The New Furniture

How Modern Technology is Changing the Furniture and Cabinet Industry

By

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Introduction

Custom woodworking, or more precisely the business of building custom cabinetry and custom furniture, is a surprisingly large industry. When you add high-production factory manufacturing of furniture and cabinets, we have one of the largest industries in the US.

A lot of people work in this industry. In addition to those working in high-production factories, tens of thousands of smaller shops, perhaps as many as a hundred thousand small shops in the US alone, work every day building custom cabinets and furniture. You will find them working in barns and garages and store fronts and small buildings in every city and town. Many don't have signs, don't advertise, aren't in the yellow pages and don't have fancy logos, stationary or business cards yet they work every day building custom cabinets and custom furniture. They work directly with their customers, get business by word of mouth and generally do quite well, with most making a good living from their craft.

Today, the ratio of standard designs built in large quantity to custom designs built specifically for a customer seems to be changing. There are a lot of forces driving this change, not the least of which is an entire new body of technology and cooperative programs that make custom woodworking practical and cost effective. This changing industry and the emerging technology that is driving this change is the focus of this book.

The furniture and cabinet industry in the US, and perhaps through most of the western world, is in a state of profound change. Political, economic and technological forces are pushing and pulling. Companies and practices that have been stable, even stagnant for decades are changing at almost uncontrolled speed.

Cabinets are looking more like furniture. Furniture is being built in like cabinets and whole new classifications of product, such as closet systems, are emerging.

Manufacturing these products is a very large industry. It rivals automotive and aerospace, yet unlike automotive and aerospace, no single name or group of names or companies dominate. It is characterized by tens of thousands of companies and shops. Some of the furniture companies and cabinet companies have become relatively large but most are small and medium sized, yet they comprise a major industry with a major impact on the economy and employment.

Most American industries have taken a different path than the woodworking industry. Their industries have evolved. Large expensive machines and efficient factories have dramatically reduced the cost of manufacturing their products. Technology has created processes that require these expensive machines just to make the product. Smaller shops that did not or could not employ these capital intensive systems were long ago forced out of business.

This evolution stopped at different places for different industries. Some industries such the manufacture of automobiles or aircraft evolved until a very few large companies remained.

There are, of course, small auto manufacturers but they generally produce a very small quantity of highly specialized products. The vast majority of the market is served by the large market leaders who are mega companies.

Other industries, such as plastics, have a few major feed stock suppliers and then thousands of smaller molders and processors. A small plastic processor, however, still requires a fairly heavy capital investment and typically has 100 or more employees.

The woodworking industry, including furniture and cabinets, is the only industry I am aware of where really small shops of less than five people can be both competitive and successful on an ongoing basis. There are several possible reasons for this.

The first reason may be the product.

Most industries produce fairly standard products. There are only so many models or designs for an automobile. In the overall, the number of available choices is really quite small. The plastics industry, for the most part doesn't produce tens of thousands of different parts. They produce one part, a glob of shaped plastic. Each shape may be a bit different, but they are all processed the same way through the same equipment.

One reason for this is that using the mechanized factories that have evolved, production volume means lower costs and lower costs mean more sales. They minimize the number of variations so that volume is higher and cost lower.

Furniture, on the other hand, is directed by design and there are tens of thousands of different designs in dozens of wood species and thousands of different finishes. You might argue that they are all just wood parts put together, however, unlike plastic, different design wood parts must be processed through different machines using different processes and techniques.

All the techniques needed to process wood into cabinets and furniture however, can be performed by inexpensive tools. The base requirement for expensive machinery that has evolved in most industries is not a requirement in custom woodworking. A craftsman with a table saw and some hand tools can build custom cabinets and furniture. The entry price for this industry is very low, which might be one reason there are so many smaller shops.

Wood furniture and cabinets are also unique products from the consumer's standpoint. Unlike most products, furniture is considered better, higher quality and more desirable if it is custom made by hand. An old piece of furniture, worn and distressed from use is more desirable and generally more expensive than a newly minted, perfect example fresh from a factory. In fact, furniture built in a small shop by artisans is more emotionally desirable than furniture mass produced in a factory. For most people, their furniture is the most prevalent form or art in their homes. Its purpose is both functional and artistic. I have had others describe furniture as fashion for the home. In either case, how a piece of furniture looks and blends with the home décor is as important as how comfortable or useful it is.

It is understandable that an industry consisting of a large number of smaller shops would develop to address this

market. It didn't actually develop, it existed for centuries and just wasn't overwhelmed and replaced by a modern industry, as most others were.

Even today, cabinets and furniture, even really good cabinets and furniture can be built with a relatively small investment for machinery and equipment.

At one time, virtually all woodworking, including both cabinets and furniture, was built by small shops. At that time, it was almost always custom made for an individual customer. Then, furniture manufacturing began to gravitate toward factories, as managers discovered that the efficiencies of standard parts and the production line could be applied to standard lines of furniture. As with other industries, higher production volume meant lower costs.

A primary furniture industry structure developed that has endured, pretty well unchanged, until recently.

This structure starts with the design. Typically, talented furniture designers created these designs, normally based on variations of traditional design elements but modified for today's customers. These designs are then filtered by managers and executives within each furniture company based on (1) what they like, and; (2) what they think others will like and buy, mostly because it's what they like.

These designs are then built up as samples and further modified by production people so that they can be built using existing factories and equipment. These samples are then taken to what is known as a "Furniture Market". These occur a few times a year, generally centered around High Point, North Carolina. At these "Markets", buyers for retail

outlets come together with the furniture manufacturers to place orders for the newly offered products. Note that the actual customer for a major furniture manufacturer is not the consumer but the retail store buyer. This is important to know if we want to understand what is occurring in this industry.

This entire effort is quite expensive in today's world. In and around High Point there are dozens of large buildings in which the "Market" occurs. These buildings, for all practical purposes are only open for a few days, a couple times a year. This is expensive. In addition to the building cost itself, each furniture manufacturer must create and maintain an elaborate furniture showroom in these buildings, a showroom that, like the buildings themselves, is only used a few days a year. As a result, retail markup of factory prices in furniture are between 100 and 300%. After all, somebody needs to pay for all this investment.

After the "Market", the furniture manufacturer looks at their order books and determines which of the new designs is worth producing.

This is how the furniture industry has been operating for some time now. To participate, a furniture company must be of a minimum size so really small shops do not normally function through this distribution channel. There has also been a certain amount of nepotism in this process. A few people, ingrained in the industry, had the power to determine which companies got to display in which areas. A more desirable display area meant more sales and more success. This process was fairly efficient in keeping "newcomers" and foreign companies out. This whole

approach, however, has been under a great deal of strain lately.

The first problem occurred a few years ago. The basis of American furniture manufacturing, or any volume manufacturing for that matter, is volume. For many years, the furniture industry focused on equipment that took some time to set up but then produced parts at a very rapid rate.

The primary focus of these furniture manufacturers, when they purchased new equipment, was the speed at which it could process wood. Although the time required to set up the machine was at least a minor consideration, the overwhelming factor was the speed at which the machine could cut.

As a result, the average furniture manufacturer could very efficiently produce thousands of parts, and that is just what they did.

Production batches or “cuttings” consisted of thousands of suites. When a new design was sold, it was built in volume. The initial orders were shipped and the remainder put in the warehouse and shipped as orders came in.

After awhile, a particular design quit selling because either the public quit buying it or the retail buyers got tired of it. At that point, the furniture manufacturer might be stuck with a warehouse full of furniture that they needed to sell at a discount. This not only eliminated profit on the overstock pieces but also soaked up consumer demand at lower prices, reducing the available market for their new profitable designs.

As a result, the concept of “just-in-time” and minimum inventory became popular. In an effort to compete, companies began offering more and more design and cutting them in smaller and smaller quantities. Costs went up as this practice strained existing manufacturing methods.

The high-speed equipment they used might take an hour to set up and then complete the cutting in ten minutes. It became common for 75-85% of total factory time to be used in setup. The industry was faced with a choice.

About this time highly flexible computerized equipment was becoming available, which could efficiently handle the varying requirements. The concept of this approach, however, was contrary to the long-held beliefs of the industry. It might take a CNC machine twice as long to process a part as the high-speed standard machines and they had a hard time with this concept. The fact that no setup was required meant that the job would be complete in twenty minutes instead of an hour setup and ten minutes cutting, however, it did require an extra ten minutes of CUTTING time.

This is when furniture manufacturers discovered that they could have their furniture built in China at a fraction of what it cost them to build it in North Carolina, or anywhere else in the US. An hour set up is a lot more acceptable if you are paying fifty cents an hour. China offered them a way to keep their long held beliefs and preserve their bias toward high production rate, single purpose equipment while reducing cost and becoming more competitive.

Unfortunately, the quality of goods from China was not very good. Furniture companies began sending their experts to

China to teach them how to build furniture to a level of quality acceptable to US consumers.

The Chinese are a motivated and dedicated people and they learned. The quality of furniture from China became acceptable and a substantial portion of furniture manufacturing was closed down in the US as furniture was sourced from these newly trained Chinese factories.

This approach might have worked for one or two companies. Once the majority of the furniture manufacturers switched over, none had any more advantage over the other than they had previously. That alone was bad enough, but collectively they had another problem they should have recognized. The prices they were paying were too low.

Furniture manufacturers had to realize that the furniture they were purchasing from China was bought at below cost. I am aware of one instance where a veneer log was sold to China, shipped to China and the resulting veneer purchased and shipped back to the US for less than they paid for the log.

At this point, however, the US furniture industry had lost much of its value. It had designers and perhaps a marketing label. It no longer had a factory to produce the product and they had already taught the Chinese to build American quality furniture. It should not have been a surprise that their retail customers, who can also buy a plane ticket to China, began to bypass the “Furniture Market” and the American furniture companies and began to buy their furniture directly from the Chinese manufacturers. This resulted in a 30-40% discount, which translated to even more savings to customers after the normal retail markup.

This caused panic among furniture companies. A number of them, including many who were pioneers in working with Chinese suppliers, got together and filed an anti-dumping suite against the very Chinese factories they were working with. They were hoping for a large tariff that might make their American factories competitive again by making Chinese furniture sold directly to their customers much higher priced.

It didn't quite work out that way. They did win in court and they did get a tariff applied but it was less than 10% and that level was reduced when several of the Chinese companies appealed the tariff.

What this action did do, however, is create new friction between the retail buyers and the American manufacturers. Some of the buyers, who wanted freedom to buy directly from China, threatened to boycott the American manufacturers who participated in the suite.

As a counter to this, several American furniture manufacturers decided to open their own retail outlets and sell their products directly to the consumer in competition with their former customers.

Then, a counter market to the ones in High Point was established in Las Vegas. As you might expect, it was boycotted by many of the larger furniture companies who had both large investments and political advantage in High Point. They hoped that without their presents the market would fail. It didn't.

Buoyed by the lure of Vegas, buyers came and liked the experience. I happened to be in town during this first market

and overheard several retail buyers talking about the markets. It was a real eye opener.

High Point, North Carolina is a small town in which to hold a national event and the locals take full advantage of it. Hotel rooms double or triple in price and that is if you can get one. People rent their homes for a few days for thousands of dollars. There are two sets of menu prices at restaurants, one for the locals and one for the “visitors”, and in the evenings there is pretty much nothing to do.

This is the character of the High Point market and buyers don’t like it. They don’t like it a lot but, until Vegas there was no other choice. I heard several buyers say that if Vegas continued, they would never go back to High Point, and if the companies they bought from did not show in Vegas they would buy from those that did.

As you can see, chaos reins, but it could get even worse.

The new obvious step is for the Chinese manufacturers to begin participating directly in the “Furniture Markets” and attempt to sell directly to the retail buyers, including those that have not yet moved their purchasing away from the American furniture companies.

The real significant thing about Vegas is that if you have the money you can get display space. The “good old boy” network doesn’t exist in this new venue. This means that the Chinese factories can display and sell directly, without interference, and they did.

This all assumes that the current economic trends and trading relationship with China remains about the same, but that is also not likely.

The Chinese economy has some serious problems that they may not be able to deal with. To a large extent the Chinese economy has been built on a rising American dollar, but as this book is being written, the US dollar is no longer rising as it has throughout the nineties. Let's look at a little history.

In 1994, Chinese manufacturers were not generally competitive on the world market. On New Years day of that year they did two things that would change their economy and the economies of much of the world. First, they cut the value of their currency in half. Then they pegged it to the US dollar.

Since China remains a controlled communistic economy, the government and not free markets, determine the trading rate for their money.

This immediately cut the cost of everything sold to the US in half. Now they were competitive. American companies in search of cheaper and cheaper goods began to source more and more goods from China as American companies taught Chinese companies how to produce products that were acceptable to American consumers.

At the same time, actions were being taken in the US that would benefit China economically. Our biggest problem in the mid-90s was inflation. To try and keep inflation down, our government embarked on a strong dollar policy.

Through certain actions, governments can influence the trading rate for their currencies on world markets. This is not as sure or steady as an official trading rate set by a government as China has done, but you can influence the relative strength of your currency with respect to other currencies.

Most countries tend to like a slightly weaker currency since it means that products produced in their country sell for less when exported to other countries. This improves their economy by promoting exports and encouraging native industries.

In this particular case we were doing the opposite.

A strengthening dollar means that imported manufacturered goods are lower cost, not because they cost less to manufacture overseas, but because the trading rate of the currencies favor the foreign manufacturer. Lower cost imported goods means lower inflation rates, and lower inflation rates means you get re-elected.

This action does reduce the rate of inflation but it also makes American manufacturers less competitive in other countries and reduces exports. Some even go out of business as we buy more and more “low cost” goods from overseas.

For China however, a stronger dollar does not help them sell more because their currency is pegged to the dollar. As the dollar strengthens, so does the Chinese currency. A stronger dollar does, however, help them buy. They can buy raw materials from anybody (but the US) at a lower and lower price as the US dollar gets stronger and stronger. So everything seemed to be going their way. They had a good

market in the US for their goods, guaranteed by an artificially low value for their currency when compared to their largest export market. They had ever decreasing raw material cost as the US dollar got stronger by simply purchasing from anybody but the US, and they had millions of workers willing to leave the starvation rural existence and move to the cities to work in factories for low wages.

Although this sounds like a guarantee of success, they blew it. For some reason, whether it was to generate even more jobs, or to compete with other third-world suppliers or because they just didn't understand, they consistently sold products at below cost.

In a free market, this is guaranteed to put you out of business. In their controlled economy, however, when you finally run out of money and can't make your payroll, you simply go to the government owned bank and ask for some money. If it is for payroll, they just give it to you.

It looks like a loan and is shown as a loan on the bank's books, however, since you are not making money, it is unlikely you will ever pay it back. You probably won't even pay interest on it.

Most business in China, unlike the rest of the world, is still owned and controlled by the Chinese government. As foreign influence increased, they added layer upon layer of complex ownership, but when you strip away the layers, you find the government still owns most of the economy.

This helps explain why the government owned banks were so willing to lend money to losing ventures. It was like loaning money to yourself. Actually a type of subsidy.

The US dollar continued to strengthen in the late 90s, rising some 45%. The Chinese continued their practices creating more and more bad loans, until the early 2000s when things started to change.

First, how many bad loans did the Chinese create? For comparison purposes, I believe the non-performing loans in the US are about one tenth of one percent of the GDP. The Chinese government is willing to admit that up to 45% of Chinese loans are bad. Private economists have estimated this number at 65-70%. Several rural Chinese banks have failed and their bad loans were about 96% of the total. Regardless of which of these numbers is correct, they have a serious problem, but it is even worse.

The low cost goods from China have caused hundreds of US companies, including much of the American furniture industry to close their US factories and begin sourcing most or all their products from China. Our appetite for cheap goods has caused us to buy much more from foreign suppliers than we are able to sell to them. This creates an unbalance in trade called the trade deficit.

Our annual trade deficit has reached alarming rates. As I write this, it is about 5% of our GDP. At this level, there is reason to be alarmed. Every other nation in the world has seen their currency totally collapse when their trade deficit reached 4% of their GDP. We are 25% above that right now.

I do not believe our currency will collapse like others, however, I do believe the value of the US dollar will fall, and perhaps fall considerably. It has already fallen about 35% from its top and the deficit has not responded much yet.

Natural laws of finance are taking over. Our government and perhaps other governments may try to prop up the dollar and may actually reverse the slide every once in awhile as they have for the last year or so, however the overwhelming pressure is driving it down and no government has the power to stop it. I believe it will stop falling when the trade deficit becomes sustainable, which I believe is less than half its current level.

If we consider China in all this, the very mechanism that built them is now working in reverse. Their selling price to the US is locked in, in fact they are finding more competition as American manufacturers find ways to compete, and yet they are losing money on these sales. Their material costs are also going up as the US dollar goes down.

Of course, as the US dollar and the coupled Chinese currency fall in value with respect to the remainder of the world, Chinese products are becoming cheaper in these other countries. These other countries, including most of Western Europe however, are not offering quite the same open access to their markets that the US has.

China is also experiencing a labor problem. In the past, Chinese citizens from the rural areas moved to the industrial coast cities in droves to escape the almost starvation economies of rural China. In the cities, they lived in dormitories and worked 60-80 hours a week, 6 – 7 days a week. Life was not all that good in the cities either, but at least they could make enough to eat.

The factories were also not all that safe or healthy. They have none of the health, safety or pollution rules found in

modern Western factories. Companies that sourced their product in China thought this was great because there were none of the costs associated with these items. If a worker was injured or killed, there were five more willing to take their place and without health insurance or workman's compensation there was no lingering cost for these accidents or deaths.

Meanwhile, back in the rural areas of China, to avoid a general uprising, the government began raising farm prices and trying to improve the rural economy. It helped. In fact, rural life became better than the slave shop conditions in the coastal factories. People stopped coming to the city and, in fact, when workers in the city began talking to their relatives back on the farm, they started to see that life was better back home. Many began moving back, creating a labor shortage in the factory towns. Wages began to rise, especially in the American factories which were known for having the poorest working conditions and lowest wages.

China is in a very tight spot and there is no guarantee that their controlled economy will survive any more than the USSR did. You cannot predict what will happen from this point forward, however, this is just one more uncertainty to put into the mix.

The major furniture manufacturers have tied their fate to purchasing their products from cheap labor areas of the world, rather than exploring and embracing the technology and structures that could make local production feasible and profitable.

