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# Wood Door Manufacturing Process and Research on Chinese Wood Door Industry

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<p>Abstract</p> <p>This thesis was to illustrate the wood door manufacturing process in Anhui Fuhuang Wood Door Company. It was based on the author's working experience in Fuhuang. It explained what types of doors were there and how the doors were made in Fuhuang company. The second goal was to research the Chinese wood door industry and the market.</p> <p>In China the wood door industry grew rapidly because of the booming of the real estate business. However, the lacking of standards in China makes it impossible for the wood door firms to make a further growth. None of the firms could increase the market more than up to one percentage. The wood door business is very regional in China.</p> <p>Based on the thesis, the research suggested that it would be better if Fuhuang entered the business to consumer market. By doing so, it can build a better company image and saves company cost in long term.</p> <p>In addition, some development ideas were generated after introducing the manufacturing process of wood door in Fuhuang.</p>			
Keywords Wood Door Manufacturing,B2B,B2C, Types of doors			
Public			

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## Terms and abbreviations

B2B	Business to Business
B2C	Business to Consumer
CRM	Customer Relationship Management
MDF	Medium Density Fiber Board
NASDAQ	National Association of Securities Dealers Automated Quotations
R&D	Research and Design
VOC	Volatile Organic Compound

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# 1 Introduction

Wood door is a door made of wood. It is very commonly used in constructions and known for its good machinability, strength and durability along with a lot of other abilities.

Why wood? According to Professor Paul Epp [1] at the Ontario College of Art and Design, using wood as a material is beneficial in many ways. First, it is sustainable and recyclable. Wood comes from a plant which grows and dies. No matter how it is used and processed, eventually it goes back to mother earth being benign element of soil. In the meantime, wood can be reused, re-purposed, and reapplied to other projects if the wood is kept safe from decaying. Second, it is highly workable. Its form can be completely changed from how it grew to whatever it is wanted to be. It can be cut up and reassembled to a new form. It was flexible, split-able, carve-able and glue-able and it is very easy to apply different kinds of finishes to it. Another good thing about using wood to make doors is that it is insulating. Wood is a nature insulator. It does not conduct heat which makes it very suitable as a material to make doors of. It means that wood door has more energy efficiency than many other types of doors. On the top of that, it is also very beautiful. The grain structure is orderliness because of the cycle of growth (also known as age rings of a tree). Combined with its diversity of patterning and warm coloring make wood a real visual treat. Each piece of wood is unique. The last but not the least good reason for using wood to make a door is it is light and strong at the same time. Other materials may be lighter and stronger but wood is a product of nature. It does not require any procedures to become light and strong. [1]

The all reasons presented above make wood an ideal material for manufacturing doors. That determines the wood door industry to be strong. Let's take a look at the country with the highest population of the world: China. It has a total market sales amount of more than 70 billion Yuan (equivalent of about 7.83 billion euros). It is a very valuable and a huge market. Due to the rising of the eastern dragon, the potential growth of wood door is also very promising in China currently. It has an average growing speed of 20% per year which is astonishing.

As the market increases so fast, the door factories are changing constantly. In the old days, most of the work was done by skilled workers and very basic tools. Nowadays, sophisticated computer numerical machines are doing most of the jobs automatically. It was simple design with few functions in the earlier times. Nowadays, doors are multi-functional and complicatedly coated on the surface. They have the abilities to be water proof, fire proof, energy efficient and long lasting life-cycle. All these improvements cannot be achieved without modern machines and manufacturing processes.

This research is aimed to illustrate the process of manufacturing wood doors and the techniques used. A short market strategy analysis on the Chinese wood door market will also be concerned. The manufacturing process is based on the working experience in Chinese wood door company called Fuhuang Wood Doors and Windows Company Ltd. There will be an introduction about Fuhuang later. The market strategy analysis is aimed to analyze target marketing segments and the product position in the market for Fuhuang wood door company. Some development ideas will be presented after the description of the manufacturing and analysis of the market strategy.

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## 2 Case company: Anhui Fuhuang Group

There are three parts in this chapter. Firstly, there will be a short introduction about the case company. Secondly, different types of doors and technologies in a door will be explained. The third part is about products of the case company.

### 2.1 General introduction

The case company of this research is the Fuhuang Group. It locates at North East of Chaohu city, Anhui Province, China. It was founded in 1989, the time when China was implementing the reform and opening-up policy which definitely boosted the growth of the company. In just three years, the company with only 15 employees turned into a big corporation with three sub-companies and hundreds of employees. In 1992, the Fuhuang Door Company was established. At the beginning, it was nothing more than a small workshop. There were only 20 employees in Fuhuang Door Company originally. The equipment fell far behind the time. The turnover of Fuhuang back in that time was only 230 000 Yuan (about 30 000 US dollars in that time). The achievement of the company was astonishing if comparing its turnover with present time. The turnover in 2009 was 168 720 000 Yuan (about 21.9 million US dollars). There are 600 employees in Fuhuang Door Company nowadays. It consists of 482 regular workers, 60 admin employees, 16 R&D engineers and 42 season workers. In *Figure 1*, there is the outside view of the Fuhuang Door and Window Company Ltd. Nowadays, with annual production capacity of 200 000 pieces of doors, it is a large scale door enterprise, which is mainly engaged in manufacturing high grade solid composite wood doors. The company provides designing, research and developing, producing, sale, installation, and service. It was one of the top 30 door manufacturers among thousands of door enterprises in China. [2]





*Figure 1 .Outside view of Fuhuang Door Company.*

In *Figure 2*, the view inside the Fuhuang Door Company is shown. Most of the machines were brought from overseas and are state of the art.



*Figure 2 .Inside view of the factory of Fuhuang Door Company.*

## **2.2 Techniques in manufacturing a wood door**

It might occur that people think how hard it could be to make a wood door, since the wood is such a good material that it is able to be shaped as far as you can imagine. In the real manufacturing world though, it turned out to be very complicated to make a wood door of acceptable quality. There are different kinds of doors which require a lot of different

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techniques in the real manufacturing. To explain those key factors of making a proper wood door, the types of wood doors will be introduced.

Wood doors can be categorized in many ways. By the different manufacturing method due to the structure, the doors can be divided into three categories. Each category of doors has a very different structure from each other.

## **2.2.1 Real wooden tenon-joint door**

### **2.2.1.1 Structure**

As it is suggested by the name, a real wooden tenon-joint door is a door made of real wood. This means the material in the door core is wood from the forest. A tenon-joint is a projection in the end of a timber for insertion and mortise. There are different kind of real wooden tenon-joint doors. The typical structure of a real wooden tenon-joint door is presented in *Figure 3*. It consists of many pieces of real wood with already made tenon-joints and mortise assembled together.

As it is shown in *Figure 3*, the typical real wooden tenon-joint door consists of several real wood pieces and is connected to each other with tenon-joints. There are six panels and a lock rail in the middle. Three mullions are placed in between panels to hold them together. There are four rails with dowels that are glued to the two stiles at the sides. All parts are holding each other like a whole piece of wood.

