (Assume 150000)	
Fuel	13104	
Outsourcing	30000	
Raw Material	Wood	195000 (Basswood) + 277500 (Mahogany) + 130000 (Ebony) + 600000 (Maple) = 1202500
	Pickups	1200000
	Bridges	750000
	Truss Rods	22500
	Fret wires	47250
	Tuning Heads	45000
	Jack Plates	30000
	Inlays	1000
Sum	Primary Investment: 281180	Monthly Cost: 3548754
	Fixed Cost: 180104	Variable Cost: 3368650

The additional element is loan interest; it depends on the loan amount and loan type.

10.2. Income

By considering the configuration of our products and competitors' prices, author sells the product with 5000 Yuan per unit. The net profit is 7500000

Yuan. The profit is 7500000 – 3368650 – 180104 = 3951246 Yuan per month, which is 111.34% of cost.

11 RESULTS

As the data shows in the financial calculation, this is a very successful case, which would earn 111.34% of the cost.

First of all, the author combines the marketing result, the properties of different raw materials and the knowledge of instruments to design the most competitive guitar property.

As to the raw materials, the guitar uses maple to make the head stock and neck, ebony to make the fingerboard, basswood or mahogany to make the body. The pickups are high-end brand, DiMarzio, with S-S-H structure, while the bridge is Floyd Rose brand's locking tremolos. These main elements position the guitar as the high-end guitar.

Regarding machinery, the author used multi-functional sliding table saw and R-Rp1300-1 wide belt sander for roughing, Metabo BAS 505G WNB band saw, MP-550 automatic programming CNC milling machine and gang drill for shaping, fret press system for installing frets, and finally buffing machine, curtain paint room, Ω Disk-type coating machine and large drying room for painting.

The suppliers are also reliable and geographically convenient. Two wood suppliers are located in Shanghai, Wood Industry Development Co., Ltd.

Shanghai Senlian and Wood Co., Ltd Shanghai Tian Qi. The pickup supplier is located in the Guangzhou province, Music Great wall. The bridge supplier is BOO HEUNG, whose factory is located in southern China. And the outsourcing company is Dongguan Xiangnan mill, which is in Guangdong.

In the view of human resources, it is not difficult to recruit labor force of high quality at a comparatively low price. In the case, the monthly salary is about 172400 Chinese Yuan.

12 PROPOSAL FOR ACTION IN THE FUTURE

As can be seen in the case, there are only two guitar types. In the future, product diversification is the main trend. Product categories should range from low gear to high-grade. This requires a more specific and comprehensive market research. And more suppliers should be included in the supply chain. Based on the experience of strong competitors, like Gibson, Fender, BC Rich, Ibanez and such famous brands, the factory should have its own characteristics. The characteristics should give customers a compelling reason to buy the product. It requires the coordination of an experienced guitar designer and staff.

Secondly, the output of this plant is now 1500 per month. But this amount clearly does not meet the needs of the huge Chinese market. That is, a lot of potential customers and business opportunities must be buried because of the limited production. In other words, it is essential to expand production. So in the future, a new plant site covering all major markets in China is one of goals.

Thirdly, the author hopes that the factory's products can be exported to foreign countries to keep up with the pace of globalization. Now 'Made in China' is very common. In a lot of instrument forums, Chinese guitars are very popular because of their cheap price and good quality. The price of products with the same components as components used in the case is about 1000 euro. But the product in the case is only 500 euro. So 'Made in China' has a very competitive superiority. Globalization can maximize the profits.

13 CONCLUSIONS

The aim of the bachelor thesis was to design an optimal process of making a guitar. The case included almost all the activities of the guitar life circle.

The guitar is a special product. There is no clear definition of a good guitar. So the guitar design must meet the preferences of target customers. The raw materials were based on the highest degree of customer's concern. It takes the properties of products and feasibility of various raw materials into account. Some key components like pickups and bridges were famous brands. It could guarantee the quality and attract customers.

The supplier selection was the result of consideration of both the price and transportation. The author regards of the priority to ensure the low cost and then maximizes the convenience of transportation. To avoid foreign purchasing as much as possible is one way to decrease transportation cost.

Only the brand DiMarzio pickups are produced in Europe, but the supplier is a dealer of the brand DiMarzio in China.