Some of these firms have already seen problems with China and have begun exploring other areas of the world, such as

Viet Nam, as an even lower cost alternative as the Chinese demand, and get, a living wage and better working conditions.

But, there is yet another potential problem that could affect this balance, oil. Our modern world is currently tied to oil. We get our power from oil. We transport goods with oil. And, we are likely running out of oil.

In order for the industrialized nations of the world to keep growing, the world must also produce even more oil each year and herein may lay a serious problem.

Credible sources say we have already used about half the available world resources and extracting the other half will occur at ever increasing cost. Most Americans believe the Mid-East has a inexhaustible supply of cheap oil just bubbling from the ground and that if they want they can produce any amount of oil we might need. This just isn't so.

Most Americans would be surprised to learn that the last major oil field in Saudi Arabia was discovered in 1965 and that few fields of any significance have been found since then. Also, over 90% of their production comes from four major fields and they are showing signs of peaking.

Oil trades on a free market system and the price is determined by supply and demand.

Today this is a precarious balance. Even a small disruption, such as a hurricane in the Gulf causes oil prices to spike. As this is being written, terrorists are trying to disrupt the oil supply because they also realize the potential impact. Maybe they will succeed, maybe they won't.

Regardless, if you compare the added resources producing nations can bring on line with the projected demand that will result from consumer nations continuing to grow and use oil at current rates, there is a serious shortfall coming.

I do not believe we will return to the dark ages as some suggest. We will handle the problem as we have other problems in the past. We will probably substitute other forms of energy for oil as oil prices increase and it is all but inevitable they will increase.

It's a little difficult to determine a time table for this since we are not sure whose projections are really accurate and nations of the Mid-East have stopped providing field by field production reports many years ago. In my mind, however, it is inevitable that oil prices will rise to over $100 a barrel and eventually to over $200 a barrel.

Other than quite a bit of disruption and restructuring, the most serious effect of this will most likely be very high inflation. I say "most likely" because central governments and our Federal Reserve will be faced with a choice between a deflationary depression or high inflation. With this choice and the current make up of the fed I believe they will opt for inflation.

This new world will be balanced differently than the current one. Shipping products half way around the world will have a real cost, and that cost may be high enough to affect the competitive advantage of cheap labor. The location of the manufacturing or producing facility will take on new importance more like the 1800s than like modern times.

Today large centralized low-cost factories make economic sense, even if they are located half way around the world. This is because we can ship at relatively low cost. In the future it is possible that regional and even local factories might make sense, even if their manufacturing costs are somewhat higher because shipping costs could be 5-10 times more than they are today.

One cannot say with any certainty when or if internal problems in China, or higher manufacturing costs or disrupted or dramatically higher cost transportation will affect the furniture industry, however, with the number of serious potential problems on the horizon the future of the furniture industry is not all that clear. Assuming things will stay the same far into the future has seldom been a correct assumption. I don't think it will be case here either.

In the mean time, a large network of custom cabinet shops exists in the US. Kitchen cabinets, bath cabinets and now, closet systems are a large and growing industry. A portion of this market is addressed by large companies that build standard boxes which are mixed and matched into semi-custom kitchens.

The remainder of the market, however, is addressed by tens of thousands of small shops that design and build totally custom kitchens, generally selling directly to the consumer or to a builder who is working directly with the consumer.

Although most of these shops are small, they tend to be fairly sophisticated, often using advanced design software to design and sell their offering.

Even with the current state of the furniture industry, many of these small shops are uncovering opportunities in building custom furniture in addition to their cabinet business. In many cases, custom furniture is being built-in, rather than being the traditional self standing, movable pieces.

It is in this atmosphere that this book is being written.

I believe an opportunity now exists to develop a renewed woodworking and furniture industry. An industry based on thousands of small, highly profitable shops building customized furniture, cabinets and home furnishings and selling directly to the consumer or at least through a relatively short distribution network that has a more reasonable markup than the distribution network used by major furniture manufacturers.

The reason this opportunity exists now, and did not exist in the past, is technology. The technology to do this exists today, just as the technology to efficiently produce small batches existed a few years ago for the furniture industry. They however, did not embrace the technology.

This time we are dealing with smaller companies and shops. These are people who have already demonstrated a willingness to embrace new technology and techniques. In my experience, I have found them to be much more aggressive and entrepreneurial than management in the traditional furniture industry.

The only real requirement is for them to be exposed to and understand the technology and techniques that are available to them. That is the purpose of the remainder of this book.

A new body of technology, supported by new techniques, structures and programs, has emerged and continues to develop. This new technology supports custom manufacturing of cabinets and furniture. The efficiency and cost penalty normally associated with producing a single instance of a product is rapidly diminishing. The things that are happening are quite exciting and, for some, are hard to believe. The idea that you can design and then produce any molding shape in a few minutes without special tooling seems impossible. The idea that you can make a solid wood carving in whatever species you want at whatever size you want without any carving skills seems unlikely, yet both of these and much more is not only possible, but easy, today.

Much of the technology I will discuss in this book is available from my company, Thermwood. Some of these technologies may also be available from others but I am not in a position to determine that. Some of this new technology, however, I am certain is not available from others, because we either have patents or have applied for patents on it. The fact that one company is in the middle of the development of a new body of technology does not diminish it but, I feel you need to be informed that, like much cutting edge technology development, it is currently available from only a single source.

That being said, the technology is both diverse and varied and somewhat disconnected. There are many ways to use the technology with different paths and different results depending on how you use it. Methods and techniques can be modified and combined into an almost unlimited number of business approaches. I am not going to offer a cook book solution. In this area there is no one-size-fits-all path. Like

any tool, there are a lot of different things that can be done with it.

Instead of trying to offer fixed recipes, I will try to show you how to cook. I will try to focus on areas that are new or not well known by the average woodworking shop, but will assume that each person reading this has a basic understanding of the methods and techniques used today. I will focus on the ways that the new technology enhances or modifies current methods.

Chapter 1
Changing Technology

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When trying to organize this book, I first thought of covering each of the various technologies in their own separate chapter. The problem with this approach is that the various technologies are so intertwined and interwoven that something would be lost if I tried to discuss each independently.

As a result, we have this overview chapter that will attempt to describe the history and evolution of existing and emerging technologies that can be applied to custom woodworking, custom cabinets and custom furniture.

One aspect of this technology, that is the ability to communicate and transfer complex data files and freely exchange ideas via the web, has important consequences, not just because of the technology but because of the networks and business structures that can result from those technologies. Rather than try to include these ideas in this chapter, I will separate them into another chapter so we can explore the possibilities in more detail.

So in the next two chapters, we will look at two major areas that each has a substantial impact on modern custom woodworking.

First, what is custom woodworking?

I am going to define custom woodworking as building specific products in quantities of one, or at most in very small batches. This is to differentiate it from production woodworking which is building a more or less standard design in production quantities.

To understand this better, let's look at a simple cabinet box. Building 32" cabinet boxes may or may not be custom woodworking. If you build 32" cabinet boxes over and over each day, this is production woodworking. If you build one, or five or even ten 32" cabinet boxes as part of a job you designed specifically for a customer, this is custom woodworking. Why does this even matter?

The reason it matters is that the technical tools needed for production woodworking are different than the tools required for custom woodworking. The technology needed for production woodworking has been around for some time and is pretty well understood. The technology needed for custom woodworking is just emerging and is not well understood.

This is even more complex, because components of the technology, computers, software and CNC routers for example, are the same for both production and custom, they are just used differently. Understanding this difference is important to understanding the differences in the technology itself.

Let's start by looking at CNC routers. These flexible machines have become the banner child for automation in woodworking. If you talk to a woodworker about automation, they automatically assume you are talking about CNC routers.

Before we can understand the changes that are occurring, let's look back at the history of the CNC router and see the path through which it has progressed.

Let's go back to the mid-1970's. At that time a company called Ekstrom-Carlson offered an NC router which operated using a General Numeric NC machine control. NC controls, at this point, use punched tape to store, transfer and execute programs. CNC controls were still years away.

To use this system, a programmer must develop code for each individual machine motion. This code is transferred to a roll of tape by punching holes in the tape. This tape is taken to the machine, loaded onto a tape reader in the control and, as it is fed through, the machine executes the motions specified by the punched tape.

There is no computer in the control. It is just like a player piano. It simply executed the motions specified by the holes in the tape.

It was in this environment that a small plastic molding company in Southern Indiana, Thermwood, developed the first CNC control. In truth, this was not part of any grand scheme. Much of it occurred just because we didn't know what we were doing.

At the time we were running a very successful plastic molding operation, selling simulated wood grain plastic parts to the furniture industry. Because of the Arab oil embargo and difficulties in obtaining oil, which is the feedstock for plastic, this market was diminishing. We were looking for new opportunities. We found some new applications for our molded plastic parts, but the parts

needed to be trimmed. I had been exposed to the Ekstrom-Carlson machine at woodworking trade shows and felt that this was a good way to trim my plastic parts. The price of the machine however, was incredibly high.

The plastic molding processes we were using were unique at the time so, we had built much of our own plastic processing equipment in order to mold these parts. Therefore, we were not intimidated by the idea of building a trimming machine. We, however, knew nothing about the control. We went to General Numeric to discuss using their control on our machine and they told us to forget it, it was just too technical for country folks like us.

At about the same time I bought a calculator. I went through engineering school using a slide rule so this was a real technical marvel. It could add, subtract, multiply and even divide. It also had nine memory positions and only cost $1,000. A lot of you reading this don't remember those days, but that's what it was like. For an engineering type like me, this was nothing short of magic.

I then had an idea. If we could some how make each of the memory positions in the calculator represent positions on the machine table, we could cut parts with up to nine lines. This may sound pretty crude but, remember, this was a long time ago.

Because we didn't know anything about this new electronic stuff, we decided to find a book. There weren't many, but we did find a book, in a three ring binder that talked about this new thing called a microprocessor. We couldn't understand the book so we called the author and asked if he could help.

His name was Dick Kruse working at a three man shop called Martin Research. He built a little four inch by four inch PC board using one of these new microprocessors that he thought we could use to run our machine. We estimated that developing the control would cost between $7,000 - $10,000 and would take about six weeks. It actually took about a year and a half and cost over $1 million.

At the end of this we had the first CNC router. We also developed some other firsts that we did not recognize for many years.

NC controls could not accelerate and decelerate so accelerations and decelerations had to be part of the program. A single straight line had to be programmed as a series of lines, each running at an incrementally higher feed speed and then a series of lines at incrementally slower feed speeds where all the lines added up to the single line you want. This was cumbersome at best.

Our first machine used stepping motors to drive each axis and these are highly intolerant of rapid changes in speed. They would only work if they were accelerated and decelerated smoothly and evenly.

When we tried to execute a motion, we quickly learned that we needed an acceleration ramp to accelerate and decelerate at the beginning and end of the motion. It never occurred to us that this function should be part of the program and not part of the machine. In fact, because of the limitations of the stepping motors we were using at the time, the idea of having the programmer supply acceleration and deceleration for each motion would not work anyway.

Since we had a computer inside our control, we were able to perform these accelerations and decelerations automatically inside the control. As far as we can tell, this is the first time automatic acceleration and deceleration was used on a CNC control.

To get an idea of how difficult this was, realize that we programmed the entire system in hexadecimal machine code. There were no assembly editors at that time, and we were not able to use them when they did come out because the code they created was not efficient enough for the highly limited computing capability of early microprocessors.

There were no debugging tools.

We offered the first CNC router for sale at the Louisville woodworking show in 1976, the predecessor to the IWF show in Atlanta. This was a pretty crude machine which used a hand router and a Sears radial arm saw as its machining heads. We used a rotary table to mount the heads which were rotated into position. Inside Thermwood we called it the “windmill”.

This initial machine did demonstrate some of the real potential for this concept. We received the Challenger Award at that show, at a time when only a single award and four runner ups was awarded. We got that single top award.

Much of the work in the ensuing years was in refining and advancing the CNC control and improving the machine mechanics. We switched to servo drives to improve acceleration and performance.

At the beginning, we approached the programming requirement by using a hand held programmer. In fact, for many years we did not have a CRT screen, only the hand held programmer.

At that point in time, computers had two characteristics in people's minds, they were very expensive and they broke a lot. We hid the fact that our control was based on a computer and focused on the fact that it was an easy to use and as reliable as a calculator. This was helped by the fact that the Hand Held Programmer did look like a big calculator.

The hand held was actually quite easy to use. You would move the machine head, using the hand held programmer until it was at a location you wanted to save. You then pressed the Save button, moved to the next point and press Save again, until the entire path was defined. We added key strokes to make arcs and circles, ellipses and eventually splines.

This proved to be a great way to program because, unlike other programming methods where a person needed to mentally switch between numbers and physical positions of the machine, people could simply think in terms of saving positions on the table. There are a lot of people that can't easily make the transition between numbers and physical positions. The hand held programmer let them think in only physical positions on the table and never even displayed the CNC code.

The hand held programmer from those early days is still, today, our most successful option, being part of almost every machine we sell.

The first version of the hand held programmer and every version since had its own microprocessor. This means that our control working with the hand held programmer was the first multiprocessor CNC system ever sold.

Our first controls used the CPM operating system, which originated from a company called Osborne Computer. They eventually went out of business and we soon found that the CPM software really didn't fit our needs well. Our software people, who were at that time located in an R&D office in Dallas, Texas, then developed our own operating system which did fit our needs quite well.

This was still in the 1970s and our operating system was a full preemptive multi-tasking operating system. This means that it could execute more than one stream or program at the same time. Our first system could execute up to four independent threads simultaneously. This was at a time before MS DOS ever existed. One of our software folks told me that this was a really valuable system that could be a stand alone product, but, at the time, we had absolutely no idea how you go about marketing such a product to an emerging computer industry.

When MS DOS came out, we switched to it. Some of the folks that developed the original DOS (not Microsoft) showed us that it could be used as a multi-tasking system with a few little tweaks. We used this until OS-2 came out, which proved to be a much better platform. Finally when IBM lost the operating systems wars, we switched to Windows.

The players in NC/CNC router business changed regularly. C.O Porter came out with a CNC pin router, succeeded for a

few years but then went out of business. Ekstrom-Carlson went bankrupt, left the router business, emerged from bankruptcy and I believe is still in business today but not in the CNC router business. A company called Campbell Automation was started with the help of a disgruntled Thermwood dealer, flourished for a few years and eventually fell on hard times, sold out and was discontinued. By the late eighties, a large number of companies began joining the market. The technical barriers at that time were much lower, since you could now take almost any machine base and add a standard commercial CNC control and you were in the CNC router business.

Throughout this development, the biggest impediments to increased use were high costs and difficulties in creating CNC programs. Again, we will use an historic overview to set the stage for what is happening today.

The very first CNC programs were incredibly difficult to develop. The programmers had no advanced tools to help. They had to write individual instructions to the machine using specific codes. These instructions specified certain machine motions. In creating a program, the programmer had to allow for the diameter of the tool being used and had to compensate for dynamics of the machine itself. It required tremendous amounts of time and de-bugging to create even simple programs. Obviously, with this much effort, you could only afford to program parts that were to be produced in large quantity.

These instructions were written at what amounts to a word processing station and then transferred to punched tape which was taken to the machine and run. This was a slow, difficult process.

The first real advance occurred with Thermwood's hand held programmer. Instead of writing instructions or code for the machine, the hand held programmer was used to physically move the machine. You would specify the axis to move by pressing an "Axis" button and then selecting the axis, 1 for X, 2 for Y, etc. Then enter the distance to move, for example "25.5". Then press the "+" button to move in the plus direction or the "–" button to move in the minus direction. The X axis then moved 25.5 inches.

You could then move it again or move another axis. When you had the head positioned where you wanted it, you pressed the "Enter" button and the hand held programmer automatically wrote the code necessary to move from the last position entered to the current position. The process was then repeated for the next step and when all the steps were executed together, a proper program resulted.

One really major advantage of this approach was that you could actually see where the tool was so if you didn't compensate for tool diameter properly, you could adjust the position before entering the point.

This still took a lot of time and also tied up the machine during programming, but it was light years ahead of the traditional way of creating programs. Using this approach, literally hundreds of ordinary woodworkers were able to program their parts where otherwise it would require highly skilled and very expensive programmers.

After awhile, a new technical development emerged called Computer Aided Design or CAD. This was a software program that was used to design parts on a computer screen.

Initial systems cost millions of dollars and were used almost exclusively by military and aerospace.

Once you could design a part, a method was soon developed to create the machine code needed to make the part that was designed using these new CAD systems. This combination, which became known as CAD/CAM was the first major evolution in machine programming. Programming had advanced from having to write a line of code for each and every machine movement to designing a part and having the computer create the individual lines of code needed to generate the machine movements needed to actually make the part.

Although revolutionary, it was still quite involved with a lot of possibilities for misstep. Let's look at this complete process to try to understand the basic steps needed to create a design and then develop the CNC code necessary to actually make the part. These basic steps are pretty much still the practice today, so understanding them is valuable.

To help us understand CAD/CAM programming we will create a program to machine a square with radius corners. Although this is a relatively simple part, it will illustrate the steps quite well. Let's start with the CAD package.

Using the CAD package we will design the part we want. Start with a tool that creates a square. This is pretty simple and straightforward. Now, we will use a tool to radius or "Fillet" the corners. We specify the radius of the fillet and click on the two lines that make up each corner. As we do, the CAD system cuts the two lines short and adds a curved radius arc of the proper radius to connect them. The result is our square with radius corners.

This really wasn't all that difficult, but we now need to figure out how to develop the code necessary to tell the machine how to cut the part.

Let's look at the things needed to accomplish this.

First, we must re-order the geometry. When we designed the part, we created a square and then we added a radius to each corner of the square. We did not pay any attention to the order in which we did these tasks. The geometry is stored in the order in which we designed it. If we were to use the geometry as is, the machine would first cut four straight lines and then would, in the order in which we created them, cut the fillets to connect the lines. This is not what we want.

We would like to start out off the part, specify the direction in which to cut and then smoothly move around the part until it is complete. To accomplish this, we must shuffle the order in which the individual geometric entities are saved. We may also need to change direction of some of the geometry. If a line was drawn from left to right and we want to cut from right to left, we must change the line to one that runs right to left.

Then we need to create a path that defines the movement of the center line of the tool. We can't use the lines that make up the part because if we move the tool along that path, the actual part we cut will be smaller by the radius of the tool we are using. We need to shift the path over to allow for the diameter of the tool.