# Door Components

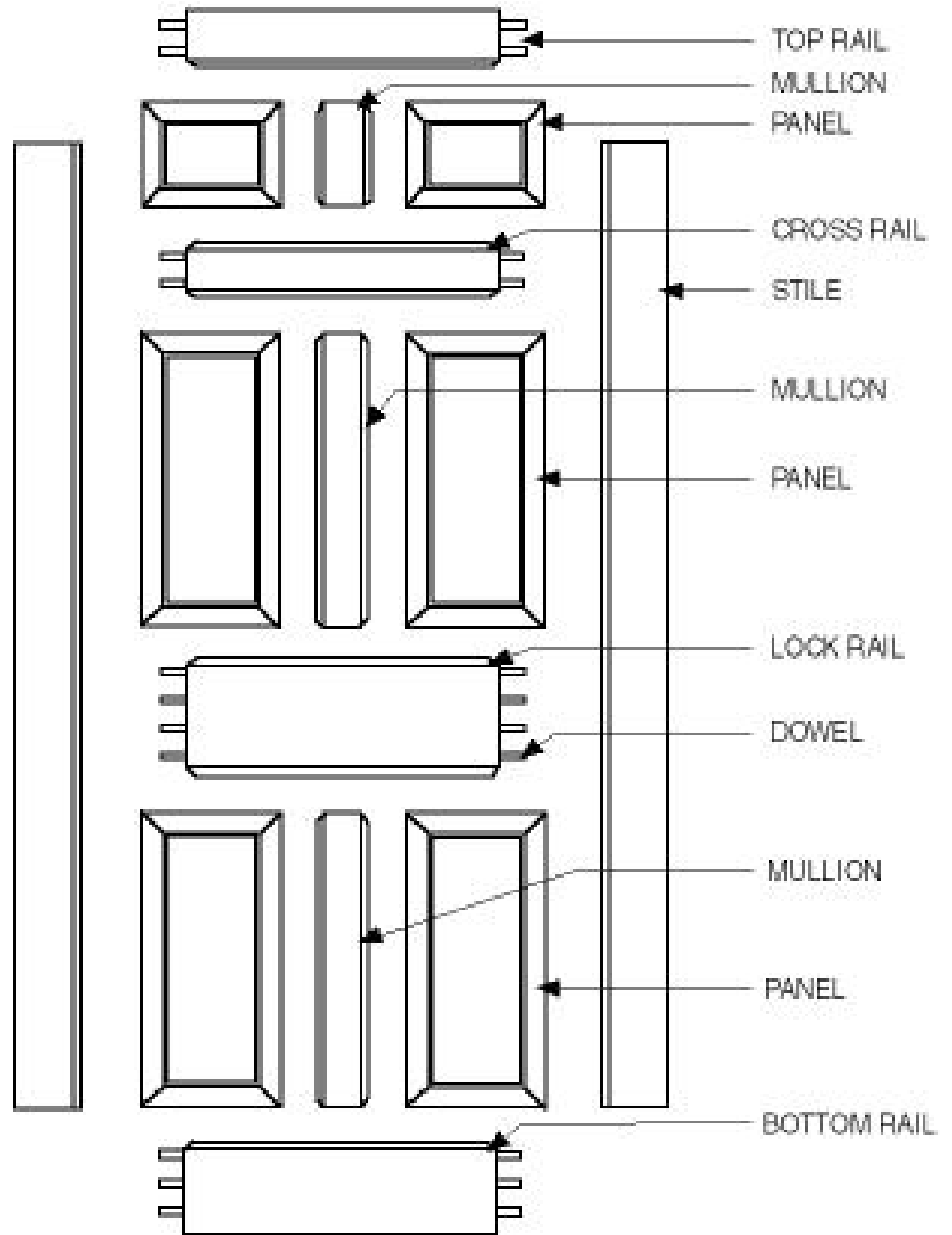
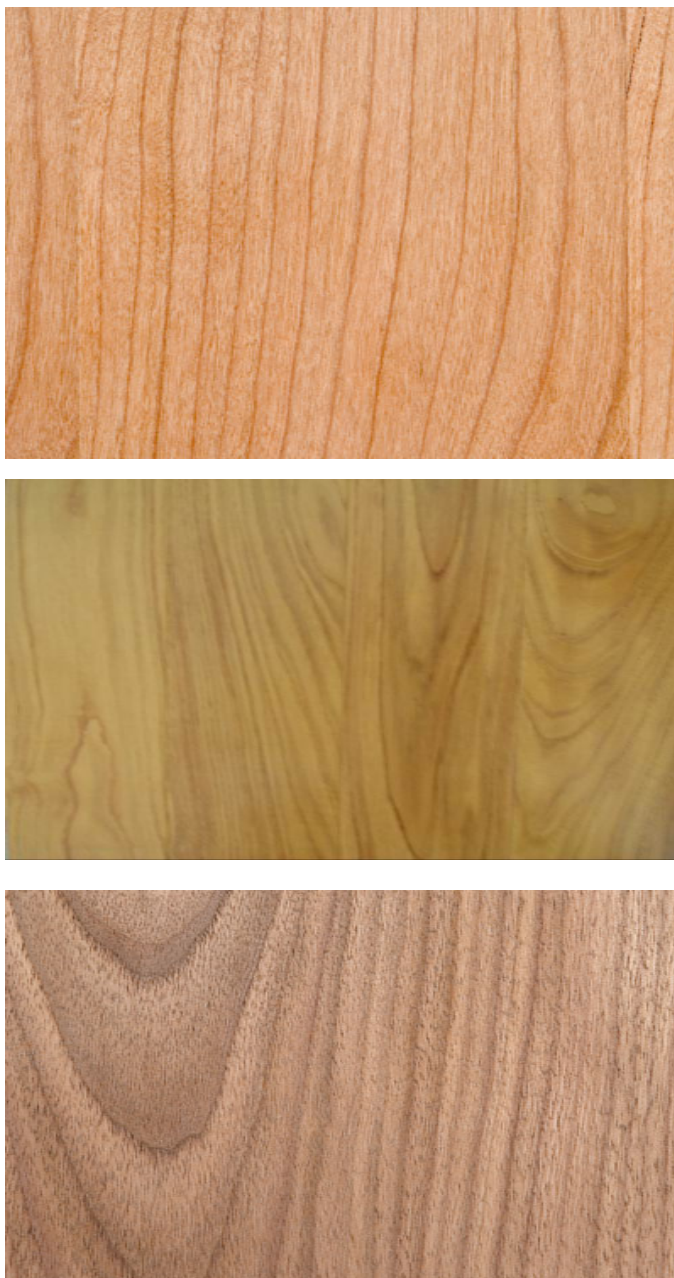


Figure 3 .Structure of tenon-joint wood door [3]

### 2.2.1.2 Advantages

Tenon-joint wood doors are mostly made of precious and luxury wood like cherry, teak and walnut see *Figure 4*. These woods are commonly agreed as the most beautiful and valuable wood materials. People prefer the natural and warmly look of the real wood. It is natural, noble and classic. It is classy and of high grade.



*Figure 4. From top, samples of cherry, teak and walnut*

But it is far more than just good looks. Real wood has also very decent quality and has a long lasting service life. The real wood makes the door durable and hard to be deformed due to its structure which makes it work as one piece.

The real wood door has better water proofing than a wood composite door. Unlike the composite wood doors, the surface of the real wood tenon-joint door is real wood and not wood veneers or other materials laminated on the surface. The laminated surface might be destroyed by water. Because of the thick solid wooden structure, it also provides far better sound proofing than other doors.

### **2.2.1.3 Disadvantages**

Though there are plenty of advantages of real wood tenon-joint doors, the disadvantages are obvious as well. It has a good outlook, but the real wood material is expensive. The price of a real wood tenon-joint door can be very high, even ten times more than average price of a door.

It is also very difficult to manufacture them in a cheap way. It requires the highest grade of quality of all kind of doors. The materials for this kind of door were always the most expensive ones. The machines have to be very precise and thus the machine is very expensive also. The required building quality is very high as well; otherwise the real wood would be easily deformed.

One last disadvantage about real wood door is that it is very heavy. It could be up to two to three times heavier than a door made of synthetic materials.

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## 2.2. 2 Wood composite door

### 2.2.2.1 Structure

Wood composite doors are the most widely used wood doors of all kind. They are made from more than one kind of wood. Real wood is used for the rails and stiles, another kind of real wood or laminated wood is used as the core of the door. In *Figure 5*, a structure view of a wood composite door is shown. In the center there is the block board core, which is often made from MDF (medium density fiberboard) and tubular board. It is then cross banded with cross bandings made from various kinds of materials on both sides. Cross banding is veneer placed between the core and face veneers in which the direction of the grain in 2-ply construction is at right angles to that of the face veneer. After that, they are fitted into the stiles and rails (also known as the frame of the door). Eventually, wood veneers or veneers made by other materials are hot press glued on the surface to cover the door on both sides. After all these steps, the edge of the wood veneer will be lipped with edge banding. In some cases, a PU (polyurethane) layer is stuffed inside the door to make it more energy efficient, to keep more heat inside the door. For example, in Finland, the front door which is made from wood is often stuffed with PU.