Considering the factory, the total primary cost including machinery, hand tools and a truck is very cheap, 281180 Chinese Yuan (31242 Euro, with the rate of 0.11). And the monthly costs are 3548754 Chinese Yuan (390363 Euro), including the rent, electricity, employees, fuel, outsourcing and raw materials. Most of the machinery and raw materials are locally procured in China. All the employees, hand tools, and truck are procured in China as well. It dramatically decreases the cost, which makes the profitability of 111.34% possible. The machinery layout is circle-shaped around the storage area. It is efficient because of short internal transfer time. All operators have an easy access to raw materials or a semi-finished product rights.

Recruitment in this case was perfectly consistent with the Chinese features. The author fully used the salesman, which was caused by the incomplete sales system. The promoting effect of a salesman is even more powerful than expensive advertising.

In conclusion, this was a very profitable case. It follows the guitar life circle. All the elements, including guitar design, marketing, factory layout, supply chain, selling system, transportation and recruitment are based on the situation of the Chinese market. It describes the current situation in China, which is also useful for other industries.

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FIGURE

TABLE

APPENDIXES

Appendix 1: Shapes of guitar bodies

Strat®

Tele®

Thinline

LP

LPS

VIP

Soloist

SG

Explorer

V

V-2

Star

Iceman

Firebird

Musiclander

Jaguar

J-Master

Jagstang

Mustang

WGD

L5S

Blanks

Z Body

Double neck bodies:

Double S-Caster

Double T-Caster

Double Strat/Tele

Double Precision/Strat

7 string bodies:

7S

7CT

Appendix 2: Shapes of guitar headstock

Strat®

Angled Strat®

Jazzmaster

CBS

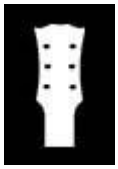
Tele®

Superwide

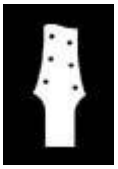
Explorer

Jackson®

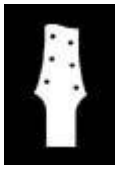
KWS



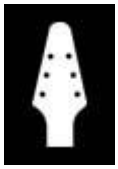
LP



Warmoth

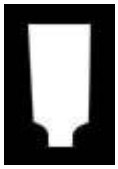


Superwide Warmoth

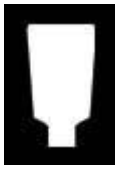


V

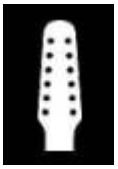
Arrow



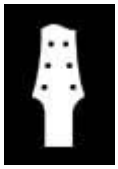
Angled Paddle



Straight Paddle



12 String



Variax®

Appendix 3: Wood lines

Alder

Ash

Basswood

Bubinga

Koa

Black Korina

White Korina

Lace Wood

Maple

Flamed Maple

Quilted Maple

Spalted Maple

Birdseye Maple

Burl Maple

Mahogany

Padouk

Poplar

Rosewood

Brazilian Rosewood

Figured Walnut

Zebrawood

Appendix 4: Dimensions and properties of fretwires

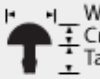
Narrow/Low

Modern standard mandolin fretwire. This size is sometimes used for approximating old style small banjo fretwire.

Narrow/Medium

A bit larger than pre-war Martin guitar wire or pre-war banjo wire. This is the standard modern fretwire for banjos and dulcimers.

Medium/Medium

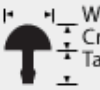


For acoustic or electric guitar. The most popular wire for refretting Martin, Fender, Guild, Gibson and other guitars.

Medium/High

For acoustic or electric guitar. Somewhat narrower than our #0149 wide/medium fretwire, it can be redressed without becoming too flat.

Medium/Higher



Dan Erlewine's favorite fretwire!
For acoustic or electric guitar. Combines extra width with extra crown height.

Medium/Highest

For acoustic or electric guitar. Extra height for leveling and recrowning after installation or refretting.

Wide/Low

For electric guitar. As wide, but much lower in height than modern jumbo rock frets. Good for partial fret jobs, to match large worn frets.

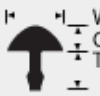
Wide/Medium

For electric guitar or bass. Slightly taller than old Gibson jumbo wire; for leveling new frets with plenty of metal remaining for a traditional jumbo feel.

Wide/High

For electric guitar or bass. A little extra height for leveling and recrowning, if needed after installation or refretting.

Wide/Pyramid



Unique pyramid profile for electric guitar or bass. A little extra height, and a unique profile with sloped sides.

Wide/Highest

For electric guitar or bass. Modern "jumbo" fretwire used on ESP, Jackson, Ibanez, Kramer and similar guitars.