We may also need to add lead-in and lead-out movements for each cut. Generally we do not want to simply plunge into the edge of a part and start cutting because several bad

things can happen. If we simply plunge down, the pause at the bottom of the plunge before we start to move sideways may cause the tool to burn certain materials. There are problems at the end of a cut also. First, the burning problem can occur just as it may at the start of the cut. Also, most router bits actually bend slightly as they cut. The cutting forces as you move through the material causes the bit to flex slightly. The direction of this flex depends on the direction we are cutting. With a climb cut, which is normal with a CNC router, the tool will flex away from the part.

If we make a cut and then stop while still on the edge of the part, the tool will relax, cutting a very slight divot into the edge of the part. Even though the actual depth of this may be very small, it is still generally visible.

One way to avoid both of these issues is to start off the part and move through a short path called a lead-in. When we reach the actual edge of the part, the tool is already moving avoiding the burning. At the end of the cut, we then move off the part before we stop moving. This is called a lead-out. As you can see, this avoids both the burning and the divot caused by the tool relaxing.

In actual practice, there may be a lot more issues that must be dealt with at this point. Generally the part we are cutting is combined with other parts in a nest and the actual CNC program cuts several parts from a larger sheet. In this case, the order in which the parts are cut can be important.

The system commonly used to hold material to the machine table top today is a high-flow vacuum arrangement. This approach holds larger parts quite well but offers reduced holding force for smaller parts. This fact must be taken into

account when we develop the CNC program needed to cut the parts.

Generally, a technique is used where the small parts are cut before the large parts and are cut in two passes. The first pass cuts almost, but not quite, through the part leaving a thin skin often called an “onion skin”. This skin keeps the part attached to the larger parts around it allowing the heavy cut to be made without the part moving. Then, a second cut is made, cutting all the way through the skin.

Since the skin is rather thin, cutting forces are fairly small and generally the part will not move. Even for very small parts that generate very little hold-down force, they generally won’t move until the point where they are finally cut loose. This leaves, at most, a tiny thin dimple that can be knocked off with a piece of sandpaper in a few seconds.

When working with a nest, the lead-in and lead-out may not be as straightforward because these additional motions may hit adjacent parts or force parts farther apart, reducing yield. In this case, other approaches may be needed to allow for the plunge problems without traditional lead-in and lead-out motions.

So at this point you can see that there are a lot of issues that must be addressed before we can actually cut our part.

To do these things we turn to another software package called CAM or Computer Aided Manufacturing. Working with this package we can reorder the geometry, select cut direction, add lead-in and lead-out movements and offset for the tool diameter. The final result from the CAM software is a definition of the path for the center line of the tool. This,

however, still can't be sent to the machine. We have only developed the path we want the centerline of the tool to trace. We need to create actual machine instructions that will cause the machine to trace the path we just developed.

You will often hear of CNC programs referred to as "M" and "G" code. This is because the actual CNC program consists of specific instructions that start with the letter "M" or "G". These instructions are defined in an Electronic Industries Association standard called EIA 274-D. As with any standard developed by a cooperative of industry members, it's not all that standard.

The primary purpose of 274-D is to bring order to CNC programs and provide consistency between controls, machines and software supplied by different manufacturers. It does this, sort of.

When developing the standard, they tried to balance two goals. First, they wanted to create order and compatibility between different manufacturers but they also wanted to allow for future developments and provide a standard that did not stifle creativity. The final result was three different classifications of code.

First, there was a group of standard codes for basic functions which were defined, fixed and everyone used exactly the same code, more or less. Thus, a G01 is a linear move on every CNC control because it is a fixed command under the EIA 274D standard.

I said "sort of" because, after the "G01" comes a number that defines the distance of the linear move and different manufacturers can format the number differently and still

comply with the standard. This means that they are not exactly interchangeable with each other.

The second category is a series of codes that were reserved for possible future use by the EIA in the base standard. Should a new feature need a standard code, the EIA has codes available that they can use.

The final part of the standard was a series of codes that each individual manufacturer could use any way they want. In fact, different manufacturers could use the same code to do totally different things. At this point, you really don't have an effective standard between manufacturers. Basically, you cannot freely exchange CNC programs between machines built by different manufacturers even though they all comply fully with EIA 274-D. OK, but as long as you are working with machines built by the same manufacturer you can exchange programs between machines, right? Actually, NO.

Remember, in the process of developing our simple program, we are trying to turn our tool path into code that the machine can use to generate the correct path. This is generally done by a software package called a "Post Processor" or "Post" for short. This package takes the path we want to generate and, taking into account the physical and mechanical characteristics of the machine, generates the program needed to make that particular machine cut the path.

Since every machine is mechanically different, you generally have a different Post Processor for each machine.

You process the tool path through one Post for the first machine and if you want to run the part on another machine, you must process the tool path through a second Post Processor for the second machine. You cannot normally take a program from the first machine and just run it on a second machine.

When CNC started to proliferate, this became a major problem for aerospace and defense industries who embraced the new technology enthusiastically. This problem was especially serious when working with three dimensional parts and five-axis machines. A devoted group of engineers and technicians came up with a great solution which they called “Binary Cut Line” or BCL.

The idea was quite simple. Instead of sending actual machine movement programs to the machine control, why not send just the path you want to generate and then let the machine control figure out the movements needed to generate the path. Then, if you send the same path to several machines you get the same result even though the actual movements of each machine might be totally different.

These folks were fervent in their belief that this would save billions of dollars a year and make all of industry more efficient.

They were however, battling established standards, entrenched control manufacturers and politics and despite huge efforts, BCL never really caught on. The idea behind BCL, however, is crucial to free exchange of programs needed to make truly custom woodworking possible.

Early on, we at Thermwood recognized the advantages of BCL. We even created an experimental control that worked with both BCL and EIA code. But after awhile, we realized that industry would not embrace BCL and it wasn't going to create a huge new market for our machines. We decided to try to get the advantages of BCL while working with standard EIA code. Our initial answer was what we called "Machine Macros".

The really major advantage of BCL is the ability to allow for differences in the mechanics of each machine without having to do it in the part program. We felt we could accomplish this same thing with machine macros while preserving the basic EIA code that everyone was comfortable with.

The idea behind machine macros is that, instead of executing certain basic functions as individual steps in the part program, we instead create small programs that are resident in the machine, called "macros", to perform these functions. Then, we assign one of the unused EIA codes to the function and put that command in the program instead of all the individual moves. In this way, all of the programming code that is specific to a machine resides in the machine and not in the individual part programs. An example might make this clear.

Suppose we have two machines, each with a main spindle and an auxiliary drill. On one machine the drill is located to the right of the main spindle and on the second machine it is located to the left of the main spindle.

When we want to switch from using the main spindle to the drill, we must shift one machine to the left and the other

machine to the right. Clearly the same program will not produce the same result on both machines. If the program shifts to the left to get to the drill, it will only work on the machine that has the drill located to the left. To use the other machine you have to shift to the right, which requires a different program.

In this case, to cut the same exact part on both machines it is necessary to create a different program for each machine, one program that shifts left and one program that shifts right.

With our approach, we instead create a machine macro that resides in the control. This macro switches from one head to the other. When you want to drill you simply put a command in the program that says switch to the drill head, instead of adding the motions needed to switch to the drill head. When this command is encountered by one machine it shifts to the right. When this same command is encountered by the second machine it shifts to the left.

Both machines can now run the same program and will produce exactly the same part because all the program says is to switch to the drill head. Each machine then does what it needs to accomplish this.

The execution of this command is actually even more refined. Obviously, each machine needs to shift to reposition the drill head. Instead of adding the shift as a separate movement, the shift dimensions are automatically added to the next movement command in the program, which is normally used to position the head for the drill process. In this way, you get the most efficient program

movement possible while still allowing for difference in machine mechanics.

Although this is a simple example, this basic approach is used to account for all variations between machines, so programs can be freely exchanged between our machines without re-posting, regardless of their mechanical configurations.

This is a simple concept, but it is incredibly powerful and is an absolute requirement if programs are to be freely exchanged.

When we first started doing this, there was no immediate compelling reason to exchange programs between machines but it just seemed like a good idea and wasn't all that difficult to do.

There was one advantage to our approach that we did try to promote. With the traditional post processor approach, some companies created hundreds and perhaps thousands of programs for their machine, a substantial investment. Then, something happened to their machine, a drill head fails and the replacement is not the same size. The drill position is now changed.

They have to change their post processor and then reprocess hundreds or thousands of programs before they can use them. With our approach, we change the internal machine macro and all the current program work, without change.

Although this wasn't the prime reason for our approach, as you will see, freely exchanging programs has become a key requirement of networking, which is vital to our concept of

a new custom woodworking industry. In this case we made the call correctly and have created a foundation that allows some of the vital fundamental concepts to work.

Now, back to programming our part. We have gone through quite a few steps to program our simple part, but it was still a lot easier than writing each line of code, one at a time. If you need to make a volume of these parts, CAD/CAM is the way to go.

If you only need to make one of these parts, however, it will probably take you longer to program it using CAD/CAM than to go to your table saw and band saw and just make the part. Also, if you are making a more complex product, such as a cabinet, the task becomes even more difficult.

A cabinet is made up of a multitude of parts. Each part must be individually designed, but it is even more involved. The joinery between these parts must also be designed and the mating areas must match on different parts. This becomes really involved.

Creating all the parts of a cabinet using CAD/CAM is difficult enough, but the real problem occurs when you need to change something. If you want to change the size of a cabinet, you must go back and change every part of the cabinet that the new size affects. The ability to determine which parts change and which parts stay the same size is daunting. This is probably not something you would actually try to do using a second generation CAD/CAM approach.

This is where the next evolution in programming occurred and for the first time really opened up custom designs.

Instead of designing individual parts, a new class of design software emerged that allows you to design the final product rather than the individual components that make up that final product.

With this new software you design the cabinet, not the parts of the cabinet. The software then designs the individual components including the joinery between them. This software then gives you a cut list and dimensioned drawings of all the parts you need to make and, in some cases even creates the CNC code needed to make the individual parts. Now, in seconds you can create designs that would require days or weeks on a second generation CAD system.

This new generation of design software is the foundation of an emerging technology that is making custom woodworking a new revitalized industry.

I believe that the key to using modern technology for custom woodworking is to, as much as possible, eliminate programming. To be price competitive, the combination of programming and machining using new technology must be materially faster and more cost effective than designing and making the same parts using traditional manual methods. This, however, is only part of the answer.

The custom woodworking industry, as I refer to it, is comprised of generally smaller companies and shops building products in limited quantity. They are usually at a cost disadvantage to larger companies that build products in large volume and so must depend on the fact that their products are “custom” to sustain their business.

Volume production is the cornerstone of the industrial revolution. Prior to the late 1800s and early 1900s, products were generally built in small quantity by individual shops. Then the idea of the production line and mass production emerged. This basic approach prevailed because, ultimately, it was less expensive, but exactly why is it less expensive?

First, if you do the same thing over and over, you tend to get very good at it. You get more efficient and therefore put less time into each item you make, so each item costs less.

Then, you get this same efficiency from those who supply you with material and parts for what you make. If they make their product in large quantity they also get good at it and become more productive.

But now here is something to consider. If you supplier makes parts in large quantity his cost is lower. Why would it matter what quantity you buy it in, after all the efficiency comes from manufacturing in large quantity, not from selling in large quantity.

This is a very important concept, because it represents another real key to efficient, low cost custom woodworking.

Just as each manufacturing operation has a cost associated with it, each selling process also has a cost associated with it. Sales must be recorded, transmitted, picked, packaged, billed and collected. Each of these functions has a cost associated with it and the buyer must ultimately pay these costs.

Selling costs tend to be more or less equal for each sales transaction. If you buy one item, the total selling cost must

be added to that one item. If you buy a thousand items, one one-thousandth of essentially the same cost is added to each item. In volume, the sale transaction cost per item is a thousand times less. When you buy a thousand at a time, the price per part will be lower.

The actual impact of this can be even greater. For many suppliers, their sales transaction cost is high enough that they cannot possibly add enough to a small order to cover it. In this case, they either refuse to sell you product in small quantities or set a minimum order quantity that assures them a profit on the order.

When you build custom products, your purchase volume of any particular item will always be low. This means that, unless we can change something fundamental in the formula, you will either have problems getting what you need in the appropriate quantity or you will be paying a higher price.

This is another place where technology can change the fundamentals of the equation.

As a small shop you have very little buying power. Earlier, however, I said that custom woodworking was a very large business. Actually it is made up of tens of thousands of shops, maybe as many as a hundred thousand shops in the US alone and this many shops have substantial buying power. The real trick is to organize these shops together into a buying group or cooperative. Then, the cooperative can set up automated technological links with the suppliers so that individual purchases can occur with a very low transaction cost. As a result, everybody wins.

In this arrangement, individual shops get their supplies at a lower cost. They will still probably not get the same price as a large company buying in large quantity, but the difference will be much less. They should also have access to components that might not be available to them otherwise.

Vendors to the industry get access to tens of thousands of small shops through an efficient network that allows them to ship in small quantity and still make money on each order.

This is the basis of a program we started called eCabinet Systems. We will talk about this program in more detail later but, it does approach this problem in this manner, using the cooperative buying power of thousands of small shops and efficient electronic networks and ordering processes to keep prices low.

So basically, we have two large areas of technology that attempt to make custom woodworking more efficient, productive and competitive. The first is the design and manufacturing area, including emerging technologies that are impacting these, and the second is through networking and purchasing. We will look at these in more detail in the new two chapters.

Chapter 2
Custom Manufacturing Technology

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Custom woodworking, especially custom cabinets, has really changed in the last few years and continues to change at a pretty rapid pace. Most of this change has developed as an outgrowth of Nested Based Manufacturing.

The first evolution in cabinet manufacturing occurred when 32mm dowel construction first moved into the US from Europe. This construction method lent itself to a level of automation using a panel saw and point-to-point machining center.

This approach automated machining using the same basic approach as had been used traditionally. First the large sheets of material are sawed into individual blanks and then the individual blanks are drilled and machined into their final form, one at a time, on a CNC machine. With the panel saw/point to point, the machining and perhaps the sawing were now automated.

Cabinet design software evolved at about the same time and offered to create the programs needed to drive the panel saw and the point-to-point.

At this time, I need to explain what I mean by “point-to-point”.

The original CNC boring machine used for 32mm drilling were relatively low cost machines but were also limited in

their function. To save money, they did not attempt to coordinate axes movement when moving from one drill point to the next. Instead, they were only interested in the position of the machining head at the point at which drilling occurred. Since the machine was only used to locate drill points, it became known as point to point.

Then, axes coordination and the ability to route were added and the manufacturers attempted to change the name to machining center. At the same time, drills were added to CNC routers in an attempt to address this same market and they also called their product machining centers. Things can get quite confusing when two totally different approaches and two totally different machines are called the same thing.

Therefore, in this book, I will call a machining center that processes pre-cut blanks into final products a “point-to-point” and I will call machining centers that machine a nest of parts directly from a full sheet a “CNC router”.

It is important to recognize the differences between these two approaches because the evolution from point to point to nested based machining on a CNC router has resulted in a major increase in productivity, especially for shops that do custom work. Let’s look at the differences in actual use between the two approaches.

Let’s start with the panel saw/point to point approach.

The basic steps required to machine parts using a panel saw/point to point are to first transport the sheet material to the panel saw. These are then processed through the panel saw where the sheets are cut into blanks. The blanks must

then be sorted and identified and those that require edge banding must be separated from the rest.

These are taken to the edge bander and edge banded.

Then all the parts are transported to the point-to-point. There parts are processed through the point to point, one at a time. It may also be necessary to adjust the position of the vacuum pods as different sized blanks are machined.

Point to point machines generally use individual pods, some square, some round, to hold the blanks. These pods have a rubber seal around the top and use conventional vacuum at a fairly high vacuum level. This approach creates a substantial holding force and tends to hold the blanks quite well.

This approach only works if an unbroken seal is developed between the pod and the blank being held. This is the reason for the rubber seal.

It is therefore important that the pod be located under the blank and away from any edges that will be cut and also away from any holes that might be drilled through the part. If the pod is incorrectly positioned and the machine cuts into it, not only is the seal and thus the hold down force eliminated but, often the pod is damaged or destroyed.

For this reason, it is important that the location of the pods be verified and adjusted for every part, and this takes time.

Now let’s compare this to nested based machining on a CNC router. The first step is to transport sheet material to the machine. These full sheets are loaded onto the table of

the CNC router and parts are machined directly from the sheet.

Since the sheet is held in place using a high flow vacuum system, there is no adjustment needed to hold the parts in place.

Then the parts are edge banded.

You might notice that I did not include the step of transporting the parts to the edge bander. The reason for this is that most of the time, the CNC router operator can do the edge banding work on parts from the last sheet while the next sheet is being processed. A full machining cycle typically requires five to eight minutes, allowing sufficient free time to do edge banding. With the point to point, pods must be adjusted and each part must be handled individually keeping the operator fully occupied and not allowing any free time for other processes such as edge banding.

Overall, a process that requires four to five people using a panel saw/point to point can be accomplished with two to three people using a CNC router and nested based manufacturing. The first advantage of nested based manufacturing is that it requires less labor.

The next advantage of nested based manufacturing is that it normally results in better yield.

The yield improvement comes primarily from the fact that a panel saw can only cut straight lines while a CNC router can cut in any direction. A panel saw must cut all parts as rectangular blanks, even parts that are not rectangles. Excess material from these parts must be scrapped. A CNC router

can cut the actual part shape from the sheet so parts can be intertwined in the nest. On certain designs this can result in significant material savings.

Even on rectangular parts, a panel saw requires that the edges of the rectangles be lined up in the nest along common cut lines so the saw can cut them. If the rectangles are not the same width, this requirement results in additional scrap. A CNC router allows the rectangles to be nested in the most efficient manner (it's called True Shape Nesting) eliminating the need to line parts along cut lines and eliminating the extra scrap.

Some proponents of the panel saw point out that the kerf of a router bit is larger than that of a saw blade, which reduces yield. This is seldom true in the real world. The only case where it might occur is if the difference in kerf width determines whether one of two parts can be nested across a standard width sheet. The common cabinet depth used today allows enough clean up material around each part on a standard width sheet that this makes no difference.

In addition to labor savings, Nested Based Manufacturing produces as good, and in many cases better material yield than a panel saw/point to point producing the same jobs.

The next advantage of nested based manufacturing is that it runs parts faster than a panel saw/point to point.