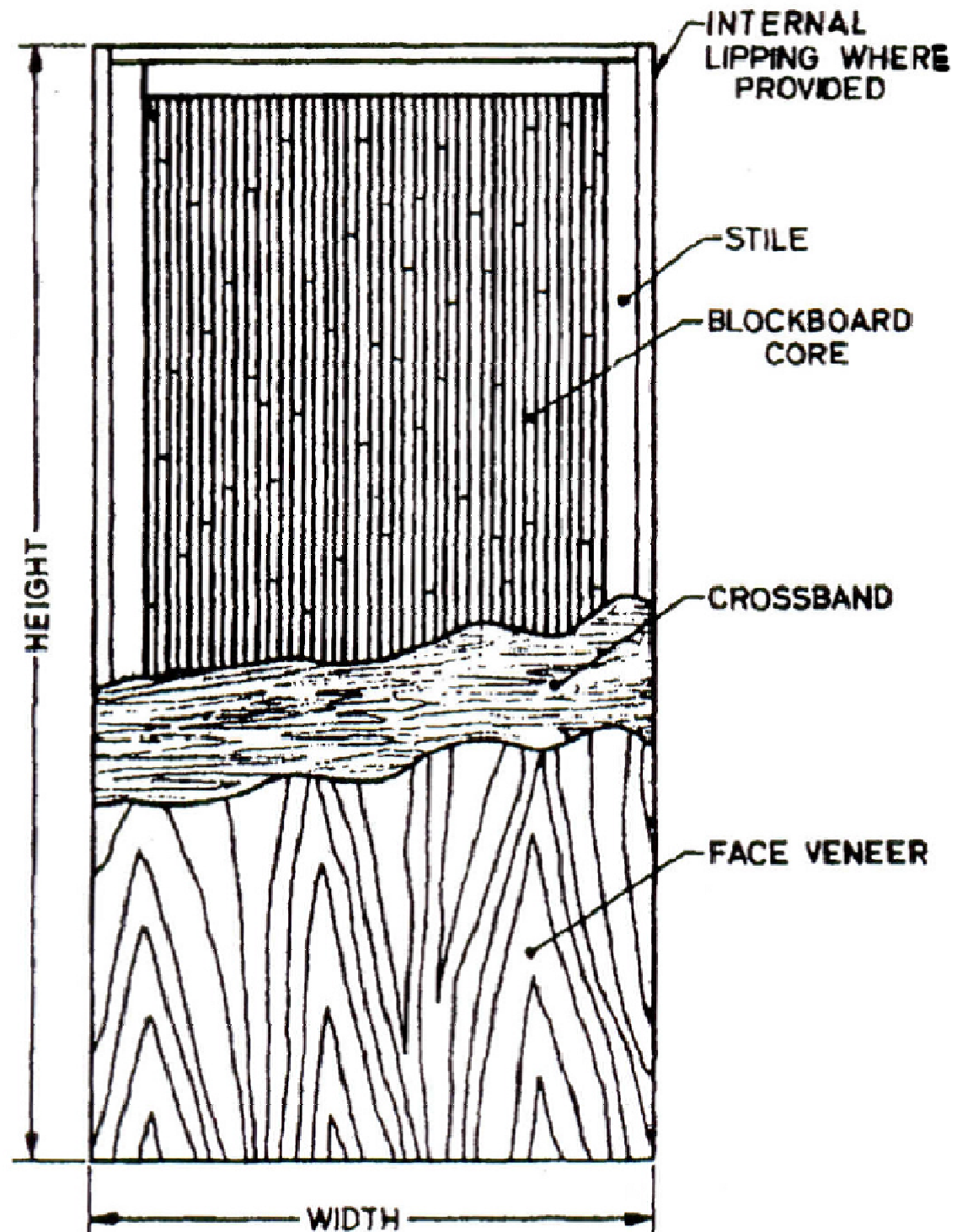


Figure 5 .Structure of wood composite door. [4]

### 2.2.2.2 Advantages

First of all, wood composite door is neither the cheapest solution of manufacturing a door

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nor the most expensive one. But it has the best performance/price ratio. It is the balance between cost and performance.

It looks just as good as a real wood tenon-joint door. By using different veneers on the surface, it may look like any kind of wood, even an expensive one. But the cost is so much less than a real wood tenon-joint door.

Comparing to wood tenon-joint, wood composite door is even more durable and less deformable. Wood is a material which easily bends and deforms if it is not dried correctly. The artificial composite material is so much more stable than the real wood and takes much less effort in manufacturing.

The doors can also be made to be fire proof and sound proof. Special coating and veneers can be used to make the door fire proof. The tube core board can absorb even more sound than real wood. There will be more on this topic later in chapter four.

### **2.2.2.3 Disadvantages**

Though the wood composite door with wood veneers looks a lot like a real wood door, it does not have the quality of real wood door. The quality of wood composite doors can vary a lot. It all depends on which machines and which methods are used. Besides that, wood composite door is a perfect choice for a wood door.

## **2.2.3 Veneer and wooden frame core door**

### **2.2.3.1 Structure**

The structure is actually very similar to the wood composite door. For both of them, the multi-ply (usually 5-ply) hot press gluing methods are used. As in *Figure 6*, the structure is



remarkably similar to the wood composite door. The differences are the core of the veneer and the hollow wooden frame core door. It has just pieces of rails and stiles but more rails than a wood composite door. It is first covered with LDF or plywood, then wood veneers. The assembly is simply made by hot press gluing for each ply.

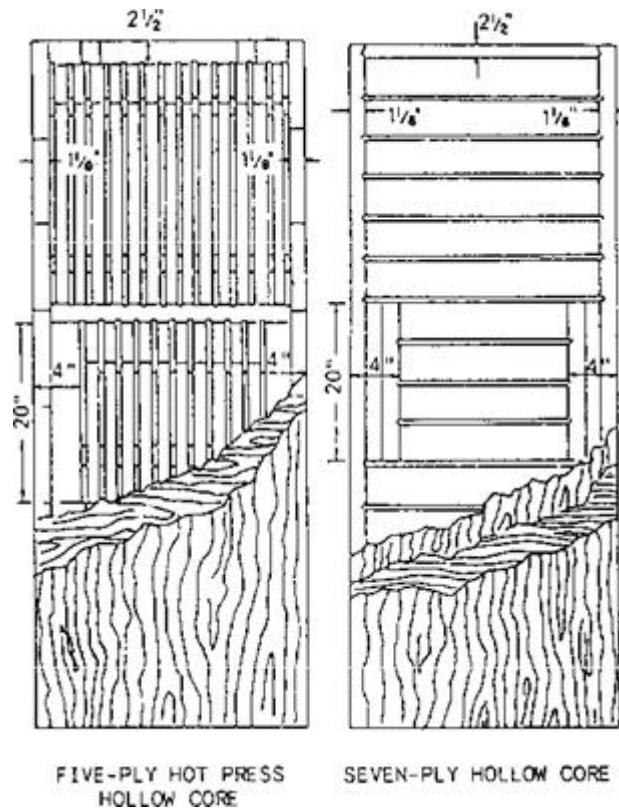


Figure 6 .Structure of veneer and wooden frame core door [4]

### 2.2.3.2 Advantages

The most significant advantage of this kind of door is that it was very cheap to manufacture. It saves material and provides the basic functions as a door. With some special veneers such as PVC, it even does not need any painting. It is the cheapest way of making a door.

### 2.2.3.3 Disadvantages

The door is cheap because it compromises with quality. The low price and less usage of

materials make the door neither very long lasting nor good quality. It cannot provide all the functions that you would expect from a door. The PVC material was even sometimes toxic if the right treatment is not applied in manufacturing. The painting used for this kind of door is cheap also. It emits the well-known poison formaldehyde which is carcinogenic.

## 2.3 Products of Fuhuang Door Company

Fuhuang not only manufactures the doors but offers door solution to customers. Their products are varied and the design is exclusive. By designing style, their products can be categorized as design doors, style doors and glazed doors. They are all wood composite door.

### Design doors

In this category, doors were designed by famous furniture designers. Each door is designed and handcrafted by experienced carpenters. In *Figure 7*, there were some examples on design door series.



Figure 7. Examples on Fuhuang design door series.

### Style doors

The style door category is the main door products in Fuhuang. It looks simple but practical as it is shown in *Figure 8*.



Figure 8. Examples on Fuhuang Style door series.

### Glazed doors

Glazed door means a door with glass in it. With the decoration of different style and colored glass, the door looks bright and clean. The below *Figure 9* shown examples of Fuhuang's glazed door. They come with various shapes and styles of window on the door.



Figure 9. Examples on Fuhuang glazed door series

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## 3 Procedures of door manufacturing in Fuhuang

### 3.1 Components in a door

To understand the process of the manufacturing, it was essential to get familiar with the components first. As it was shown in *Figure 5*, a door included core, stiles, rails, cross band, face veneers and lips. Below is a glossary for door terms from WDMA (window & door manufacturing association). It illustrates terms should be learned about a door.[5]

#### **Core**

Core is the most inner layer of section in flush door construction. Types of construction include: wood block, particleboard, wood block (lined), hollow, ladder, mesh or cellular (honeycomb board and tube board). The different materials give a door the abilities to survive in various weather and environmental condition.

#### **Stile and Rail**

Stile is the upright or vertical piece of the framework of a wood flush door. (See in *Figure 5*.)

Rail is the cross or the horizontal pieces of the framework. The top cross is called the top rail and the bottom cross is called the bottom rail.

#### **Cross band**

Cross band is the veneer placed between the core and face veneers of plywood face panels of wood flush doors in which the direction of the grain in 2-ply construction is at right angles to that of the face veneer.

#### **Veneer**

Veneer is the decoration on the surface. It is usually a wood skin made from a real wood. It covers the door with more wood looking like skin making the door look much more beautiful.