The production rate of each approach is determined by how fast parts are machined. The actual machining speed of a CNC router and a point to point is about the same.

Machining speed is normally determined by the tooling and material being cut rather than the machine. CNC machines, either routers or point to points usually move much faster than the maximum speed at which a tool can cut typical material today.

With the point to point, however, the operator must unload and reload each part. The time required to do this is added to the processing time for each part, making the overall machining time per part higher. In addition, point to point machines use vacuum pods to hold parts for machining. These must be adjusted for differences in part size, so this additional step adds even more time to the overall process.

Finally, since the point to point must process parts one at a time, any tool changes must be done for each part, adding extra time to the cycle. In Nested Based production, a tool is changed and then every part on the sheet that needs that tool is machined. This results in fewer tool changes and faster production.

Finally, nested based manufacturing requires less capital investment and less overall shop floor space. A CNC router and an equivalent point to point machining center cost about the same, however, with the point to point, you also need a panel saw. Also, two machines require more floor space and support space than one machine.

As you can tell by now, I am a real fan of nested based manufacturing. The processes around nested based have been refined so that all the little problems and techniques are handled quite well. This being said, all approaches to nested based manufacturing are not the same so now, let’s look at some of these details and differences.

The first question is where do you do the nesting? People naturally assume that the nest and the resulting CNC program is generated by the cabinet design software and then sent to the machine to cut. Traditionally, this is how it has been done, but this has some problems and there is a better way. To understand, let's look at a typical job.

The first thing about a typical job is that it will require two or three different sheet materials, probably in different thicknesses and seldom will you use every bit of every sheet. At the end of the job you will have two or three or more partial sheets of material left over. Some of these may be half or three quarters of a sheet and this material has real value. It would be nice to be able to use these on the next job.

Once you have run ten jobs or so, you have thirty or forty of these partial sheets of various materials lying around. Let's try to use these on a new job.

Most design software has some provision for using less than a full sheet. The first thing you need to do is to measure and document the actual size of the partial sheet. Now take this information to the office and input it into the design program. After the various materials have been input, you will get a nest program that incorporates these sheets along with some full size sheets. This nested program is sent to the machine normally over a network.

Now we are ready to run, but first we must sort through our pile of sheets to locate and identify the actual sheet the program wants. Depending on how many we have and how close to the same size they are, this may not be all that easy to do. It is even possible that some of these sheets have been

used for other purposes or damaged while we were programming them into our job. If that is the case, we have a difficult choice. We can either go back and re-program the job or we can use a full sheet instead of the partial sheet, but that generates even more partial sheets we have to deal with. As you can see, this is getting pretty complex.

In actual operation it is probably even a little worse than that. Most shops find that the hassle and lost time that results from trying to use this extra material costs them more than any possible savings they might realize. The idea sounds good but it just doesn't work very well in the real world. Generally, they either let these sheets pile up and eventually haul them away or they just scrap them at the end of each job.

However, there is another approach to nesting that works a lot better. What if we did the actual nesting right at the machine control, rather than in the office? If we could add some additional refinements, this might address many of the problems we just discussed.

After some serious analysis, this is the approach we decided to take. We were in a unique position since we not only developed the cabinet design software but also developed the software that operates the CNC control. We could modify both so that they worked together seamlessly to address these issues.

This approach not only addresses some fundamental issues but has also evolved to offer a lot of additional capability and functionality. Instead of sending a machine program file to the CNC control, we send a description of the individual parts needed for the job. The machine control then nests

these, does the CAM functions and then does the Post Processor functions resulting in a program that can then be run. This is where some extra features come in that are essential to make this all work in the real world.

In addition to nesting and creating the CNC program, the control also prints a diagram of the parts that make up each sheet of the nest. It also prints a stick-on label that identifies each individual part. To do this, the control itself is equipped with a set of printers.

If you look carefully you will notice that some of these labels have a bar code printed on them, others don't. The bar code is used to identify any part that requires machining on the flip side. Depending on the construction methods and design, some parts may need to be machined on both faces. When this occurs, we need a simple way to identify these parts and perform the flip side machining. The bar code label does this.

In practice, the label is positioned on the part in a specific corner. After the nest is run, any parts with a bar code are separated and stacked off to the side. Once all the full sheets have been machined, the flip side operations can be performed.

At this point we need to do several things. First, we need to identify each part. Then, we need to retrieve the correct CNC program needed to machine the back side of the part. Then we need to properly position and orient the part for machining. This could all be a major hassle if we can't find an easy way to do it.

The bar code label solves this problem. We can scan the bar code to tell the control which part we are going to machine. This means you do not need to keep the parts in any particular order and it is all but impossible to run the wrong program on a part.

Once the control knows what part we are going to machine, it can automatically retrieve and load the correct CNC program for that part.

We will use a corner of the machine table to locate the parts. There are a set of flip up stops that can be used to position the part. Then these are flipped down and out of the way so that machining can occur around the entire perimeter of the part without hitting the locator bars.

When we placed the label on the part in the nest, we placed it in a specific corner of each part. We are now going to use this label location to help us orient the part for flip side machining. Flip the part over and place the label against the stops in the corner. In this way, you do not have to worry about proper positioning or orientation, it is pretty much automatic. Press the start button and the flip side machining is done.

This approach is about as simple and foolproof as you can get. Scan the label, position the part and hit the start button. The system does the clerical work, identifying the part, then finding, retrieving and loading the correct program for that part.

This is a clear example of making systems practical for real world applications. If you are going to make 100, 200 or 500 parts, a minute or so looking for and loading a program

file is not a big deal. If you are going to run one part, any time required to find the program is a big deal. Custom woodworking has a whole new set of requirements that are not important for more traditional applications but are vital if we really want to automate the custom business.

The next big plus is that the control also prints a bar code label for the partial sheet or sheets remaining at the end of the job. This bar code not only identifies the size and shape of the piece but also identifies the material it is made from.

This is where another real world feature comes in. If you look at a typical piece of scrap, there is a fairly large unused surface that you would like to re-use. Protruding from this are thin sticks and spikes and all sorts of protrusions that are pretty much worthless and will make handling and storing this material a pain.

Again, technology comes to the rescue. At the end of the cycle, after all parts have been cut, the control examines the remaining material and cuts around the outer edge of the large blank removing the protrusions and yielding a blank of a fixed, known size that is easy to handle and store.

The next time you run a job from this same material, you will be able to use this piece. When you first load the job and before nesting is performed, the system asks if you have any partial sheets or blanks you would like to include in the job. Scan any sheets lying around in the order in which you want to use them. The control nests onto these pieces first, then uses full sheets and then prints labels for any material remaining.

As an added benefit, remember that I said earlier that the control knows what material the partial panel is made from. If you start a job that is to run with a specific material and try to use panels of a different material, the system will alert you. Again, we are trying to make the process as simple and foolproof as possible for the average shop.

As you can see, nesting at the control makes using this extra material easy and straightforward, eliminating a lot of steps, fumbling and sorting sheets but it also allows you to address another possible problem.

It is possible that one or more sheets of material may have defects that you do not want to include in your parts. When you nest in the office, this presents a real problem. When you nest at the control, however, you can identify the bad area and the control nests around it. You can now use the sheet where otherwise you would either need to discard it or spend some real effort to try to program around it.

This could be an interesting feature in the future. We have had discussions with some of the largest manufacturers of sheet material, discussing possible ways of using sheets with surface defects.

In their process, they use vision systems to verify the quality of the surface of each sheet of material they make. Some of these have surface defects and must be rejected. Depending on a lot of factors, the number of these sheets can be rather large. Sheets with surface flaws may account for as much as 5-6% of production and when you are producing tens of thousands of sheets a day, this is a lot of scrap material.

Their vision system can not only identify the defect, but can also identify the location of the defect. If this information can be supplied to the machine control, it might be possible to automatically nest around defects in each sheet of material. Thus, the material goes from something with little or no value to material that is practical to use.

The material supplier will still need to offer this stock at a deep discount, but not as deep as today. The cabinetmaker can easily use this material and perhaps enjoy a substantial discount in the process.

By now you are starting to see that some interesting technology has been developed whose primary purpose is to make machining custom nested parts practical. From this core, additional capability has been added to provide even more flexibility.

This might be a good time to talk about the CAM and Post Processor functions. These are not quite as simple of straightforward as they might first appear. When doing nested based machining of sheet stock, some of the limitations of the cutting and part hold down process must be taken into account in the actual CNC program.

One of the requirements of nested based manufacturing is a system to hold down any size part without the need for individual or special fixtures. If you had to adjust vacuum pods or in any other way modify the hold down system to machine nested based sheets, much if not all of the advantage might be lost.

So we need a system that will hold down pretty much any sheet. This need has been addressed by a high flow vacuum

system that goes by a number of names. We call it “Universal Vacuum”.

We first developed this approach in the 1980’s. We had been working with some large aerospace companies cutting aluminum aircraft skins. They had developed a method of holding these by gluing together pieces of balsa wood into sheets where the grain ran perpendicular to the surface of the sheet. Vacuum then pulled through this grain rather easily. They used special high flow vacuum pumps and covered any area where there was not aluminum with either newspaper or plastic film. The process worked well but the balsa sheets were extremely expensive.

We decided to try to find a cheaper material with which we could do the same thing for the woodworking industry. With a little experimentation we found some low density particleboard and MDF that worked quite well. We were excited about our prospect because this opened panel machining as a new market for our CNC routers.

We quickly created a new machine to compete with the point to points of the day and included our new ‘Universal Vacuum” system on it. We dubbed our new machine the “Panel Processing” center.

Now for a marketing blitz.

We took our new machine and hold down method to our dealer in North Carolina and invited all the major furniture companies to a private showing. They came and were totally amazed by the technology. Being proud engineers, we were happy to explain exactly how we were able to do what we did.

The final result of this effort was that the furniture companies added universal vacuum to their Shoda routers and the name “Panel Processing” was fully embraced by the industry. I am not sure we ever sold a single machine from this effort, but we did create an essential hold down technology on which the entire nested based manufacturing process relies. Other than that it was not all that profitable a venture.

When properly applied, the high-flow vacuum system works, and works well but, there are some limitations that must be addressed. Basically, this system generates vacuum of a couple of pounds per square inch of surface area. For larger panels, this generates more than enough hold down force to keep from moving the panel during machining.

A one foot by one foot panel has 144 square inches of surface. At two to three pounds per square inch you have something over 300 pounds holding the part. This is reasonable force and should hold the part during machining if you don’t try to hog through it too fast.

As parts get smaller, the amount of holding force becomes less. Eventually, parts become small enough that they move during machining, regardless of how careful you are. We have to find a way around this problem.

There are several things you can do in the program to address this. One approach is called “onion skinning”. Here, you cut almost, but not quite through the part, leaving a thin skin on the bottom surface. It is in this first pass that the major cutting forces are generated. Assuming there are other parts around the one you are cutting, this thin skin holds

them all together and they act like one big part. Then, we can come back and cut this thin skin separating the parts.

Obviously cutting this thin skin generates much less cutting force so parts should not move. You can improve this process in a number of ways. First, you should cut the small parts first, and it is best to start the cut along the longest edge facing toward the center of the tables. In this way, it is much more likely that there will be larger parts still attached when the final separation cut is made. If the final cut is toward the outside, it is likely that the part has already been fully separated long before the final skin has been removed.

Another approach that works well is that during the final skin removal cut, instead of just plunging through the skin and starting the cut process, you can taper the cut into the edge as you move along until you are cutting all the way through. Then, as you move toward the final separation point, you are cutting a skin that is getting thinner and thinner so the cutting force is becoming less and less as you approach the final point of separation.

These approaches work very well, but require a lot of effort if you are manually generating code with a CAM system.

When the program is generated within the CNC control, the specific characteristics of the machine can be accounted for and these functions can occur automatically. As you can see, although the operator does very little, a lot of technology is happening during this automatic process.

Once the control is able to automatically perform CAM and Post Processor functions, there is no reason to limit these functions to parts that come from cabinet design software.

In fact, if we can find a format that the control can understand, there is no reason why we can't nest together part designs that come from anywhere. So how do we find this format?

There is no official standard file format that all CAD and design software use. Each package has its own unique format in which they store data and designs. There is an answer, however, that resulted from marketing pressure, and it actually works quite well.

Back when full blown CAD systems cost a half a million to a million dollars, a small start-up company called Autodesk developed a CAD program they called AutoCAD that operated on the small limited PCs of the day. Best of all, it was relatively inexpensive.

It soon became quite popular and even with its limitations soon became the standard CAD system for PCs. After a few years, others saw their success and decided to jump in the market. Other CAD packages started to appear, but almost everyone was already using AutoCAD.

AutoCAD used a file format they called DXF for Data Transfer File to store their geometric data. Anyone that wanted to compete with AutoCAD found they needed to be able to read and write DXF files if they were to have any chance at all. So as things evolved, everyone had their own primary proprietary file format that they saved their designs in but they all also had the capability of reading and writing their designs in AutoCAD's DXF format. DXF became an unofficial standard.

Through the years, almost every CAD and design software had the capability of importing and exporting DXF files. The DXF file format also evolved and changed, but the changes were normally adding additional fields and information, leaving the core part design data pretty much in tact. Therefore, if you can import and then nest DXF files, you have about as close to a universal link as possible.

We added the ability to import and use these files to our control to allow programs from different sources to be nested together in a single job.

In order to go directly from DXF files to programs that will run the machine, we used a feature called layers. Designs are made up of various classifications of data. The actual shape of the part is one type of data. Dimension lines are another and text is another.

To be able to tell which of the lines on the screen represent the part itself, which lines are dimension lines and which lines are text, we commonly store each of these on a different layer. There is one layer for the part geometry, another for text, etc. The DXF format supports this layer concept.

All we need to do is use common layer names for specific layers and we can use the data directly. Most software allows you to name the individual DXF layers so at most you may need to re-name layers to our standard to use the file.

Some software suppliers handled layer names of their DXF files differently so we needed to make provision for their

specific format, but overall it is quite easy to allow for these minor variations.

The final result is an interesting technology that removes barriers and allows a great deal of flexibility. This flexibility becomes quite important as custom builders network together and share production capability. We will talk about this area in more detail in the next chapter but it does represent an important fundamental capability.

If we stand back and look what is happening with this technology we will see that the CNC control is taking on much of the routine repetitive programming tasks and automating them, leaving the cabinetmaker responsible for only the design. This is an important trend, because if you are only going to make one example of a part design, you cannot spend much time programming it. The ultimate goal is that you do not need to program at all.

In attempting to achieve this goal, we added another simple interface that can be quite useful and that is the ability to nest and cut rectangular panels. While this seems like a pretty simple feature, it is actually quite practical.

Sure, you can simply use a table saw and cut up the panels, but then you have to manipulate the sheets, measure, set fences. Etc. It is actually quite a hassle.

With this system, you simply slide the sheet on the machine table, input the sizes you want and press start.

We set up the control to accept panel sizes in three different formats. First, you can create an Excel file that lists the quantity and sizes you need. This Excel file is then loaded in

the machine control and the control nests and cuts the panels.

There is also a file format that some design software uses to output directly to panel saw optimizers. It is called CPOUT and we also accept these files directly into the control.

Finally, you can just type the length and width and quantity right into the control screen and the control nests and machines the panels.

Because the control uses true shape nesting, it is possible that this gives you better yield than a panel saw or table saw. With a saw, parts must be lined up along common cut lines but this is not necessary with a CNC router. This generally doesn't make much difference when making cabinet parts because cabinets have evolved so that their sizes allow for efficient layout using standard sheet sizes.

If you are just cutting random rectangles, this can make a real yield difference by eliminating the need to line parts up along common cut lines.

This approach is not intended as a substitute for a panel saw. If you have a lot of panels to cut up, the panel saw is likely the fastest method. At the same time, if you only have a few panels to cut up, this approach is often faster and a lot less hassle simply because there is little front end prep work.

Again, this a technology aimed directly at a user that only needs a few odd parts in different sizes and wants these as quickly and easily as possible. The real benefit is for those that build in small quantity and need flexibility.

As you can see, the combination of powerful design software and nested based machining from full sheets really starts to make CNC routers beneficial to custom manufacturers, but this is only the beginning of the technical revolution going on. The next step addresses another limitation of small batch and custom production, custom tooling.

When designing custom wood products, custom shapes are needed for moldings, door edges and beads, valences and the like. These shapes require tooling ground to the proper profile which is then used to machine the profile on the part.

If you are going to make a lot of parts, this is not much of a problem, simply order the custom tool from one of the myriad of suppliers and in a few days to a few weeks you have the needed tool.

Of course, you must invest both time and money to get this tool. If you are building only one piece or only need a short section of molding, you have a problem. You need to buy a custom tool and the cost of this custom tool must be added to the cost of this one job. This can add a lot to the job cost without actually improving your profit. Another possibility is to try to find an existing tool or a standard tool that is close to what you want and use it instead. This is also not the ideal solution. Some shops grind their own tools, but this also costs material and time and there is a very real cost to this. None of these solutions work well for a small job, however until now there was no other choice.

For those with a CNC router, there has always existed another alternative, although it was seldom used. You could design your profile in the CAD software and then, using

appropriate CAM software you could create a program to model the shape using standard modeling tools. Typically, a ball nose router tool is used to generate the basic shape. It traces along the edge, shifts over a small distance and traces back. This back and forth motion essentially carves out the profile shape into the part.

The ball nose tool cannot cut sharp inside corners, so a second square bottom tool is used for these.

This is not all that difficult a machining process and done properly, profiles can be machined in a reasonable amount of time. For example, a typical eight foot section of molding can be machined in ten to fifteen minutes.

If this is such a good idea, why aren't more folks using it? The reason is simple, programming.

You need to own and then work with two or three software packages to do this and the overall effort is not really all that easy, especially when you need to integrate with yet another design software. This is a great idea if you can avoid the programming quagmire.

Again, emerging technology has addressed this emerging need. The ability to generate modeling programs for profiles has been added to the CNC control.

The profile shape you want is created in the eCabinet Systems software. Profiles are fairly easy to create and different software users can share profile tool designs easily. The profiled parts display as machined solids in the software so you can see exactly what you designed, all in a single

software package. When the job is sent to the CNC router, the parts with these profiles are also sent.

When the control encounters a profile, it asks whether or not you have a tool for the profile you want. If you say yes, it uses that tool. If you say no, it generates a modeling program to machine the profile using standard modeling tools.

You do need to design the profile you want, but that is relatively easy to do. After that, everything is pretty much automatic.

This gives incredible power to the custom shop. Just think, you can machine virtually any molding profile without tools, but it is even better.

The profile does not need to be on a straight linear edge. It can be curved or serpentine or round. You can put a profile on a table top, or the raised panel of a door, or on a valence or on almost anything. This new technology allows you to easily produce truly custom profiles on almost anything without the need for custom tooling.

Although it does take a little longer to machine, this approach virtually eliminates the major penalty that has been associated with custom profiles.

A unique use for this approach is reproducing one-of-a-kind five piece doors. Later I will talk about producing designer furniture. One thing designers do is create doors with unique style and custom profiles and these profiles are generally vital to the overall appearance they are trying to achieve.

One bit of complexity is reproducing these five piece doors without having to purchase special tooling for each design. Again, if you plan to produce these pieces over and over it is likely worth the investment to buy the proper tooling. Otherwise, you can use the modeling techniques to machine not only the outside profile, inside bead and raise but you can also flip the top and bottom rails over and model the cope that matches the bead on the stiles.

There is one cut that this approach doesn't make, the horizontal groove that the raise fits into. Also, normally a five-piece tool set cuts a tenon into the cope on the rails that fits this same slot.

In the new approach, a simple table router with a tee slot cutter is used to cut the groove. It also cuts a slot into the end of the rails. Generally you don't want this slot to protrude through the outside edge. This gives a nice finished outside profile.

A square biscuit is used to attach the rails and stiles together using the slot cut we just discussed.

This same slot cut could also be done on the CNC router but there is no real advantage over the simple router table and holding down the relatively small door parts can be difficult for a heavier cut like the tee slot. This is less of a problem for modeling since each pass removes very little material and so generates little cutting force.

This approach does a great job of reproducing unique and difficult five piece door designs without a lot of hassle and without expensive, special tooling. This allows designers complete freedom to design anything they want knowing

that the average shop can reproduce these easily and inexpensively.

Another area that has almost the same characteristics as profile moldings is dovetail drawers. Virtually every set of cabinets need drawer boxes. Every cabinetmaker needs to deal with drawer boxes.

Some build their own. Others buy drawer boxes but every set of cabinets has drawer boxes and they generally represent a hassle.

When it comes to drawer box design, dovetail drawers are considered the highest quality. Making a dovetail drawer box, although not difficult, can be time consuming and in the past has required some special equipment.

There are a lot of dovetail fixtures available to cut the actual dovetails into the drawer end. These are generally on some type of fixed centers which may, or may not work for a particular height drawer. Adjustable fixtures or multiple fixtures may be needed.

The process starts by first determining the size of each drawer box needed. Then the individual components are cut to size. Dovetails are machined on the ends and the box assembled.

Using a special dovetail tools it is possible to cut a dovetail joint using a CNC router and making all cuts from above instead of having to machine one part from the end. The process uses two tools. The first is a dovetail cutter with a radius at the top that matches the second tool, a small diameter straight bit. The male dovetail pins are thinner than

the full thickness of the sides providing clearance for the radius inside corner that results from machining from above.

Although you probably won't understand the joint from that description, if it a really nice joint that works well, once the programming is done. And, therein lays the problem.

Programming this joint using traditional CAD is tricky at best. This is especially true if you want to adjust the dovetail width so that the pins fit evenly across the end for each height drawer.

Here is another case where if you add up the time needed to program the drawer box parts including the joints on a CAD system and then create the nest so they can be machined on a CNC router, it would probably take less time to make them the traditional way.

And once again, emerging new software has changed the balance. The latest version of eCabinet Systems software has the ability to almost automatically make drawer boxes including dovetail drawer boxes.

The user creates a drawer design that tells the system exactly how to build the drawer boxes and how to fit them in a cabinet. Then, each time a drawer front is added to a cabinet, the correct size corresponding drawer box is added along with all the joint and construction information. When the job is sent to the CNC router, the drawer boxes are also sent. They are then automatically nested on the proper material and machined by the CNC router.

Another bonus from this is that, again pretty much automatically, the mounting holes for the drawer slide are

machined into the drawer box sides as well as the cabinet sides. Again, this saves a lot of manual labor when actually installing the drawers and assures the most accurate possible alignment.

Using this approach, dovetail drawer boxes are almost trivial. There is so little preparation work that drawer boxes can be made in small quantity with almost the same efficiency and at the same cost as higher production box operations in larger factories.

This is getting pretty exciting. If we could just do carvings, we could, in small quantity, do everything the major furniture companies do. Yes, you are right. I brought this up because we can do carvings, although the approach is a bit different.

Let's look at this whole area of carvings.

Traditionally, carvings start with a hand carver. Someone must carve the first instance. For some really expensive custom furniture, perhaps these hand carved parts are actually used to construct the final product, but not normally.

These wood carvers are actually artists, adding their experiences and eye for proportion to these patterns. Some work has been done on systems to generate these carvings directly from drawings using CAD techniques and we have successfully done this. In general, however, the number of carvings where this works today is limited. Without the carver/artists instincts the resulting carving can be flat, too structured and just not attractive.

The initial pattern, which can cost anywhere from a few hundred to many thousands of dollars is normally used by the furniture industry as a guide for producing carvings in quantity. The most common way of doing this has been to use a multi-spindle carving machine. This is a long machine with anywhere from twelve to fifty spindles. The pattern is placed in a spindle in the center and a highly skilled carver traces it using stylists that are the same shape as the cutting bits in each of the spindles. As he traces the part, he cuts twelve to fifty copies of the original. It's like a giant three-dimensional panagraph.

A single carving cycle can take many, many hours to process this way. Each cycle, however yields two to four dozen parts. Once they come off the carving machine, they go to sanding where additional time is put into them.

Many years ago, we began working with a major carving company to try to automate the carving process. Our first successful machine actually automated the multi-spindle carving machines they were using. This turned out to be a major technical achievement. The basic idea was quite simple, just record the motions of the skilled machine operator and play them back. Although this sounded easy, it turned out to be quite involved.

The machines that were being used for carving were not all that rigid. Without knowing it, the machine operator would take into account the physical dynamics of the machine, dampening machine flex and overall making it work.

Most people know that CNC systems trace a path that was programmed. What most don't know is that, as they do this, they can be several inches from where they are supposed to

be at any particular time. This difference between where the program tells the head to be and where it actually is, results in a following error. This following error is amplified and fed to the drives to move them in the direction needed to eliminate the following error. This is how a traditional servo loop works.

As long as all the axes have about the same following error, the path that the head follows is accurate, even though its position at any point in time can be pretty far off. It is like pulling the head around using a pointer that is connected to the head by a spring. The faster you go or the faster you try to accelerate, the more extended the spring. In this analogy, the pointer is the program point that is tracing the part and the head is the actual position of the cutting head. A traditional servo loop relies on this error signal to generate head motion. This traditional servo loop almost worked for carving, but not quite.

This approach did produce the correct path. It was the path the programmer input when he made the part. The proper path that we recorded however, didn't work with a machine unless the motions were also executed at exactly the same time and rate as the operator's input. We needed a servo loop that did not have following error, which was the primary signal that made the system work in the first place.

The details of how we approached this get pretty complicated, but the basic approach we took is to look ahead in the program and examine the motions coming up and, knowing the dynamic response of the machine, guess what we think the following error might be and use that instead of the actual following error. We sort of jump the gun and create artificial following error before its time.

Thus, we get the machine to move before the following error actually develops. Then as we run we can check how our estimates are doing and make fine adjustments.

It worked. We were able to operate with following errors measured in thousandths of an inch rather than in inches. We began building carving machines and today, the vast majority of wood carvings produced on CNC equipment is produced on Thermwood machines.

Over the years we switched from automating multi-spindle carvers to building stand alone CNC carvers. Hand programming evolved to automated touch probe programming which resulted in much more efficient programs. Now, laser programming is replacing the touch probe and sophisticated software is making the process even more efficient.

An interesting point is that we make only one control, so the same control used on our expensive carvings systems is also on every CNC router we make, regardless of its price. This also means every machine we make is capable of producing wood carvings.

With all these advances, the major fundamental problem still exists. It is still very expensive to develop the initial CNC carving program. You still need an original pattern. Scanning systems are quite expensive and the sophisticated software I just mentioned cost more than some CNC routers. Developing a carving for a one up custom job just doesn't make sense using this traditional approach.

We need a new approach. Basically, if we want this to work, we can't be bothered with the entire programming task.

If you think about this problem, it is almost like programming applications software for a PC, nobody does it. If you need a spreadsheet program or a word processing program, you simply buy one from somebody that writes software. Why can't we do the same thing with carving programs?

One reason is that maybe you only need one carving. It's just like custom tooling. You hate to buy the tool and then just use it once.

The ideal solution is to rent the program. The rental can be charged per part so it could be fairly low and you only need to pay for what you run.

This sounds like a great approach and we only need two things, a library of carvings and the technology to make this all work.

As we worked toward creating technology for custom woodworking, we decided to tackle this. First, the technology.

This really wasn't that difficult since we make both the design software and the CNC control software. Also, we have been connecting our controls to the web for some time in order to provide virtual service. It would be easy to use this same connection to access carving files and keep track of rental fees.

Next comes the carving library, and here we got lucky. We were able to get access to a huge collection of carvings that we could program. This included thousands of pieces from drawers and doors and decorations to bedposts and chair

legs. We had every style, every era and every kind of part. It was time to start programming.

As this is being written, that is exactly what we are doing. We have full time people creating carving programs every day. There are still complexities in this process, but in addition to ongoing programming, we are also working on ways to automate the programming process.

Eventually these thousands of carvings will all be programmed and available for rent, but it is even better than that.

We have found ways to flip or mirror the carving so non-symmetrical carvings can be used as lefts and rights or tops and bottoms. Also, we found a way to scale the carving. If the original is not the exact size you want, you can make it bigger or smaller and you can scale it on each axis independently.

Through this program, for the first time it is possible to incorporate carvings into custom products without the unworkable cost of the past.

So what happens when we have programmed all our carvings?

We are hoping that the carving library becomes a dynamic and every expanding resource. We are inviting wood carvers, artists and sculptures to submit designs that can be included in the library. We will create CNC programs to reproduce these designs and split any fees we collect with the person that submitted the design.

There are huge libraries of carving designs lying in back rooms all over the place and I would love to get those out and make them available to this new and exciting industry.

Making this work will require that we further automate the program development process, however, this challenge is no greater than others we faced so I am confident that we will be able to accomplish it.

In order to produce three dimensional parts such as posts or legs, we developed a rotary playback axis. This is simply a single axis from one of our CNC carving machines configured to work on a typical CNC router table. This allows the carving of these elaborate pieces, but also opens another tool for the custom woodworker.

Once you have a way to turn a part as you machine it, you should be able to make turnings.

This is a feature planned for eCabinet Systems. We will add the ability to design and incorporate turnings into jobs. The rotary playback axis can then be used to machine these turnings using standard modeling tools. At that point, not only can you make any molding but you can also make any turning. This has not been completed as I write this but very well may be available when you read it. When it comes to emerging technology, it is difficult to keep track.

There is an interesting overall theme going on here. Pretty much everything we have been talking about can be done on any CNC router with the proper program. The real value of these features to custom woodworkers is technology that allows these things to be done without special programming and without a lot of preparation effort.

At the time this is being written, we have identified quite a number of basic joints and fundamental features that can be machined on a CNC router that would also be of great value to custom shops. These include a KD/blind dado joint where the blind dado aligns the parts and a KD fastener holds the joint together. You may be able to put the KD fastener on the outside of the joint where it does not show and use it to clamp the pieces together after they are glued, eliminating the need for case clamps while assuring that the parts are absolutely square and straight.

Another idea we call the “puzzle joint”. This looks like the tabs used to hold a jigsaw puzzle together. It is ideal for assembling a face frame. By stopping the joint a quarter to an eighth of an inch from the front surface, the face frame looks like a standard face frame from the front, however, it assembles quickly and accurately without clamps, screws or nails.

A really interesting idea is to machine these face frame members from veneer covered plywood and then edge band them. These components could then be machined directly from sheet stock as part of the nest. These smaller parts could fill in openings in the cabinet nest, using material that might otherwise be scrapped.

One area that needs some work however, is developing a way to edge band the thin face frame components, but once a demand develops for this, methods will follow.

There are a lot of these ideas, but they all have one thing in common. Unless you can get these features without a great deal of time and effort programming them, they are of little real economic value. If you can get these features as a

natural output from the basic cabinet or furniture design without requiring extra time and effort, then they become very valuable.

We are in the process of incorporating these and other features into our eCabinet Systems software and we expect that more and more basic functions will emerge in the future. When you design a drawer, you will specify it has a dovetail joint and the system will automatically machine a dovetail joint for you. No hassle.

When you design a face frame cabinet, you will specify it is to be made of sheet stock and all the parts needed for the face frame are automatically added to the nest. These ideas will make custom woodworking more and more capable and more and more cost competitive but to be really useful, they must also take full advantage of new technology that is rapidly eliminating steps in the programming task.

The idea is to simply tell the machine what you want to build and it makes all the parts you need to build it. We are a lot closer to this goal than you might realize.

Chapter 3
The Network

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In the last chapter we looked at a body of technology that is emerging, which allows custom woodworking shops to build custom cabinets and furniture without having to deal with all the individual details of the various parts. It takes a small amount of high level design and does all the details and programming pretty much automatically. This brings exciting new capability to the industry but, these new capabilities can be multiplied several fold by adding networking to the mix.

What exactly do I mean by networking?

Networking means tying together the diverse individuals, groups and resources so that they can help each other and all benefit from the relationship.

Overall, the effort and industry I am describing in this book consists of thousands of small shops and individuals. These shops and individuals are at a disadvantage to larger companies that can wield more power and influence.

If they can be banded or networked together, however, they might be able to effectively compete with these larger companies and perhaps even prevail. Let me give you an example of this.

Let’s say a small shop is getting ready to machine a material they have never processed before. They are not quite sure

what kind of tooling to use or what the feed speed should be or which direction to cut.

They could buy a few different kinds of tools and then try them at different speeds and directions. They could check with their tooling salesman who would then recommend a tool they sell, whether or not it is the best choice.

Let's look at this same problem in a larger company. They would simply call their resident tooling expert and have him or her consult with the experienced engineer on the project to select the correct tool. The small shop doesn't have a resident tooling expert or a project engineer, so what do they do?

More and more in today's world, they ask other small shops. This is primarily done through a myriad of forums that network people with common interests together. Networking.

This concept of being able to rely on others knowledge and experience to answer questions is the basis for networking and it allows the small shop to function as effectively as the large factory.

Here again, the key is the ability to do this networking with as little time and effort as possible. If networks are to be of a real benefit to small shops the networks must be efficient and effective. In this instance it would make sense to try to develop networks specifically targeting custom woodworking. We have been trying to do exactly that.

In our view, however, we see networking as going well beyond a simple exchange of ideas. We see a network

through which almost anything is exchanged and shared from designs and programs to actual components and production capacity. We have been working to develop just such a network. Some of the essential elements have been put in place and others are planned for the near future.

Before we discuss these network elements let's look at some of the underlying technology needed to make this work.

The first thing we need is compatibility. Everyone in the network needs to speak the same language or they can't communicate. This also goes for their computers.

To make the network work, we need common file formats and common ways of storing, retrieving and using designs and information.

For our network we are using the eCabinet Systems software and the various formats in which data and designs are stored. We have put special emphasis on allowing individual elements from the software such as door designs or tool profiles or cabinet designs or display items to be stored as individual files. These files can then be directly exchanged or shared between people who use the software.

This common format extends to the output that is sent to a CNC router. Earlier we discussed the methods and efforts we have put forth to allow the free and easy exchange of CNC programs between Thermwood machines. It is in this networking area where these efforts really pay off.

Again, I would like to contrast the difference between a large and small company. Large companies use a straight line approach to production. They buy whatever production

machinery they need, organize this equipment into a factory and run their product through it. When they need to perform a function on a part, they either process it through existing machinery or make arrangements to add the function to their production capability.

Small shops, however, don't have this advantage. If they need to perform a function on a part but they don't have the equipment, they either need to avoid making the part or try to purchase the part from someone that does have the proper equipment.

This type of purchasing is seldom cost effective, especially for custom made parts. The cost of negotiating, communicating what you want, handling the transaction, setting up and running the part is substantially higher than the cost of just making the part when you own the proper equipment.

If you were a large company, you would just design what you want and send the electronic file or program to the proper machine where it would be made. There is no reason however, why a small shop couldn't do exactly the same thing if they belonged to a network and someone within the network had the proper equipment.

The real advantage in a large company that typically doesn't exist between different companies is that the big company has made sure that all their equipment can talk to and communicate using a common language. Everything is compatible.
If a network of small shops were also compatible, there is no reason that they could not share production capacity in exactly the same way the large company does.

One of the interesting aspects of a network that includes electronic communications is that shops in different towns and even in different states can function together in almost the same manner as departments located in different parts of a single building in a large manufacturing company.

We call this concept “production sharing” and we have been working to try and make it a reality. The fundamental core requirement, compatibility, is in place. Using eCabinet Systems software and/or DXF files from other CAD and design programs pretty much full compatibility exists with Thermwood controls. Then, the ability to freely exchange CNC programs between machines makes it quite easy to share production time.

The final requirement for this is some method of linking those Members with extra production time available with other Members who need parts produced. We have been doing this through an area of the eCabinet Systems web site.

In this area, any eCabinet Systems Member that has a Thermwood CNC router can post their name, contact information and a description of their experience and the type of work they want to do. Any other eCabinet Systems Member who wants work done for them simply contacts them directly.

Arrangements are made directly between these parties. The operators of the network have no direct involvement in these arrangements other that trying to get the parties together. We have also made our booth space available to Members offering production sharing services at major trade shows. We do not charge for this but do it instead to help promote the free exchange of Thermwood production time. In the

end, we also benefit because as production capacity is used up demand for more machines will grow.

This has been quite a successful effort and we believe it will continue to grow over time. Those who design their jobs using the eCabinet Systems software generally find that they can save money by having someone machine their nested parts on a CNC router, even after they pay a profit to the machine owner and pay for shipping. The machine owner is able to better utilize their equipment investment and in some instances can cost justify a machine when it would not be possible just running their own production requirements.

Production sharing is a powerful concept. As carvings, moldings, turnings and various new joinery are added to the mix, the ability to rely, not only on your own capability, but also on the production capability of a network of shops, new opportunities emerge.