### 3.2 Workflow of manufacturing a door

Fuhuang Door Company manufactures mainly wood composite doors. The production line was introduced from a German Company Homag Group, the market leader in the woodworking machinery. Homag provided machines, systems and plants for woodworking industry. The Fuhuang production line is shown as an example to help understand the procedures in manufacturing a door.

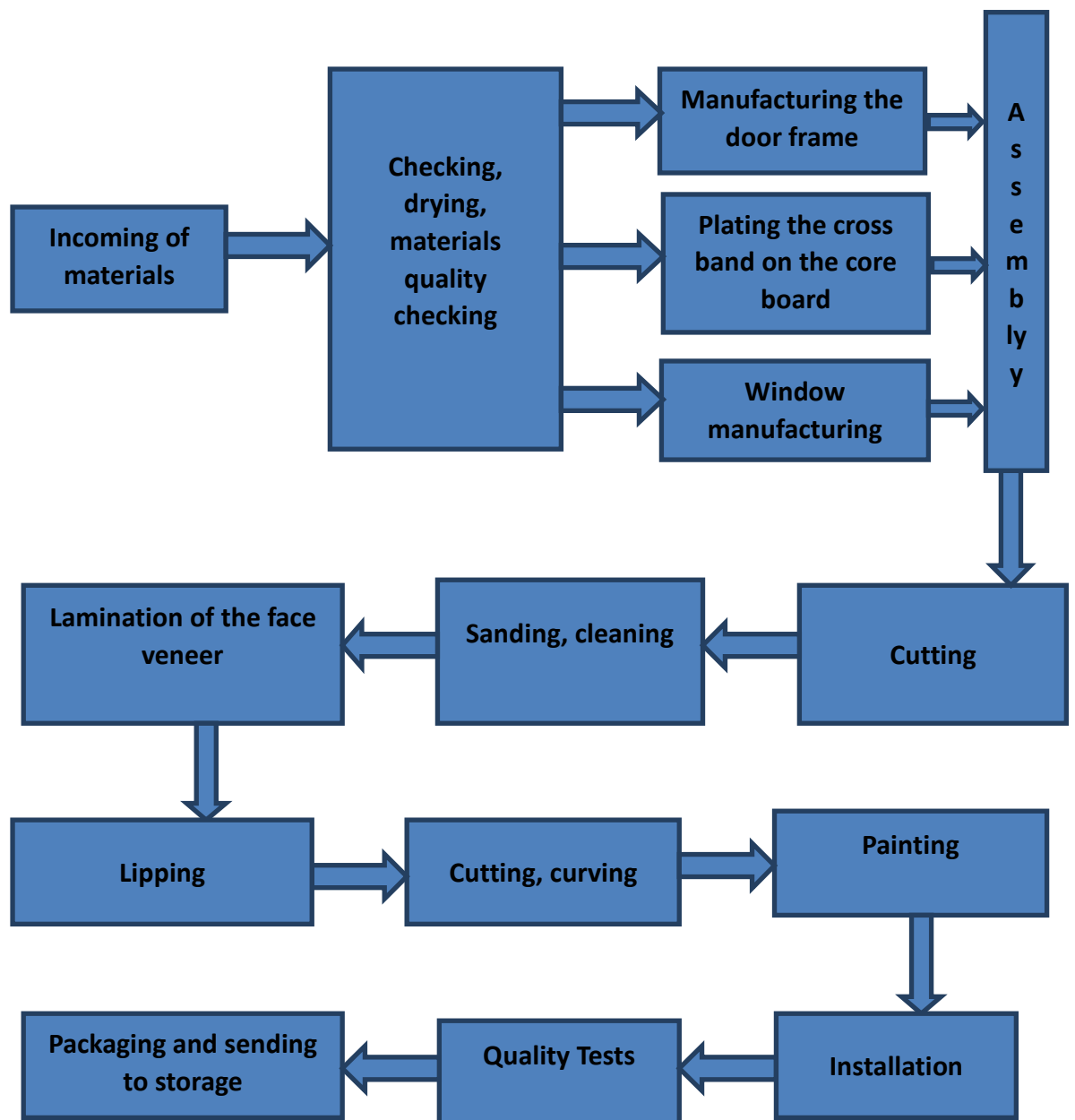


Figure 10. Workflow of door manufacturing

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In *Figure 10*, the workflow is shown in the flow chart. The manufacturing process has fifteen procedures. First it is to get the materials needed. Second, it is to check the quality of materials and as it is wood to dry it if needed. The third step is to manufacture the door frame. It includes manufacturing the two stiles and rails and then to assemble them. The third, fourth and fifth steps take place simultaneously. It is to manufacture the center part of a door which is also called the core of a door and to manufacture a window. Ply-wood cross bands are placed on both sides and hot press glued to the core board. The sixth step is to assemble the parts from third and fourth step. The following step is cutting and curving. Then the door is sanded and cleaned to prepare it for laminating. The lamination of face veneer protects the core and to decorate the door. After lamination, the edge of the veneer is lipped with edge bandings. It protects the veneer from being ripped off the door. The next step, cutting, is implemented for lock holes and hinge holes. The curving is done in this step as well. Then the door is sent to the painting department to paint with protective and decorative paintings. The door has three layers of paintings normally. After the painting has dried, the accessories of the door are installed on the door. The installation depends on requirements of the customer. After the installation, some doors are selected for a series of quality tests. The final step is packaging. The door is covered with protective plastic package. After all the steps, it is sent to storage or customer.

The process of door with windows is somewhat different than the one without a window.

### **3.2.1 Incoming of materials**

The materials are various. They contain lumber for door frames and window frames, wood lines for lipping, artificial wood boards for door core and cross band, veneers, adhesives, paintings and glass for windows. There are several kinds of artificial boards which have different functions. There is honeycomb board, the tubular board, plywood, medium density fiber board and high density fiber board. The tubular board is the new generation material. It is 60 % percent lighter but much stronger than real wood. It can take 20 kg press in one square centimeter. The special tubular structure provided more than more strength, but it

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also absorbed more sound than real wood. [6]

### **3.2.2 Material quality checking**

In this stage, all the materials are inspected for quality. Fuhuang Company requires a high standard on quality from its suppliers. The inspection includes many aspects.

The wood board is first visually inspected to check if there are worm holes, rot and knots. Then the moisture content is checked. The moisture content must be not over 12%, otherwise the wood board will crack in the production. In Fuhuang, it was said that the moisture content must be smaller than 9%. To ensure the moisture content to be at the right level, Fuhuang has its own infrared drying room as well. Fuhuang dries the wood board by their own if the moisture content of the wood board exceeds 9 %.

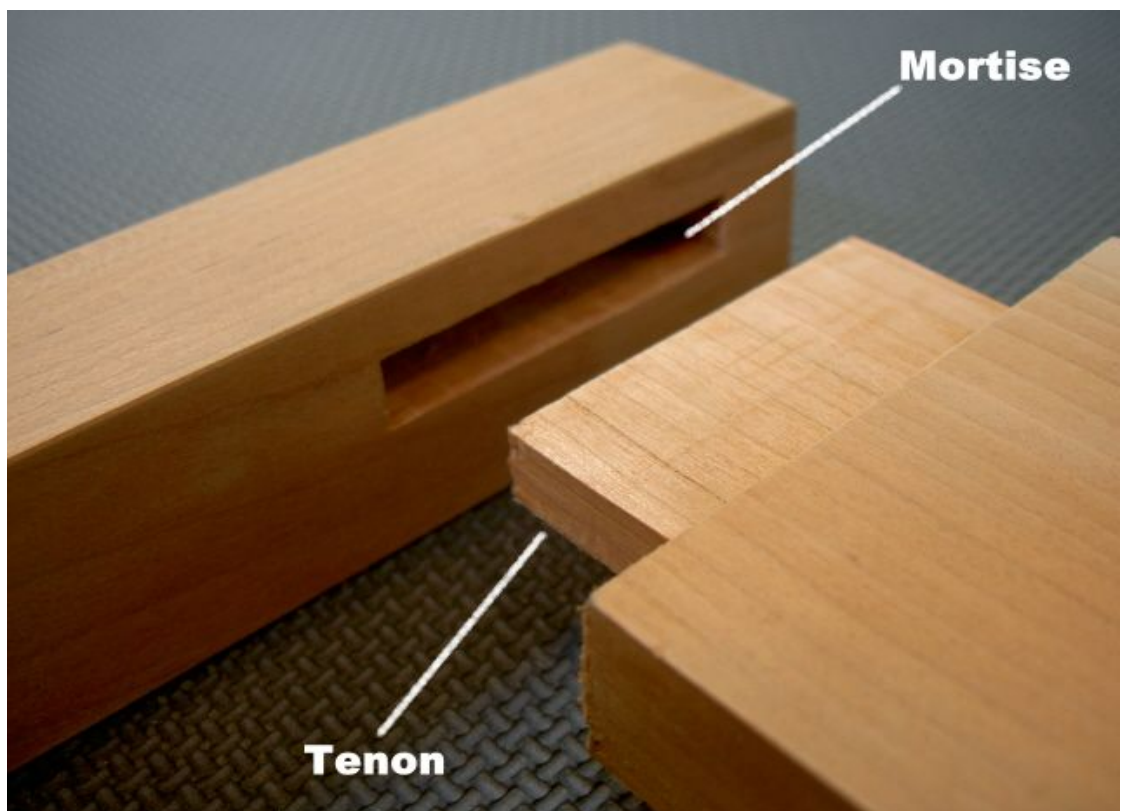
There are also chemicals to be inspected. The adhesives used in the production are tested for strength and for melting temperature. The paint is inspected for color, evenness and impurity substance. The paint must meet the European union E1 standard. The VOC content must be less than the limitation which is no more than 0.08 ppm of the formaldehyde emission. VOC is an abbreviation for volatile organic compounds, such as formaldehyde. The artificial board is also inspected for formaldehyde emission due to environmental reasons. Fuhuang do not have labs that can do those tests. Emissions must be tested in the authorized and properly certified laboratories. [7]