One of the more obvious places where a network can really benefit small shops is in purchasing the myriad of parts and components needed to complete their jobs. Actually, there are a couple of advantages to this beyond just getting better prices.

Like anything else, the buying process takes time. Whether you purchase locally from a retail store or buy through dealers or catalogs, purchasing takes time and effort.

The first requirement is to determine precisely what you need for a job. Then you must locate these products or an acceptable substitute, perform whatever process is needed to order them or pick them up. Overall, this process can take a substantial amount of time and labor. This time and labor is

as important and as expensive as the labor used to actually build your product. Any labor savings in this area is as important as labor savings in the manufacturing area. Perhaps it is more important because these tasks are typically done by the shop owner or other high-level individual whose time is quite valuable.

Modern technology and networking offers some possible solutions to these problems. We have discussed design software already, however, it is also possible to integrate within this design software a system to select, specify and then purchase the items you need, more or less automatically.

This is one of the core ideas behind the eCabinet Systems program. eCabinet Systems has integrated within the program a method of simplifying and automating this purchasing process. This effort starts with the industry vendors themselves.

The eCabinet Systems program has been opened to industry suppliers and vendors who have been encouraged to offer their products through the software.

These products are then integrated with the software so that they can be selected during the design process and incorporated in the actual cabinet or furniture design.

When these designs are then used in a job, the software can collect all the parts from all the designs in the job and provide a list of everything needed for the job. We call this list a “Buy List”.

The idea behind this program is that the shop then purchases these items through the program automatically and electronically. These purchases support the network and software development. This means that members of the network do not have to directly pay for software development or maintenance.

The idea was a little slow getting off the ground. The first Buy Lists were a little rigid and associating parts with cabinets was not as flexible as needed. Subsequent versions of the software addressed these shortcomings.

Because purchasing was totally voluntary, quite a few members used the software to design their products and then used the Buy List but continued to purchase from their current suppliers. Virtually all say they intend to buy through the program but changing comfortable practices is often difficult.

Despite this, more and more purchases have occurred through the program and with this growth comes more funding for development and support. Over time, we expect the majority of members to buy at least some of their requirements through this program and others to buy virtually everything because they find it both less expensive and faster.

As volume increases, we expect this network to become more and more beneficial to everyone involved. Current vendors will offer more products and better pricing once they view this as a major outlet for their wares. New vendors will join, broadening the selection, once the program is viewed as a major distribution channel.

Note that just as the network is open to all professional woodworkers at no cost, it is also open to all industry vendors and suppliers, again at no cost. They do have to organize their product and input them into the software, however, we can give them special software that allows them to manage their offering in the program.

As this is being written, some vendors use the software and manage their own offering but others will only offer their products through the program if we do the clerical work needed to input and manage their offering.

At this point, these offerings are important to the program and to the members using the software so we do this work, however, it does siphon off resources that could otherwise be used for development of new capability.

Sales volume cures most of these ills and we have already seen things improve as volume improves. To really become a major benefit to members, however, the program must become an important distribution channel.

That being said, the fundamental concept behind networking together to purchase is a core requirement for developing a new growing and vital custom woodworking industry.

In addition to sharing manufacturing capacity and group purchasing there are other fundamental advantages to networking custom woodworking shops together. To understand one potentially major benefit, we must examine how current design software functions.

I am constantally amazed at how many ways there are to build cabinet boxes. When you add furniture design, the

choices become even greater. Every shop has their own approach and each believes theirs is the best. So how does design software cope with this diversity?

There are actually several approaches, but they all trade ease of use with flexibility. The more control the user has over the basic construction and design, the more involved and complex the software must be.

The easiest software to use I call “catalog cabinets”. In this approach, the software developers determine the basic construction of the cabinet. The user may have a few options to select from but they tend to be limited. Then, using this basic construction, entire libraries of cabinet are offered. The user then selects the cabinet needed, resizes it, if necessary, and puts it in the job.

This software tends to be quite easy to use since the software user does not need to deal with all the design and construction details of the cabinet. This software is also easier to write because the software developers have much more control over what will be done with each design. This generally means that software developed this way tends to be quite a bit less expensive.

The real drawback to this approach is that most shops will need to give up individual design techniques if they are not part of the core methods. Some software developers have created several different catalogs of design in an attempt to address this, but unless the user has control over every aspect of the design, they will always want something they can’t get.

The other approach is to provide full design freedom.

Software that offers the user control over all aspects of cabinet design and construction is more involved. All software that offers this ability, regardless of who supplies it, is based on a single concept. That concept is that each and every detail of cabinet construction is controlled by a parameter. Change the parameter and that particular detail changes.

Obviously this is more involved and puts more demand on the software developers. The software should understand how changing one parameter affects other parameters. Some software simply ignores these interrelationships, so if you change one parameter, a back for example, you must also specifically change any other parameter that is affected, such as the top it overlaps.

I don't think this is a good idea and this is not the case with eCabinet Systems. eCabinet Systems automatically adjusts every parameter affected when you make a change.

There are two different approaches to managing parameters and this difference has led to a lot of confusion in the market. Understanding this difference is important, because it can have a rather substantial impact on just how flexible the software really is.

The approach used by some software developers is to offer an area where the user defines each and every detail of cabinet construction. All parameters are displayed and the user defines his or her preference for each and specifies how conflicts are handled. This list of parameters resides in the software and defines how cabinets are created.

At this point, cabinets do not exist. Once parameters are defined, you create a cabinet by instructing the software to create a cabinet of a certain size and configuration using the defined parameters. Parameters dictate the details of cabinet construction. Anyone used to full design software that is not eCabinet Systems understands this approach.

Although it sounds simple, this approach has two drawbacks. First, it is difficult and time-consuming to define all cabinet parameters before a single cabinet is created. This must be done when you first install the software. This is also the time when you know the least about the software and parameters.

The second drawback is that this approach tends to make it difficult to develop and work with a variety of designs. Changing parameters back and forth to create cabinets that differ from each other is complex. Also, you must actually create a cabinet before you can see the effect of any parameter change, so users tend to make all cabinets essentially the same once they find a set of parameters that work.

eCabinet Systems takes a different approach. In eCabinet Systems you DO NOT EVER create cabinets. Cabinets already exist. You modify, duplicate, and save them using new names but you do not create new cabinets from scratch.

In eCabinet Systems, the list of parameters is part of EACH CABINET not part of the SYSTEM. Although this sounds like a simple difference it has profound impact on how the software functions.

Instead of specifically defining parameters for each cabinet, existing cabinets already have parameters. To obtain a different design, the user modifies the parameters they want changed, leaves the others alone and saves the result under a new name.

The key ingredient to the eCabinet Systems approach, which really characterizes the software, is the ability to display highly detailed, accurate three-dimensional graphic images of the cabinet, including all joint and part detail while you are adjusting parameters. These images show exactly what the cabinet looks like with the current parameters. Changing a parameter causes the image to change, so you can immediately examine the result. If you like it, keep it. If you don't, change it back.

This image can be moved, rotated, exploded and zoomed. Components can be hidden, made transparent or turned into wireframe. In short, the user can examine in minute detail the actual effect on the cabinet of any parameter change.

You start with a standard cabinet from a directory called "Standard Cabinets" and modify parameters until you fashion a cabinet designed the way you want. This new cabinet is saved under a new name in a new directory. The original cabinet still exists in the old directory under the old name.

The new cabinet can then be loaded, further modified and saved under yet another name. Now you have three, the old cabinet, the new cabinet and the modified version of the new cabinet.

This approach makes development of entire libraries easy and yet provides almost total flexibility.

To develop a library, start with a standard cabinet. Change it to include the parameters you want to be shared by every cabinet in your new library. Save this in a new directory as a "seed" cabinet.

Now, load this seed cabinet, resize and modify it to the first cabinet you want in your library. Save it. Load the seed cabinet again, fashion and save your next cabinet. In a short time you have an entire library of cabinets that all share the same characteristics as your seed cabinet.

Should you need to change any of these for a specific application, it is easy because the parameters reside with the cabinet, not the software. So, exactly how do we change the cabinet parameters?

To help understand, we might want to separate changes to the cabinet into three categories, size, configuration and parameters.

Size is well, size… height width and depth. This is changed on the *Main* page of the *Cabinet/Assembly Editor* but can also be changed whenever the cabinet is used in a job.

Configuration includes shelves, partitions, face frames, moldings, doors, drawers, etc. The configuration of a cabinet is developed through a series of Editors that are reached from the *Main* page.

Parameters are the little bitty details concerning everything about the cabinet. Material, joinery, fits, insets, and about

everything else. These parameters are adjusted in an area called *Construction Settings* that is also reached from the *Main* page of the *Cabinet/Assembly Editor*.

There are actually two kinds of parameters, which can cause some confusion. Some parameters, a *back inset* for example, affect the cabinet as soon as they are changed. Other parameters define how items, a shelf for example, are added to the cabinet. Changing this second type of parameter doesn't change existing shelves, it only affects shelves that are added after the change. Of course, to make it even more confusing, if you highlight a shelf and then make a parameter change it changes the shelf that was highlighted.

This is done for a good reason. It allows you to add multiple shelves and make each different. Add the first, change the parameters and add a second. The second shelf has the changed parameters. Change the parameters again (in doesn't affect existing shelves) and add a third shelf. It is now different from the other two.

Each area that has this "add" feature has this same capability.

Despite this small bit of complexity, it's actually pretty simple. Change size on the *Main* page or when you use the cabinet, change configuration using Editors and change parameters in *Construction Settings*.

Regardless of how many configurations and parameters the software allows for, cabinetmakers will always want to do something more. To address this, a *Part Editor* is available. Using the *Part Editor*, any part of the cabinet can be cut,

pocketed, profiled or machined. This lets you create almost anything you can imagine.

The system also lets you import DXF files from other CAD systems and use them to either make parts or to cut or pocket their shape into a part.

The amazing thing is that all of these creations can be actually machined on a Thermwood CNC router from the file created by eCabinet Systems software. You can cut and profile individual cabinet parts pretty much any way you want.

If you want to put an edge profile on a part in the software, you will need to develop a tool with the correct profile. This tool is developed in an area called a *Shape Manager*. Tools developed in the *Shape Manager* are used in the *Part Editor* to cut a profile on a part.

An interesting note about this feature is that once a profile is placed on a part in the *Part Editor*, that profile can be machined on a Thermwood CNC router, even if a custom profile tool is not available. The Thermwood control can create a modeling program using a ball nose and corner bit to machine the profile edge using modeling techniques.

If you are designing a part that is used on a cabinet that may change size, you will need to define how you want the size and position of the machining operation to behave as the part size changes. This is done in an area called "*Configuration Manager"*. You define "constraints" and then see how it reacts as the cabinet size changes. You then adjust the "Constraints" until you get what you want.

So far it has been pretty simple but now we are going to add a valuable feature that can make it a bit more confusing if you don't understand it. It has to do with the word "Assembly" in *Cabinet/Assembly Editor*.

A lot of complex cabinets and furniture cannot be defined with a single set of parameters. The approach eCabinet Systems uses to create these more complex pieces is to allow multiple cabinets to be loaded into the *Cabinet/Assembly Editor* at the same time and saved together as an "Assembly". This approach is very powerful, but can be confusing. Let's look at an example.

Suppose we need an upper island cabinet with a face frame and doors on both the front and back. We need to remove the back and put a face frame and doors on it.

In designing software to allow for this, you could create parameters for a face frame and doors on the back, but then someone will want it on the side. There are thousands of these variations and you simply can't make parameters for everything or the software would really get confusing. Instead, eCabinet Systems allows you to combine elements from two or more cabinets into an Assembly.

In this case, we take our first face frame cabinet and remove the back. Then we take a second copy of the cabinet (we can copy and paste it right there) and remove everything except the face frame and doors.

At this point the software sees two cabinets, one without a back and one without everything except the face frame and doors. Move the face frame and doors from the second cabinet to the back of the first cabinet and we have the

assembly we want. It looks like a single cabinet with a face frame and doors on both ends but we know that, as far as the software is concerned, it is actually two cabinets, each with parts removed.

We can address and change the parameters of either cabinet by highlighting it and accessing *Construction Settings*.

This is an important concept because this simple approach allows for almost unlimited flexibility and still offers the ability to address and adjust every aspect of every cabinet involved.

This software offers almost complete freedom to design almost anything you want. But, with complete freedom and flexibility comes more complexity and a real need for a core understanding of the structure of the software.

This is actually the only major criticism of the software I have seen that I feel is somewhat valid. People used to the library approach feel that the learning curve for the parameter approach we have taken with eCabinet Systems is steep. There is a very real effort needed to learn all the intimate details required to adjust every aspect of a design, but, since quite a few people are perfectly happy with library software, there might be a way to have it all using networking.

We call this concept “Design Sharing”. There are some users of the software that have become very, very good at doing anything they want. They are real “power users”. What if we could find a way for them to design cabinets for everyone else?

This is the idea behind design sharing. The basic idea is that power users create entire libraries of cabinets that they would share with other users not as familiar with the software. It would be like having a library software and a fully capable design software in one. If all you wanted was to reproduce existing designs, it would be quite easy. If you wanted almost any kind of changes, you could also do that. If enough users offered libraries, there might be enough variety that few new users would need to create their own. The only real question is why would these power users want to do this? We have to make it worth their while.

The approach we came up with attempts to address everyone's needs. First, we group the designs into "libraries" and make these libraries available for a fee.

We then split the fee with the person that created the library.

This is the first layer of networking.

Then, if you use someone's design and actually build it, you agree to purchase as many of the parts and components as possible through the network. We then share any margin we make on these sales with the person that posted the design.

This approach should be a plus for everyone. The person using the design gets hours of work for a relatively small fee as well as tapping into the design experience of the power user. They also must agree to buy through the program, however, in most cases the prices through the program are equal to or better than what they are paying today. In the rare instance where a price might be higher, they should view this as an indirect cost of getting access to the designs.

From the eCabinet Systems standpoint, this increases sales which benefits us, but in the long run also benefits everyone that is part of the network. In our discussion of buying, we saw that as the overall volume of the program increases, the funds available for software development increases and, ultimately prices are reduced.

From the power user standpoint, this offers them the ability to generate additional income from their knowledge and experience.

This also offers another interesting possibility. When a member gets a job to build a complex custom product, they have another possible source of income after the product is built and paid for. They can post the design in the design sharing area and if others use it, they get compensation.

Exchanging designs is easy, but how will we keep track of whose designs generate part sales? This required some additional capability in the software.

When a design is posted, we assign it an electronic tag that identifies it as having been submitted by its creator. This tag stays with the design regardless of how extensively the cabinet of assembly is modified. This tag is also assigned to any component that is part of the design and placed in the Shopping Cart.

The person that shared the design is credited with the sale of any items that originated with his design.

Is this really going to work?

As I write this book, we are adding the final technical capabilities to the software to make all this possible. If the members responsibly follow the purchase requirement, the program should work well, but how can we be sure people purchase as they agreed?

There is no way to be absolutely sure, however, I have found that few people will agree to do something and then just not do it. I have some real faith in people and believe that most will abide by the spirit and intent of this program.

I am, however, not so naïve as to believe that no one will intentionally cheat. I also have very little tolerance for deliberate cheating.

In the practical world, we don't have a lot of legal options. We can't, from a practical standpoint, sue someone for a few dollars even though we may have the legal right to. We can however, control whether or not they are part of the program.

If this program gets as large as I believe it will, being excluded could be a stiff price to pay for cheating. Our intent is that if we find someone that intentionally violates the agreement and never even attempts to purchase when they build a shared design we will not allow them to continue to use eCabinet Systems software or participate in the program.

If someone wants to use the software but absolutely doesn't want to participate or support it in any way, they are free to do that but they do have to design their own product. They are not free to take someone else's work without proper payment.

I am not sure exactly where design sharing will go, but it has the potential of being a really powerful resource for custom woodworkers. With all the other tools we have added to the software, this opens a great new portal to share creativity. It is really amazing what happens when development is spread out over hundreds or thousands of people. I look forward to the results.

In the next chapter I am going to discuss a version of design sharing, where professional designers share their designs with custom woodworkers.

Although we set up a mechanism to formally share cabinet and assembly designs, we are also making it possible for members to easily share other designs. There are areas in the software where three dimensional display parts, or tooling or profile designs or shapes are created and used. It just makes sense that when one of these is created by a member, they post it on our web site so others can use it without replicating the design effort.

When you need a tool, visit the shared designs first to see if a suitable design is available. If it is, use it. If not, create the new design and then post it for the next person. This communication or networking has the potential to be a powerful resource. This is not a resource that can be offered by a software developer. The only way something like this will work is if members share and network with other members.

The final area I will discuss in networking is communications. Again, today's approach is different then the past. In the past, a vendor or manufacturer, like ourselves, was the central depository of knowledge. When

you had a question you asked the software or machine supplier and, if you were lucky, they gave you an answer. They gave you the best answer they had, but you were limited by their knowledge.

It is not uncommon with software for those using it to know more about how it works than those developing it. This also applies to machines. Those using it in the day to day work tend to know a lot more about its operation than those that designed and built it. At least, they know a lot more about what it is like to use it in a production environment.

In this model, progressive companies sought out and listened to some of these users and used this information to improve and enhance their product, but this whole process is seriously limited by resources of the one company through which all this flows.

A better approach is to use an open forum where not only the company but also everyone participating in the design, manufacture, use and maintenance of the product can openly and freely exchange information, attitudes and, yes even complaints, with each other.

These forums are common on the Internet today but few appreciate just how powerful and industry transforming they are.

An example of this occurs each time we ready a new version or release of the software. Once all our internal testing people have worked with the new software and feel it is ready, we then send it to a group of power users who have agreed to be beta testers. Their job is to try the new release and see if they have any problems.

This worked OK with the beta testers reporting back anything they found but worked immeasurably better when we established a beta tester forum where they could not only report to us but also freely communicate with the other beta testers. The combined resources of these folks working together proved substantially more effective than the one way approach used earlier.

We also maintain a user forum where members can ask questions, make suggestions and help each other, and it has worked great. I believe that this type of communications is not only necessary but vital to developing and expanding a custom woodworking industry.

Free and open communications coupled with sharing of resources and pooling of purchasing when coupled with entrepreneurial spirit can create a rather interesting business model that, I believe is different than anything that has occurred before. To explain I need to take a short detour.

There are two basic economics systems in the world today, communism and capitalism. Both strive to make peoples lives better, however they take different approaches.