### **3.2.3 Manufacturing of door frame**

This procedure is done simultaneously with two other procedures. After the quality checking, materials are sent to all the departments. In this part, made wood beam is transformed into a door frame.

The wood beam is first be measured for dimensions during the previous step. The standard size of a door in China is  $2000 \times 800$  mm. However, other size of doors can be made also. In

different regions the size may be different. The needed alteration is marked on the beam. The beam then is first altered to proper dimensions with NC machine. At the meantime, the mortise is cut in the wood beam for stiles and tenon-joint is produced in the wood beam for rails. Using tenon-joint and mortise are a common way of connecting wood as it is shown below in *Figure 11*. The frame does not always have top rails and bottom rail. Some doors are also equipped with a lock rail. It provides the door with a platform for installing the lock. The inner diameter of the wood frame should be one centimeter more than the dimension of core board. It is due to the expanding of wood by heat and contracts with cold. The core board must fit into the door frame no matter is the weather is hot or cold. The rails and stiles with tenon-joint and mortise are then agglutinated with adhesives. The preferred choice of adhesives would be glue which is water resistance. The wood frame would then be sent to a buffering storage for later usage.



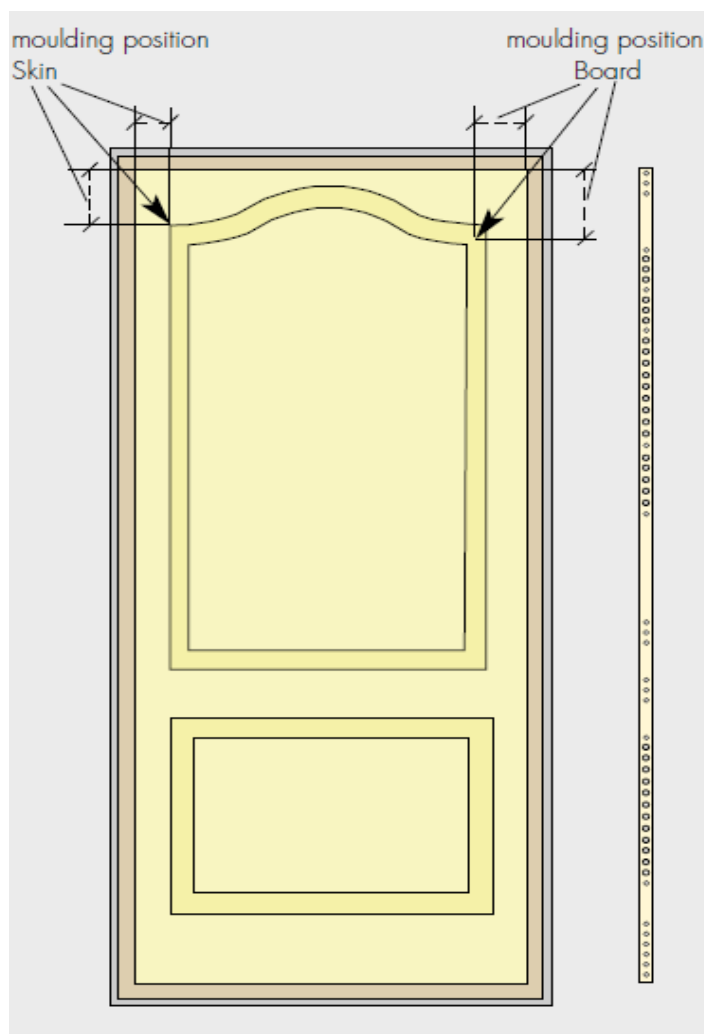
*Figure 11 .Mortise and Tenon-joint.*

### **3.2.4 Core board manufacturing and assembling to the frame**

The core board is the most important component of the wood door. It is vital to have a good



core board so that the door would not be deformed after a fairly long time of service. Nowadays, the technology provides us with advanced and good performance materials. Fuhuang utilizes an artificial board called tubular board for core board. The tubular board was invented by a German company named Sauerland Spanplatte. It is made from wood particles and glue. The difference between a tubular board and a normal particle board is that the tubular board is lighter but able to provide better suspension. As it is shown in *Figure 12*, there are tube-shape holes going through the wood board from the middle which forms an arch bridge structure. The tension on the surface is evenly resolved and suspended. This ensures the door to be stable enough to have a long service time.



*Figure 12. Tubular board side view and tubular board.*[8]

The tubular board is then plated with cross bands and assembled to the door frame. The MDF board is usually chosen to be the cross band if there is no special order from the customer. To combine the cross band, the core board and the door frame, two pieces of

MDF board, one piece of tubular board and the door frame from previous steps they are sent to a thermo compressor together. The thermo compressor is shown in *Figure 13*.