Communism relies on central government control. At its core is the fundamental concept that trained, educated and highly intelligent people in the government armed with the best information available can do a better job of planning and running things and that less talented and educated individuals will be better off than if they are allowed to run things themselves.

It starts with a plan. Perhaps a five year or a ten year plan. This plan is implemented through mid-level bureaucrats.

The citizens are working to make the state better and the state has the responsibility of taking care of the needs of its citizens.

At first glance, this looks pretty good. It should work, but it doesn't. It hasn't worked anyplace in the world and there is little danger it will work in any of the few places it still exists.

This basic approach doesn't take into account human nature. People don't work hard or make careful, considered decisions except when they are doing so for their own benefit. When they make careful considered decisions for the people they work for it is normally based on the belief that this will ultimately result in promotions, better pay or more security.

The instinct for survival is programmed into everything alive, including man. It is the most basic and most powerful motivating force there is.

If you think about it, the desire to be successful and improve your life taps into this basic instinct. That is why I believe that people really take care of their own money, really promote and support their own careers and carefully consider their own investments.

This self interest is at the core of the second major economic system, capitalism. In capitalism, people work for themselves, not for the state. There is no five year plan. People do what they believe is in their own best interest and will benefit them most.

As a result, some decisions are good and bring profits and wealth and others prove bad and bring failure and bankruptcy. The system is self pruning, with competition clearing out the bad ideas and running with the good.

As a result, the system works well. The overall economy grows and prospers, even though no one is trying to make the overall economy grow and prosper. Apparently, if everyone focuses on their own well being it also makes the overall economy better.

With this background, here is an interesting thought. If central control and communism doesn't work, why does virtually every major corporation use this system?

Just think about it. At the core of every corporation is the fundamental idea that top management knows exactly what needs to be done, just as the communist state believes that its leaders know how to run the economy. Top management in corporations create and refine their five and ten year plans. They implement them through mid-level managers. The workers job is to help the company be profitable and the company is responsible for the needs of the workers.

This sure sounds a lot like our description of a communistic state economy. If this approach doesn't work for a national economy, why would it work for a corporation?

Actually, it doesn't. When we say a communistic economy doesn't work it is because we compare it to a capitalistic economy. The capitalistic economy results in more prosperity and a better standard of living. If we did not have the capitalistic economy to compare against, it might be

difficult to tell if the communistic economy is working or not.

This is the problem with corporations. Because there is nothing different to compare it to, a determination of whether it works or not is difficult to make.

I believe our network may provide that comparison. It appears to me that the network of shops, vendors and eCabinet Systems is a capitalistic corporation. We are not all officially part of a single corporation but are banded together for our mutual benefit. It is certainly a different business model than a typical corporation.

The members are not interested in making the cooperative stronger and more profitable, they are interested in making themselves stronger and more profitable. Just as with capitalism, if enough of them are successful at this, the overall program will also grow and prosper.

I find this a fascinating experiment. As with capitalism, there is no master plan. The program coarse and direction are not known. There is a general idea of where we are trying to go, but this is constantly modified by actual events and competition and those things that members are willing to do. The result, or at least the current position of the program at any time, is a reflection of the collective thinking of all the various groups that are participating in the program.

We intend to remain as caretaker of the basic structure and software and network that ties this all together but fully intend to follow the direction that members of the program want. If a capitalistic corporation is to be given a fair

chance, it cannot turn into a dictatorship. It must operate by the collective will of those participating in the program.

The purpose of a central government in a democratic capitalistic economy is to provide those services to individuals that they cannot provide themselves. It provides standards and regulation so that the economy is efficient. This includes things like a common rail width, or consistent phone service or parsing out radio bandwidth or setting rules for weight and measures.

A central government also provides other service and support such as defense, maintaining law and order, fire protection and maintaining a national highway system.

All of these have in common that they are not things individuals can easily provide for themselves.

This is the same function we provide in the eCabinet Systems cooperative. We develop the software that everyone uses. We arrange to purchase items or material that individual shops cannot obtain themselves, such as finishing material, which we will cover later. We make arrangements with furniture designers to provide members with truly professional designs and establish programs and mechanisms for members to share their own designs. We establish and maintain the web sites members use to communicate and the production sharing areas they use to sell their services to other members. In short, in this capitalistic corporation, Thermwood provides the functions that a central government provides in a capitalistic economy.

I find this both an interesting and exciting experiment. Using the networks and technology available today, we are trying something that has not been done before. The outcome is unclear. In fact, the direction is not all that clear but if the success of capitalism is any indication, this should work and work well. If it does, we will be successful but so will thousands, perhaps tens of thousands of shops. Our goal is to make thousands and thousands of these folks millionaires.

So, that's the story of networking. The network is the backbone of this program and until the technology and communications that make this type of open networking possible came into being, the whole idea behind eCabinet Systems and our cooperative network of custom woodworking shops was not possible. Today, it is not only possible but is a reality. I can't wait to see what tomorrow brings.

Chapter 4
Furniture Design

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My last book, “The Furniture Network” focused on an emerging opportunity that was developing in the furniture industry. If anything, this opportunity is getting stronger as time passes. In this chapter I will revisit this idea in light of the technical advances that have occurred and examine what is left to do to make this a reality.

Let’s start with a view of the industry and how this opportunity fits in.

In the first chapter I discussed the current state of the industry and the current distribution structure. Now, let’s examine what I propose as an alternative and see just how it might work.

Current structure for the furniture industry focuses on the lowest possible product cost, with products manufactured in volume in centralized facilities. These products are then marketed through a distribution channel that increases the price from the manufacturer between 100% and 300%.

You can see why low cost manufacturing is so important when every dollar of additional cost could mean up to three dollars of retail price increase.

Most efforts in the past to improve the industry have focused on further reducing the manufacturing cost. Decisions are a painful compromise between making the

product better and keeping the price down. At this point, however, any significant reduction in manufacturing cost is not likely. We need to look elsewhere for a new, more competitive structure.

The most obvious place is the distribution cost. Few products I am aware of can sustain a 100% - 300% distribution markup.

Is the distribution channel gouging? Are they making too much money? I don't think so.

I am not aware of anyone making huge profits from furniture. The distribution markup reflects very real costs. The problem may very well be that the current methods of distribution are just very costly and inefficient. This, however, gives us a real opening and an opportunity.

From an overall view, you could spend a lot more on manufacturing the product and probably make the product much better quality if you did not need to mark it up as much. In fact, if the shop building the product could also sell it to the final consumer, not only could they spend more building the product, and provide a higher quality product as a result, but they could also make more profit on that sale and still be price competitive.

With this basic concept, what would it take for a small shop to build and sell furniture that is truly competitive with major furniture manufacturers?

This question is sort of intimidating. We are suggesting that a small shop build good quality furniture that is competitive with the largest furniture manufacturers and possibly

customize it or at least be able to do all this in single quantity. To be really successful in selling this product, the small shop will need to offer at least as much style variety as a large retail furniture store and perhaps more. They will need to able to build a larger selection of furniture designs than the largest furniture manufacturer is able to do today and build them in quantity one, at a profit.

For an experienced woodworker, this sounds impossible but with today's new technology and an effective support network, not only is it possible but over the next several years it could become an emerging new industry.

To try to understand this better, we need to go to the basics and determine exactly what is needed to make all this work.

There are actually three major ingredients needed by the small shop to build truly fine furniture. These are also ingredients that virtually no small shop has today. The first of these ingredients is design.

Truly fine furniture design is an art. Like any art, there are not a lot of really talented artists. The major furniture manufacturers employ the really good designers and as a general rule, they are very well compensated for their designs.

If we want to compete with these manufacturers, we must use designers that are every bit as talented. Even better, we should try to get the same designers that the big guys use.

This is an area that a lot of small shops don't understand and many don't believe.

I have encountered numerous shop owners that fancy themselves designers much like people that paint as a hobby fancy themselves artists. While rarely one of these people is really an artist or a furniture designer, almost all are not. In fact, in most of these cases, they really don't even understand what design is.

If you want to determine if you understand design, walk into a retail furniture store and look at their offering. The first thing you need to be able to tell me is which pieces reflect today's hottest trend, which are last years models and which are total abominations. You will find all three in most stores.

If you can't answer this simple question, you will have a tough time selling anything. You should be able to tell which pieces are successful and which can't be given away without paying to have someone haul it off. You need to know the current color trends and have an eye for balance and style.

Truly professional furniture design is a talent and a rare talent at that. If you plan to sell furniture and really make money at it, you need designs created by these talented people.

Sure, you can design almost anything and probably sell a few but if you want to really be successful and command premium prices, you need PROFESSIONAL design.

I worked with designers since the 1970s, when Thermwood molded plastic parts for the furniture industry. I have personally seen the sales impact a good design has and have

also watched smaller furniture companies wither and die as their owners “designed” their own product.

The difference between a truly good design that will sell well and a similar design that will fall flat is very subtle. I can look at the two pieces and tell which is better and so can most consumers. I cannot tell why one is better than the other and am hard pressed to even describe the differences between the two.

If you are reproducing classic furniture designs you may be OK, but really successful reproductions are not exact copies of traditional pieces. They are modern interpretations of classic designs tailored for modern use. For example, I understand that in colonial times the average height was about five foot and furniture reflected that. If you build furniture for a slim five foot person today, you will have a pretty small market and you can’t just make it bigger, you have to style it bigger. If you are creating a new piece for today’s market, you really need professional design.

So, how do we get these professional designs?

The answer is the network, the eCabinet Systems cooperative. Let’s look at the designer’s lot and see how this might all fit.

The professional designer lives by his or her talent. They design products, present these to their clients who build samples of some of the designs and offer them at market. If the design sells, they manufacture the design and send the designer a fee based on a percentage of the sales of that design. With a successful design the royalties roll in. An unsuccessful design returns very little.

The independent furniture designer truly lives or dies by the success of their work. If a designer can't design furniture that sells, he has long ago starved to death. Any designer that is alive and working in the business full time can design furniture that sells.

But, as the furniture industry changes, so is the life of the designer changing. A lot of their clients are closing down US plants and moving to China. The logistics of designing product for China are more complex. Long established practices and efficient execution of new designs are changing and designers are looking for ways to adapt to these changes.

I believe most designers would look favorably at an opportunity to design furniture for hundreds if not thousands of new clients. The only difficulty that must be overcome is that we must establish a structure under which this can be done. Obviously, a professional designer cannot work directly for a one or two man shop let alone thousands of them.

Instead, they can work for a cooperative of shops. This cooperative represents substantial potential and since it exists, a mechanism to employ these professional designers can be developed.

The approach we are using is to open the program to professional designers, allowing them provide furniture designs to the network. A basic fee is charged to transmit the design. The bulk of this fee goes to the designer.

Then, virtually every professional design uses unique components, legs, posts and carvings. We can make these

components available to Members as CNC programs that can be rented. Again, the rental cost includes mostly a design fee paid to the designer.

As this is being written, several well known furniture designers have joined the program and are offering designs. We have built samples of some of these designs, developed rental CNC programs and showed them at an industry trade show to great response.

A couple of one man shops have already built and sold some of these designs at an almost unbelievable profit.

It appears that we will be able to access professional designs and as we find methods of bringing these designs to the network that are efficient, it also appears that we could realize a larger library of designs than we expected.

Designers are like any other business, they must sell their product. A professional designer sells his product to management in his clients firm. The designer designs things he or she likes and thinks will sell. This offering, however, is filtered by what management in a furniture company likes. I know of one executive who didn't like doors on dressers so nowhere in their product was there a dresser with a door. This doesn't mean that dresser with doors don't sell, it just means that the designer cannot sell a dresser design to this company if it has doors.

As a result, most designers create several designs for each one they sell. The designer likes the designs they can't sell, but the client didn't. There are literally thousands of designs, perhaps tens of thousands of designs that are already done that are really, really good just sitting in file

cabinets in North Carolina. This is a huge resource that we can tap.

One of the interesting difficulties we have encountered is getting the designer to choose designs he wants to offer. We are constantly asked “what do you want?” They are so used to bowing to the clients wishes that they are uncomfortable pushing their own ideas.

I believe that these designers are much more capable of selecting and promoting designs that will sell well than the average furniture company manager. The way we have structured this program, for the first time designers will be able to create and manage their own design offering without having to please anyone but themselves.

As this program develops I believe that we will see more design freedom with designers able to express their own tastes, likes and dislikes.

Today, furniture design is relegated to middle of the road selections that will sell in volume. Furniture manufacturers are not interested in designs with limited appeal, even if clients are available that will pay a substantial premium for these designs.

Once this program matures, designers are free to add these novel designs and you are free to sell and make them, tapping into a new market.

To make this program work, however, takes more than just good designs. We must find a way to translate these designs into a practical, workable program. So far I have been disappointed in how long it has taken to do that.

The concept behind the professional furniture design program is several years old and we fully expected to launch it by August of 2004. That is when we first showed pieces built from these professional designs. At that point, however, we really underestimated both the technology and logistics needed for the program to function.

Throughout this development, we always expected that the designs would be translated into eCabinet Systems files. In this way the designs could be easily exchanged with members.

At the time, however, eCabinet Systems only did cabinets and furniture is a lot more complex than simple cabinets. We needed some technical advances which we expected within a month or so of the August, 04 IWF show.

The first thing we needed was a concept called “assemblies”. Assemblies allowed us to combine two or more cabinets into an entity that could be saved as a single file.

The next thing we needed was the ability to create modified parts, a part editor. Unlike cabinets, furniture usually incorporates a lot of parts that have profiles and distinct cut out areas and we needed some way to make these parts.

Developing these new capabilities took a lot longer than we expected. Version 4 of the software finally came out about six months late but it did incorporate many of these new requirements. We were well on our way, almost.

We found that the original Version 4 had an undesirable characteristic, if you resized the cabinet, or performed any

other function that caused the cabinet to regenerate in the software, you lost any modifications that were made in the part editor.

The reason for this is that the system didn't know what to do with the modifications to a part if the basic part size changed. We needed to incorporate a method of defining how these changes react to changes in the part size. Another delay.

As I am writing this we are getting very close. I believe with the release of Version 5 we will have this solved and will finally have a software tool that can be used to transmit professional furniture designs throughout the network.

The next requirement for our members to be able to build professional furniture concerns special parts. When I say "special parts" I am referring to parts that a typical cabinet shop can't make.

These include carvings, legs, posts, custom moldings, bevel glass and the like. For this program to work, we need to develop a method by which these items can be easily obtained

For the wood parts and carvings we decided to offer the CNC programs needed to make them through the CNC carving rental program we covered earlier. We would develop a CNC program for each of these parts and allow anyone with a Thermwood CNC router to make the parts themselves. This also provided us with a mechanism for paying the designers for their work. For each part, we tacked on a design fee paid directly to the designer.

This is a great way to balance the contribution from a designer with the overall size and cost of a project. If a relatively large project used a single molding design from a designer, the designer gets paid for the actual item used and not on the entire project. A more complex piece that uses more of the designer's components also returns more compensation to the designer for the work.

With this approach it appeared that the special parts were covered.

The next requirement is finish. Finish is a lot like design. Most cabinet shops believe they apply a quality finish but not when compared to a real quality furniture finish. Here again there are major barriers to small shops.

The finish really makes the piece and, finishing is one area where the small shop can do a better, higher quality job than the large manufacturer.

A good finish can double the value of a piece of furniture but few if any small cabinet shops know how to apply a fine furniture finish and even if they do, the materials needed to do this are not readily available to the small shop. This was the next area we needed to tackle.

I was involved with furniture finishes in the early 1980s so decided to call some of the suppliers that I had worked with at that time. I quickly found that they had all been bought by a company called Valspar. I called Valspar.

This started a long series of meetings as we attempted to explain what we were trying to do with the furniture

program and how we might be able to work together to accomplish this.

Valspar is a large company whose marketing and structure is honed to focus on selling to other large companies. They have been extremely successful in the furniture market and while I don't know their exact market share I believe it is somewhere in the 80% plus area. They have great products but no real way to address small customers or sell in small quantity.

We worked with the designers and Valspar's International Design and Color Laboratory to develop seven initial finishes for our furniture program. We were then trained on the application of these finishes. The next step was to figure out exactly how to structure, organize and make this all work.

The single biggest obstacle to bringing Valspar's furniture finishing products to the small shop was that they were structured to work with and service large companies. There were no standard products nor was there any mechanism for selling and servicing small shops.

There was also no documentation covering the application nor any method of training small shops. They trained one on one when working with their large customers but did not have the resources nor was it cost effective to try to handle thousands of small shops the same way. We had quite a few areas we needed to address if we were going to bring fine furniture finishes to our members.

First, we agreed that the best way to handle the program structurally was for us to become a distributor for Valspar's

products. We also determined that if we were to offer quick response to orders in small quantity, we would need to do the mixing and blending ourselves.

We purchased the necessary mixing and measuring equipment and purchased all the support materials and an initial inventory of finishing material. We then went through an extensive training program to make certain we could properly blend the materials as needed.

Unlike Valspar, which has virtually no standard products, we intended to offer only standard finishes. We also offer these as complete schedules, which includes everything needed to apply a specific finish and obtain a specific “look”.

The final hurdle turned out not to be a hurdle. To legally blend and sell finishing material we needed to be able to generate a document called a Material Safety Data Sheet or MSDS. This sheet explains the safety and health issues specific to a particular material used in industry. Each time we blend a finish, we in essence create a new material which by law needs a new MSDS specific to that material.

Luckily, sophisticated computer programs are available that do this for you. We purchased the software, went through the training program and were ready to go.

The other legal requirement is that you must be certified to ship finishing material and this certification requires special training. It turned out that we already had all the necessary certifications so we were ready and legal.

With this program, we have addressed what we believe is the last basic requirement of the professional furniture design program. There is a chapter in this book that offers a detail overview of the finishing process which should give you a better understanding of the practice.

So off we ran but the first thing we discovered is that there is quite a bit of knowledge and production techniques needed to actually use this technology. None of these are particularly difficult to learn but, few if any cabinet shops have been exposed to them. We needed to find a way to teach those furniture techniques the average cabinet shop doesn't know.

We started by creating a DVD video for each furniture finish. These showed on a generic basis how to apply and work the finishing material. It soon became apparent that this was not going to be quite enough, we needed direct hands-on training.

I put on the first training class focusing on three areas, downloading and executing the carving programs, production sanding the carvings and finishing the pieces.