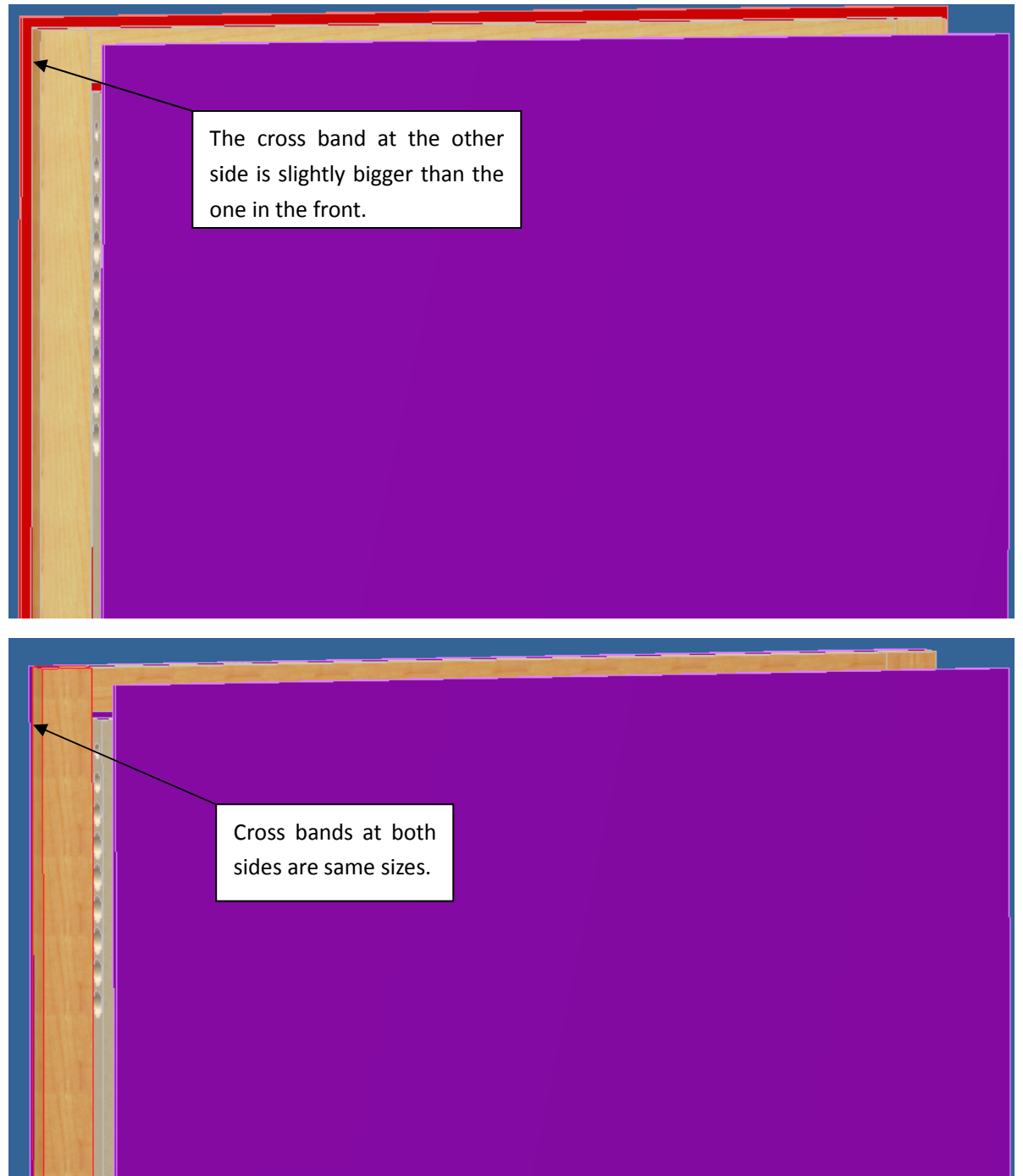


*Figure 13. Thermo compressor.*

Since Fuhuang bought production line from Germany, they introduced a new type of door to Chinese market. It is called the rebated doors comparing to the flush doors. A rebated door is a door which has a lip on the edge of the stile. The great advantages of a rebated door include outstanding sound proofing ability and better energy efficiency. The manufacturing methods of the two types of doors are different. They have the same procedures in some of the manufacturing process stages. However, two manufacturing methods for each type of the door are introduced whenever there are differences.

*Figure 14* presents three dimensional CAD drawings of the two types of doors. The rebated door and flush door are shown in a specially made fifteen degree side view in order to demonstrate the differences of them. The front cross band is set as 30 centimeters away from the surface of core board on purpose. In real life, they are glued together. In the first picture or *Figure 13*, the rebated door has lips that stretch out of the rails and stiles which are shown in red color. However, as it is shown in the second picture, the cross band has exactly the same dimensions as the outline of the rails and stiles in the flush door. That is the only difference of the two types of doors in this procedure. There is one cross band which is larger than other in the rebated door.

What else can be seen from Figure 14 is that the tubular board as the core board is not agglutinated to the frame. There is one centimeter gap between all edges of the tubular board and the edges of the rails and stiles. It is because of the heat expands and cold contracts.



*Figure 14. From top, a rebated door and a flush door show in a fifteen degree side view.*

The manufacturing procedure proceeds as follows. The core board is placed manually in the frame and one centimeter gap is left. The thickness of the tubular board must be the same as

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the one of the frame. Two MDF boards with adhesives on one side are placed on both sides of the tubular board. They are sent to a thermo compressor at same time to be compressed and put aside for the adhesives to dry. The drying process takes about four to five hours. After that, the cross bands are cut to the size as required.

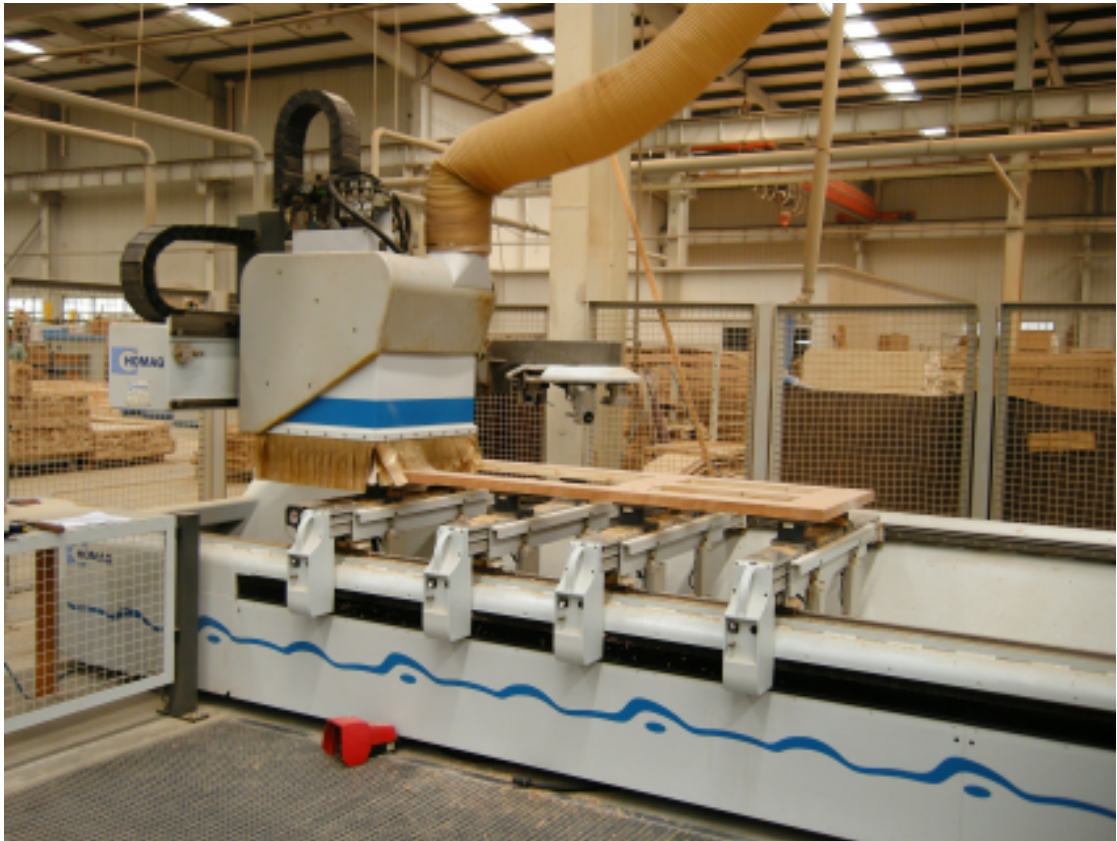
The final step is to collect all the doors to a trolley. Then they are sent to the next procedure.

### **3.2.5 Cutting and curving**

After the previous step, a basic shape of a door is generated. During this step, the parts are cut and curved according to the design. The cutting is mostly needed for the window. Since the process is of a door without a window, the door is only curved. Fuhuang has brought the manufacturing techniques from Germany, so the NC machine is of excellent quality. The NC machine was manufactured by Homag group, as it was mentioned before.

The curving takes only 40 seconds to one minute for one door. It depends on whether the design was complicated or not. The worker takes the trolley which had all the doors in it to the NC machine. Then the NC machine is fed manually with the doors. The CAD drawings of the curving are input to the NC machine. The machine curves the door exactly as it was designed.

An important matter to be noticed is that the process does not produce any sawdust to the air. When cutting or curving the wood, some sawdust emits to the room. As it is shown in *Figure 15*, the NC machine is equipped with a vacuuming system that vacuums all the dust away. It is more than just keeping the whole factory clean, it also makes the working environment safer for the workers' lungs



*Figure 15. Homag machining center for woodworking equipped with vacuuming system.*

All the doors are collected to a trolley after the processing. They are sent to the next department for further processing.

### **3.2.6 Sanding and cleaning**

This step is to prepare the door for the next step. The door is sanded by a three belt wide sander in order to make the surface smooth enough for the next procedure. The trolley that contained the doors are taken by a worker and sent to the sander. The doors are manually fed to the sander.

As shown in *Figure16*, the three belt sander is equipped with a vacuuming system as well. The dust produced by the sanding process is vacuumed. Therefore, the cleaning process takes place at the same time as the sanding process starts. After all the above, the doors are collected to the trolley again and moved to the next procedure laminating.



*Figure 16. Three belt sander with vacuuming system.*

### **3.2.7 Lamination of face veneer**

The lamination concerns the surface of the door. It is crucial for the surface to be smooth so that no air bubbles will appear after the laminating. The laminating process is done with the thermo compressor as well. The veneers are placed on the surface of the door. It is laminated in the thermo compressor.

After all the above steps, the doors are collected to a trolley. Workers send them to the next process.

### **3.2.8 Lipping**

The lipping is to protect the edge of the face veneer. Without lipping, the face veneer is

easily ripped off from the door. All the edges have to be lipped; otherwise the face veneer fails after a while.

For the edges of the door, the edge bandings are utilized to create a similar pattern to the face veneer. In *Figure 17*, the edge bandings are shown. After the face veneer lamination, the doors are sent to an edge banding machine. An edge banding machine lips the edge of the face veneer, trims the extra edge banding and sands the edge banding. The banding machine coats the edges of the door with the edge banding which has similar pattern to the face veneer.



*Figure 17. Edge banding.*[9]

After finishing the above procedures, the doors are collected to a trolley. The workers take them to the next department.

### 3.2.9 Cutting and curving for accessories

After the lamination of face veneer and lipping, there are no wooden parts that are added to the door any more. The remaining cutting procedure is mainly for the accessories in the door such as a lock, hinges and sound proofing rubber. They would be cut with the NC machine shown in *Figure 15* a second time. The opening direction of the door must be noticed before it is sent to the NC machine.

All the cuttings for the rebated door and flush door are the same in this procedure except for the hinges. For these rebated doors and flush doors different hinges are used due to the differences in the structure. As it is shown in *Figure 18*, the differences between a hinge of a rebated door and a hinge of a flush door are shown. This is the only difference in this cutting procedure between a flush door and a rebated door. The hinges are cut differently; otherwise they all are treated with the same procedure. Lock holes and slots for sound isolating rubber are cut and curved with NC machine. After these procedures, the doors are collected to a trolley and sent to next procedure.



**Hinges for a flush door**

**Hinges for a rebated door**

*Figure 18. Hinges for two types of doors.*



### 3.2.10 Painting

During the painting procedure, the doors are sanded and cleaned for several times in order to create a door with flawless paint on the surface. There are four layers of coatings, three base coatings and one finish coating. The working procedures are as follow. First of all, there is the sanding of the door. Second, it is one layer of base coating is painted. The base coating is transparent. Then the door is sanded again. After that, another layer of base painting is painted. Then the above two steps are repeated. Then, after a final sanding, the doors are sent to a pressurized painting house. It has higher than normal air pressure so that the dust cannot get inside the painting house. The painting house is also equipped with a filter. The filter does not allow the dust go through if the particle diameter is over  $4 \mu m$ . The doors are spray-painted inside the painting house. After the painting, they are left alone for 24 hours.

### 3.2.11 Installing the accessories

The installation is optional. It depends on the customer's requirements. However, at least one door from one batch of production is installed with all the accessories for the quality test. The installation is done manually.

### 3.2.12 Quality test

The quality tests can be studied in *Table 1*. The whole procedure and acceptance criteria are shown in the table.

*Table 1. Details of quality tests in Fuhuang Wood Door CO.LTD. [10]*

NAME OF THE TEST	PROCEDURE	ACCEPTENCE CRITERIA(Q.C.)
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<b>Dimensions</b>	Measure the Height, width & thickness of the door sample	The dimensions of nominal width and height shall be within a limit of +/-5mm. The thickness of the shutter shall be within a limit of +/-1mm at any point.
<b>Slamming Test</b>	Suitable fixture shall be made to hold the door shutter horizontally flat and hinged on one long edge and resting freely on a wooden rail 50 mm from the other long edge. The door shutter shall be placed in a horizontal position suitably hinged at three equidistant places or at the discretion of the manufacturer on one of the long edges. The other edge is lifted up so as to form an angle of not less than 30° at the hinged edge and allowed to drop under its own weight, 50 times on the rail at the rate of 4-5 drops per minute.	There shall not be any visible damage in any part of the door at the end of 50 successive impacts. Only superficial damage of laminate is accepted
<b>End Immersion Test</b>	The door shutter shall be immersed to a minimum depth of 300 mm in water at ambient temperature for 24 hours and then allowed to dry for 24 hours at ambient temperature. This cycle shall be repeated eight times. The door shutter shall be examined for any de-lamination in the immersed portion of the shutter	There shall not have any de-lamination at the end of the test.
<b>Knife test</b>	The test shall be carried out on a stout table to which is screwed a wooden batten against which the edge of the test specimen is placed. The knife is inserted with its cutting edge parallel to the grain of the outer veneer and worked into, or if possible, along glue line and the veneer are prized upward. It is essential that the knife be firmly guided along the glue line.	The adhesion is excellent when it is difficult to find the glue line and impossible to keep the tool within it for more than 6 mm without cutting into adjacent wood. On prizing upwards, the veneer/facing sheet usually breaks off over a width only slightly greater than that of the tool.

In *Table 1*, all the details for quality tests are shown. There are four tests in the table. These tests are done inside the factory. At least one door per batch has to be sent to an authorized laboratory to check the VOC content in order to meet the environmental standards.

### 3.2.13 Packaging and sending to storage

The packaging is rather simple. The doors are covered with a plastic foil first. Then a layer of protective PE pearl wool is added. On top of that, there are four corner protective sponges. Then the door is finally covered with carton board package. The product after packaging can be seen in *Figure 19*.



*Figure 19. Fuhuang door package.*

## 4 Marketing strategy of Fuhuang

In this chapter, the background information about Chinese wood door industry will be researched and the market strategy of Fuhuang will be introduced.

### 4.1 Background on Chinese wood door industry

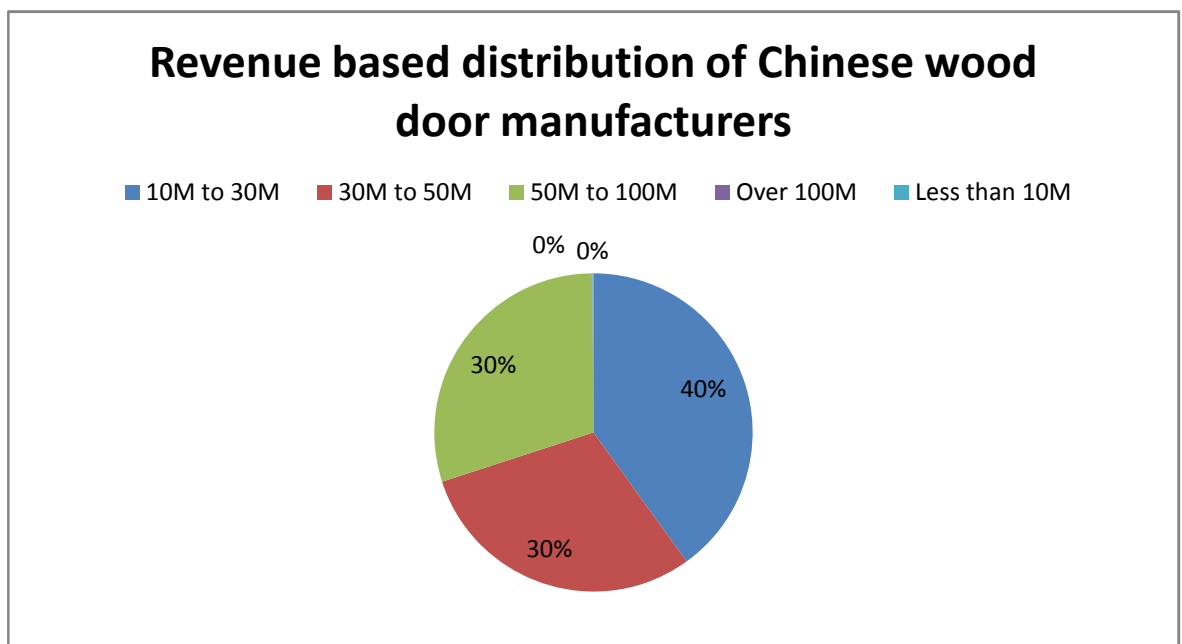
As we all know, China has the biggest population in the world, 1.39 billion [11]. So the market of wood doors is large.

In *Table 2* it can be seen, that wood industry had at least a 20% growth in revenue from 2006 to 2010. However, in 2009 the export of wood doors decreased dramatically. That was due to the worldwide economy crisis. The reason for the growth of Chinese wood door industry is the increasing construction of real estates. The real estate grew by 700 million square meters in 2010. [12]

*Table 2. Total revenue of Chinese wood door industry in 5 years. [13]*

Year	Revenue(Billion Yuan)	Percentage
2006	32	-
2007	40	21 %
2008	50.5	21 %
2009	61.9	18 %
2010	79	22 %

There are more than 10,000 wood door manufacturers in China. As it is shown in *Figure 20*, among all of them, 40 % had a revenue between 10 to 30 million Yuan, 29.94 % of them had a revenue between 30 to 50 million Yuan and nearly 30 % of them had a revenue between 50 to 100 million. However, only 30 manufacturers' revenues are over 100 million Yuan. There were no manufacturers who had more than one percent of the total market share. Each manufacturer was only strong in the regional market.



*Figure 20. Revenue based distribution of Chinese wood door manufacturers.[14]*

## 4.2 Target market and market strategy of Fuhuang

Fuhuang Wood Door CO LTD aims at business to business market. Their main customers include large construction corporations and other wood door companies such as Panpan wood door. Their most famous projects were Beijing Olympic Garden, Riverside City in Shenyang City and Qiumadu in Beijing. They sold thousands of doors in those projects. As one of the top 30 manufacturers in wood door, Fuhuang was very well known in the industry. [15]

For private customers, Fuhuang has just started its own direct-sale store in the biggest city in Anhui Province in 2010. The store is 700 square meters in size and is located in city center of Hefei city.

Fuhuang is dedicated to the high end wood door market. The price range of Fuhuang doors is from 2500 to 3500 Yuan when the average price of a door is only a bit more than 1000 Yuan. They have specialized in the B2B markets and are a beginner in the B2C markets.

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## 5 Existing problem and development ideas

### 5.1 Existing problems

Fuhuang is a fast growing and surely a profitable company. However, Fuhuang is facing problems in both marketing and manufacturing due to various causes.

Firstly, they are facing a serious inadequate production capacity problem. They have right machines and enough workers. But their manufacturing system has many bottlenecks. For example, their material handling system is very basic and limited. Only machine they use in the material handling during manufacturing is a forklift. They have not applied the conveyer lines or automatic material handling system (robots handle the material automatically). Also as it was mentioned in Chapter 4, their drying process takes 5 hours for hot pressing and 12 hours for painting. That is far too slow to be suitable for the adequate production capacity.

Secondly, the standard size of doors is usually not implemented. It is due to the fact that communication between construction industry and wood door industry is poor. The construction companies are the major customer of wood door industry. Each construction company has its own standards for thickness of wall and size of doorway. The reasons for that are that the constructions companies try to minimize their costs and take advantage of the law. China as a giant developing country has grown enormously in the last few decades. When Chinese economy has been booming rapidly, the law has not been able to keep with it. The lacking of standards in construction results in Fuhuang's production to be much harder. They have to put more effort for different customers. It is also impossible for Fuhuang to adopt the automation system because Fuhuang cannot have materials for all the sizes. Changing the materials all the time during the manufacturing is hard to manage and time consuming. That is also why there is no manufacturer in China even to try to build an automatic production line.

Thirdly, there is a lack of management in Fuhuang. In the modern manufacturing world,

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CRM software is often used to manage the storage, production etc. Fuhuang is still in the phase of using Excel tables to record the storage and production. The information exchange between employees is limited and not very efficient. The sales office takes orders from customers and has a deal of delivery time with them. The production manager makes schedules according to the delivery time. The storage manager monitors the storage and alerts the procure department if the storage is running low. The procure department makes procurements according to the storage manager. The production manager is also responsible for assigning jobs to each working group so that everyone knows what their jobs are. The information exchanging during the process is long and not efficient. With CRM, computers monitor your storage for you and tell you when to procure, when and what to produce and so on.

Fourthly, there is a very serious financial problem. In the business to business market in China, delayed payment is a very common phenomenon. If you have a strict policy on the payments you might lose your customers. There are mainly three ways to raise funds in the business world. They are loan from the bank, stock market and private loans. The stock market in China is also not quite the same as NASDAQ or other stock markets because of the high entrance admission and strict examination by government. Since the banks are all owned by government in China, loans from a bank are also hard to get for private companies if the bank does not trust your profitability. The private loan is small amount and has very high interest. So the only chance for Fuhuang to get some borrowed capitals was to ask from Fuhuang Steel Structure Company. As it was mentioned before, Fuhuang steel structure and Fuhuang wood door are both part of the Fuhuang Group, but they operate separately. The Fuhuang Steel Structure had better relationships with banks because it made better profit and sales revenue. All the factors resulted in a bad situation for Fuhuang Wood Door Company financially. Its cash flow will be worse whenever it gets a new customer.

Fifthly, doors as a consumer good are not available for consumers by Fuhuang. That's mainly due to Fuhuang's market strategy. It focuses on the B2B market. However, what is interesting is the reason why that is a problem. There is a huge debate in many firms about

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business to business marketing. Should they be dedicated to producing consumer goods or is it better for the firms to be more related to other firms? In Fuhuang's situation focusing on the B2B market is quite a problem. They are eager to get more market share but their company image is not good enough to attract consumers. Their success in B2B market cost them salaries for hundreds of sales personnel and cost of their travels. That could be avoided if they had their own distribution channel. Another problem caused by not being in the B2C market is that it is hard for Fuhuang to provide direct customer service for the customers who are really using it daily. The construction company bought the doors and installed them but they are not the end user. Those factors are not very good for Fuhuang's company image.

## **5.2 Development ideas**

The development ideas are mainly focusing on the problems mentioned in chapter 5.1 .Since some problems are beyond the control of the company, there are not solutions for all the problems.

First, there is the inadequate productive capacity problem. The bottlenecks are obvious as it was introduced in Chapter 4. The drying process takes too long time and the material handling methods are very basic. The solution would be to change into a new kind of glue and paint. They will be more expensive but they will bring more benefits. The increasing costs caused by new glue and paint could be covered with more sales and more market share. Another advantage about this idea is that there is no need for investments but only need for change of materials. The fact that Fuhuang had not done this is that it takes increased capacity. They would need more work capital, remembering that they also could not get the payments from customers on time. That is one of the down sides of business to business marketing. If your customer is too strong, you have to compromise in many aspects.

Second, the standard for the construction related to the thickness of way and size of doorway will be set by the government in the near future. But before that, Fuhuang can do



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nothing about that. The only thing Fuhuang can do is to be more accurate in the cost estimations. If manufacturing of a special size of door is not profitable, they should not make them at all.

Third, for the lacking of management problem, solution would be adopting a CRM system from Kingdee, a leading Chinese CRM software provider. Fuhuang is doing that now. With the applying of the CRM system, the information exchange will be more efficient and fluent. The data will be much more manageable if CRM system will be used wisely. However, what should be noticed is that it is vital to educate the employees for it. CRM system is a double blade. The misusing of CRM can lead to a catastrophic result to the company.

Fourth, to solve the financing problem, Fuhuang had plans of IPO in 2010. It failed at that time. However, the new IPO plan has been made that in the second quarter of 2011 it will try to IPO for a second time. The financing problem would be solved if they can get equity capital from stock market. To borrow capitals from a bank or a private sector is the second solution. However, the stock market is clearly a better way than get borrowed capitals. After all, it does not require any interest for the finance. These solutions could not solve the problem permanently. If the customers continue to not pay Fuhuang on time, the problem continues. It will even become a bigger problem if Fuhuang gets more market share. The best solution is Fuhuang to have some other good qualities that attract the customers in their product other than cheaper price than their competitors. The price of Fuhuang doors is more expensive than the market average, but it is still cheaper than the products in the same class. Also if Fuhuang enters the B2C market, it eases the financing problem as well. Private customers cannot be so strong so they have to pay in cash normally.

Fifthly, as it was mentioned in Chapter 5, Fuhuang started a direct sale store last year. They are aware of the weak company image which is bad for their competitiveness. It requires a lot of investment at first. So they have a plan of to building a distribution channel of their own starting from the local and finally going all over the nation. It does not help Fuhuang a lot in a short term. But in a long term, if the economy remains growing in China, it will

finally pay off. Also the entering in the B2C market brings new problem to Fuhuang. In B2B market, customers need the same type of doors in a large scale. In the B2C market, private consumers appreciate more options to choose between different of doors. As it was mentioned, manufacture different doors increases the variable costs and even may cause less profit for the company.

Fuhuang has a clear vision of the future. The standards in the construction will be set by government and automation will be the trend eventually. Both the B2C and B2B marketing will give Fuhuang more business opportunities and a larger market share.

## 6 Conclusions

The reason why this research contains market research and manufacturing methods at the same time is that they cannot be separated. In Fuhuang's case, the marketing strategy decides the scale and method of manufacturing. The manufacturing methods blocks Fuhuang from entering the B2C markets. Fuhuang can remain profitable if it keeps its hand in the B2B market in a short term. But eventually it will lose its competitiveness because of weak company image and financing problem caused by the delayed payments. In other hand, Fuhuang has to invest huge amount of capitals in entering the B2C markets. But in the long term, the bigger market share and better company image will bring much more profit than it needs investments. It is important for Fuhuang to see this big picture.

In this research, the information about Chinese wood industry was introduced as well as Fuhuang Wood Door Company as the case company of this research. After introducing to the manufacturing process and marketing strategy of Fuhuang, several problems were found and solutions were suggestive. Their bottleneck in manufacturing was identified. But it will be pointless if their market strategy remains same. They will continue running low on the cash flow and end up with bankrupt eventually.

As a result, the best suitable marketing strategy for Fuhuang is to involve in both B2B and B2C markets. The B2B market provides more profit at the moment, but B2C is the future. Not only it can build up the company's image but also the demand of consumer doors would grow quickly.

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