The class only took three days but the shops that attended were then able to build, sand and finish some rather elaborate carved tables. This also showed us that to really participate in this program a shop would need this specialized training. We established a formal furniture training program.

Now for the big question, will this furniture program actually work?

The answer is, it should. The numbers look pretty good. If you were to build the same pieces that the large furniture manufacturers do and sell them for the same price that the retail furniture store does, by our estimates you should make a 40% - 60% profit on every sale. This is a rather good return, however, I believe that most members can do even better.

The way you do better is to sell the product for a premium. To obtain a premium, you must offer something extra. Just the fact that the piece is being “custom” made can command a higher price.

Each piece of furniture in our program includes a “story”. This is a description by the designer of the inspiration and history of the particular design. We also provide a background and some details of life of the designer himself, which is also a valuable part of the “story”. This type of “story” is a powerful selling tool when working with the ultimate customer.

For most people, furniture, in addition to its function, is also art for the home. It is an expression of their personality and taste. Anything that adds to the emotional feeling toward the piece also makes the piece more valuable.

I collect old cars. At various car auctions and sales that I have attended certain cars are offered that have previous celebrity owners or have been used in movies or promotions. These cars always command a premium price over the exact same car without the “story”.

Our “story” is the same way. The story, along with the idea of the product being hand made and hand finished to a level not possible in a factory, should command a premium price.

I would expect, based on the current cost estimates and numerous discussions with custom shops that sell quality custom furniture that the average shop could make 50% or more on many of the pieces in the program. I am unaware of any other wood product where that kind of profit margin is available.

As I write this book, a couple of the original carved tables have been actually built and at least one sold so we have a little information on actual profitably. A one man shop in Texas built one of the small hall tables and is offering it for $3,200. Depending on the type of top used, actual manufacturing cost is under $1,000 and that assumes a $3-400 stone top. This translates to about a 66% profit if it is sold at that.

As second one man shop in Kentucky has sold a double table for $5,500 and again, I believe this will generate a 65-70% profit. These initial sales are quite encouraging but you do need to put it in perspective.

These initial carved tables represent a unique product. They use very little material, a lot of machine time and little additional labor. The small shops already have a Thermwood CNC router and they are only using it a day or two a week for their nested based requirements. Even so, it pays for itself but has several days a week of idle time. This design allows them to set it up and run carvings while they are working on other jobs. The extra pieces that come off the machine are just gravy.

From a customer's standpoint, however, these are carved solid hardwood pieces that were hand built and hand finished. It is unlikely that they can buy these tables anywhere else in the world today. No furniture company today can afford to create an intricate piece carved from solid hardwood such as cherry or walnut. Sure, you can get carved rubberwood from China but if you want the real thing, I am not sure where else you can go. Properly marketed, these pieces should command a premium.

Some of the other pieces, case goods for example, will require a bit more material and labor than the carved tables but, I think a 50% profit is likely on pretty much anything being offered.

The furniture program should work.

What about the major furniture manufacturers?

If they continue on their current path of reactive management, I am afraid that their future is dim at best. It can be quite difficult to see into the future but, at least today, the cards are stacked against them and it will take bold and decisive action for them to survive, much less prosper.

We have been trying to invite them to join our program because I believe that our cooperative offers them a path where they can exploit their strengths while avoiding the current problem areas in the market. Let's see how this might work.

The real strengths of current major furniture manufacturers are in design and name recognition. They may also have sources for raw material at competitive prices but with US manufacturing these are starting to diminish.

In the design area, they have strong designers working for them and have honed their ability to create styles, trends and finishes that sell. This is a major competitive advantage that gives value to their company.

Major furniture manufacturers also have historically done a good job of obtaining and processing raw material. This is actually one of the major shortcomings of building furniture in China. They don't have good quality hardwoods and often substitute inferior local woods such as rubber wood for the quality hardwoods that the American market wants.

American furniture manufacturers tend to be able to process this raw material into usable stock and often into a finished component rather efficiently. This ability also has real value.

In the past, they also had the ability to assemble these components and finish them. Many companies are still able to do this however, a lot of well known names have abandoned their own manufacturing and turned instead to factories in China, Mexico and Viet Nam to manufacture their products. Many of the companies that have done this have also abandoned their raw material and component manufacturing operations, further reducing the basic value of their companies.

Those that still manufacture in the US continue to have the problem of inefficiency. They are using the same structure,

machinery and practices that were used fifty or a hundred years ago and these are not competitive in the modern world.

The bold investment, restructuring and changes needed to be competitive seem to be something they are not capable of doing. As a result, they continue to be threatened by imports from areas of the world where people are willing to work for very little.

If you operate a factory structured to use a substantial amount of labor, you will be vulnerable to areas of the world where labor is cheap. If, on the other hand you use more extensive capital investment and modern technology as your competitive advantage, you can then compete with the low cost labor of the third world and, with locally available raw material that is superior to that available in the third world, you should prevail.

The final major advantage of current furniture manufacturers is their label. Many of today's furniture names have strong positive images associated with them and these names and trademarks have real value.

These basic advantages, design, raw material and trademark can be focused on our approach to custom furniture manufacturing and should benefit everyone while creating a fundamentally sound business model.

The process starts with the furniture manufacturer creating a new design. This is offered through the professional furniture program with the furniture manufacturer receiving a design fee for the manufacture of the special components through CNC program rentals, the same way designers

receive payment. In addition, the furniture manufacturer could also offer special hardware and raw materials for the designs, further increasing the amount they make on each design.

The furniture manufacturer could make as much profit on the design fees and sale of special hardware and material as they currently make on the entire piece.

Since most of these manufacturers already use Valspar finishes, it would be quite easy to duplicate the factory finish.

The custom shop could promote itself as being authorized by the factory to custom make furniture for the consumer and they could apply a label indicating that this is a custom made version of that manufacturer's line.

If the custom shop sells directly to the consumer, the price would still be competitive even though they may have paid a premium for some of the components used. Everyone would make money in this relationship.

We have come to calling this whole idea "distributed manufacturing" and it offers a real viable alternative to centralized manufacturing which is the norm in furniture manufacturing today. Centralized manufacturing has lower manufacturing cost but high distribution cost. Distributed manufacturing has higher manufacturing cost but very low packaging and distribution costs. In an overall market considering all the factors, distributed manufacturing probably has an advantage.

With this being said, so far we have not gotten any established furniture company to express a serious interest in this approach. I believe that if we can get one well known company to give it a try, we could prove the approach is viable.

An alternative that I have been proposing is for a company to take a design that has been successful in the past but that they have replaced and offer that design through the program. In this case, they have already made the investment required to design and develop the product and should still have all the programs, tooling and suppliers needed to make the required special parts. Their investment would be quite low and it would give them an opportunity to see if this approach might just work.

In either case, we are moving ahead with this program. The core technology will be in place shortly. We already have professional designs and have been offered literally hundreds of additional designs that we can work on after we have completed the initial pieces.

We have lofty goals for this program. At some point, I believe that the smallest custom woodworking shop will be able to offer a wider variety of professionally designed furniture than the largest furniture store in the world. They will be able to build a wider variety of furniture than the largest furniture manufacturer in the world. They will be able to build this in single quantity, even customize it while making more money on each dollar of sales than any major furniture manufacturers could ever dream of.

We are talking about nothing less than a new industry structure in tune with the modern world and based on new technology and networking.

Chapter 5
Finishing Furniture and Cabinets

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Finishing your product, whether it is custom furniture or a kitchen full of cabinets, offers an area where you most shops can substantially upgrade their products and gain an important competitive advantage.

Traditionally, the really fine finishes applied to high-end furniture have only been available to large furniture manufacturers who purchase material in high volume. These finishes are almost universally regarded as better, more visually appealing and refined than finishes commonly placed on cabinets.

If you plan to build custom furniture and compete with the large manufacturers, you absolutely need a finish that is as good as, and if possible, better than that offered by the major manufacturers. Until now, this was just not available to the small shop.

Cabinets, on the other hand have generally been given a relatively simple finish which looks OK until it is compared to a really nice furniture finish. If it were possible to apply a fine furniture finish to cabinets, you could very well create products that are not only easier to sell but also products that sell at a premium price, which means more profit for the cabinet shop.

One basic requirement of cabinets is that the finish, primarily defined by the clear top coat must be much more

durable than the finish typically applied to traditional furniture. Cabinets undergo much more severe use and are exposed to more solvents and chemicals than bedroom furniture, for example.

When we talk about applying furniture finishes to cabinet, we are not talking about applying the exact same finish as is used by the furniture companies. Instead, we are trying to get the same quality visual appearance found on really fine furniture but, using a finish that has the same durability and wearibility as a top quality, but visually inferior, cabinet finish commonly used today.

This is actually a new type of finish that combines the visual impact and traditional methods used by the furniture industry with the highly durable clear coats required by the cabinet industry. The combination is stunning.

I believe that finishing will become a critical feature of higher end custom cabinets in the future. That being said, you should also realize that quality furniture finishing is a really misunderstood area. If you plan to sell custom furniture or high-end cabinets and you want a premium price, you must have a really high quality finish.

This is another area that can be addressed by a network of shops where any individual shop would not be able to function.

A truly high quality furniture finish is a work of art. Art is not produced in factories, it is created by artists. In reality, a small shop can produce a finish that cannot be reproduced in a factory. It takes some time and effort and some understanding of the process, but with the proper materials

and techniques, typical woodworkers in virtually any shop can produce truly beautiful finishes without any kind of rare or special talent.

Arguably, when you sell custom furniture or cabinets, you are selling the finish. The wood and all your craftsmanship is simply something to hold the finish. The finish is what your customer sees. To a large extent, the finish determines whether or not you will be successful in building custom furniture and to some extent custom cabinets.

Most of the shops that will participate in the eCabinet Systems program are custom cabinet shops. As such, they are used to providing cabinet finishes. As a general rule, cabinet finishes are not furniture finishes. To sell custom furniture, you must learn to apply true furniture finishes. Also, once you know how to apply truly spectacular furniture finishes, using them on your cabinets will give you a powerful competitive edge. This is enhanced by the fact that you can not only reproduce the fine furniture finish on your cabinets but you can do it using materials that are resilient and tough enough for the application.

Applying a great finish is not all that difficult. There are two requirements, good finishing materials and the knowledge of how to apply them. The actual application is quite easy and something virtually anyone can do. Unlike real art, which generally requires extraordinary skill, artfully applied furniture finishes can be applied by anyone with rudimentary skills.

Finishing furniture can be compared to cooking probably better than to creating art. Heating up groceries will almost always result in something you can eat. A little bit of

knowledge and skill and the meal is better. A lot of experience and skill and the meal can be extraordinary.

Like cooking, there is no exact right way or wrong way. Different approaches and techniques result in slightly different results but all the results are good. We can show you how to accomplish the basic tasks, but your personal approach will give your results a unique and personal characteristic. This is sometimes called art and it makes what you do more valuable and more profitable.

Creating fine furniture finishes outside of major furniture manufacturers hasn't been done before, because there are several barriers to doing this well. The first barrier comes from the finishing suppliers themselves. Finishing suppliers have different marketing and distribution groups that sell different finishes to cabinet shops versus those that sell furniture finishes to furniture companies. The finishes supplied to cabinet shops do not have the same overall look or feel of high quality finishes supplied to furniture companies.

They believe that small shops should be supplied with simple straightforward finishes that require little or no knowledge. They feel the more complex finishes can only be handled by larger companies.

We tend to disagree with this basic belief. In my experience, the average small cabinet shop is run by an entrepreneur who has been living by his or her own skill. They have had to deal with many areas much more complex than finishing. In general, they are more capable and skilled than middle management in large companies or the individual

production line worker that typically applies these more involved finishes.

This area gets a bit complex because the marketing and selling methods of the finishing suppliers are different for cabinets than for furniture. In the cabinet area, a series of standard, relatively simple finishes are made available with simple instructions on how to apply them. These finishes are available in both small and large quantity to fit the needs of most cabinetmakers.

The furniture area is different, however. Finishing suppliers tend to make furniture finishes more complex and involved and, in general, offer little in the way of documented procedures. Numbering systems and material identification tend to be complex and each finish is custom blended for a particular company and a particular product. There are no standard production furniture finishes.

Operating in this complex environment requires special skills and knowledge which even the largest furniture manufacturers generally don't have. To address this, finishing suppliers provide full time technicians and ongoing technical support to their large furniture customers. Furniture companies rely heavily on these technicians and support to sort out the finishing process. These in-house people and this ongoing support are key to maintaining the account and represent a critical ingredient in marketing to large furniture companies.

As you can see, it is in the best interest of the finishing supplier to make their furniture finishes as intimidating as possible. This gives more value to the technical support they

provide and offers them a way to lock in their major customers.

These practices, however, make it difficult for smaller shops to use this same material. Obviously, unless you buy finishing material by the tanker truck, the finishing supplier cannot afford to develop special finishes for you or offer you the high level of technical support needed to deal with the complexities of the product. At the same time, if they make the product simpler and easier to understand for the small shop, they reduce the need for continuous technical help and loosen the ties that keep their large customers loyal.

It is within this arena that we decided to develop a method whereby small shops can get access to and apply really creative, quality furniture finishes in a manner that they can understand and work with.

To do this we turned to the largest supplier of production furniture finishes in the world, Valspar. If you buy a piece of furniture from almost anyone, built almost anywhere, it is likely that the finish came from Valspar, so who better to supply furniture finishes to our network.

The first barrier is a lack of standard finishes. In the world of supplying production furniture finishes, each new design also has a new finish associated with it. Often the designer that created the furniture design also has a great deal of input as to the finish color and appearance.

There are no standard finishes because there is no demand for standard finishes. Existing customers are large enough

that they can have a new finish developed for them anytime they want.

Rather than try to follow industry practices and create custom finishes for everyone, we decided to work with our furniture designers and Valspar's World Design and Color Laboratory to develop a series of standard finishes. We call these finishes "Schedules", following industry nomenclature for the recipe containing all the steps for a finish. Although we will sell individual materials, we decided to offer all the material needed for a particular finish as a finishing schedule. The finishing schedule we offer includes all the various materials needed to reproduce a particular finish for a specific number of square feet of surface area. This means we need to offer these in quantities that correspond to typical job sizes for custom woodworking shops. Thus, for the first time not only can a custom shop get the material needed to reproduce a fine furniture finish but they can purchase it in quantities that are reasonable for individual custom jobs.

We did one other thing that is a little different. We decided to pre-mix and pre-thin each of the materials so that all you need to do is pour it into the spray gun and use it. Although this is convenient, that's not the major reason we did it.

Since we are selling this material in packages intended to cover a specific number of square feet, this approach allows you to run out of each material at about the same time.

For example, let's say we didn't pre-thin. Then, if there were one material that is reduced 50-50, after reduction, you will only need half as much for each coat as another material that is not reduced. When the job is done you have

a half a can of material left over, which of course you had to pay for. By properly reducing all materials and providing the correct amount for each coat, they are all used at the same time and there should be little left over after the job so your overall cost is less.

There is no real disadvantage to this as long as we reflect the lower cost of reducer versus the prime material in the price of the final schedule. We have adjusted our prices to reflect the actual cost of the reduced material in determining selling price.

This is a different approach but it is also a different market. The requirements for small quantity custom furniture have not existed before so there was no need. In this program, this approach makes sense.

The next problem is how to get the material to the customer. In general, these are hazardous materials with a lot of regulation and government requirements to both sell and transport the material. We have addressed these areas by establishing our own color blending laboratory. We added sophisticated computer systems that can generate the required material data sheets for each blended material as well as becoming certified to package and ship these materials.

There is an additional hazardous material shipping fee, however, we can generally ship an entire schedule for a custom job for a single fee of about $20. Some schedules may require that material be packaged in two packages. The most economical shipping method is to purchase a large schedule, which generally mean material is shipped in five-gallon containers. This ships by truck line which has a much

lower has-mat fee than UPS for example. This approach makes the whole process practical and opens new competitive advantages to custom shops.

Another barrier to cabinet shops applying these finishes is a certain mind set in the cabinetmakers themselves. There are several areas in creating fine furniture finishes that just go against the basic instincts of most cabinetmakers. To offer truly fine furniture finishes, they must develop an understanding of these differences and accept the furniture methods. We will cover some of these areas shortly. Once this occurs and they see the final results, it is very likely that these same techniques will be used on their cabinets also.

The purpose of this chapter is to make this whole area clear and understandable. Luckily, despite the efforts of the finishing suppliers, applying really high quality furniture finishes is not all that complex or difficult. Even the materials are quite easy to use today.

In the mid-1980s, I set up a couple of fairly high production furniture finishing operations and had a chance to personally apply the materials available at that time. Recently, while working on this program, I had a chance to work with modern material and found that they are substantially easier to use and more forgiving than I remember. I assure you that if you have the skill to build custom cabinets and furniture, you also have the skill to apply a high quality furniture finish.

I am going to attempt to go through all the aspects of the finish using a basic practical approach. The methods, preferences and directions I offer are not the only way these things can be done. They do, however, represent my view of

the process and tend to cut through some of the chatter and complexities that the industry tries to inject into the practice.

As I have stated, in an effort to address this area, we have established, through eCabinet Systems, distribution of complete finishing schedules. We will talk about “schedules” shortly, but a “schedule” is simply a recipe for a furniture finish. It is a complete list of the steps needed along with the materials needed for each step.

In our program we are developing standard finishing schedules and then selling the material needed to apply the schedule as a package. You can buy the materials independent of the package, but having the entire package or schedule available as a single product just makes things easier. This brings professional furniture finishes from the world leader in supplying these finishes, to the small shop in a form that they can use.

In addition to providing clear, easily understood identification of the various materials, we also supply video instructions on applying the finishes for each schedule. This makes truly high quality furniture finishes practical for small shops.

The reminder of this chapter will give you an overview of this finishing process.

Let’s start with spray equipment. Pretty much anything will work.

There is a wide variety of equipment available and any spray equipment that is capable to applying a controlled, even coat is acceptable. I tend to prefer a semi- HVLP gun

operating at 20-30PSI. I also sometimes use a dual turbine system which also works well and can operate without an air compressor.

The only drawback I found with the turbine system is that it does tend to take a bit longer to lay down a wet coat than the HVLP gun. For all guns that use compressed air, I like to put a small regulator right on the gun itself. This lets me adjust pressure as I go and offers a lot more flexibility. Production shops don't really need this regulator and you won't see it in a furniture factory but for what we do, it is a valuable tool. The spray gun in a factory sprays the same material, the same way over and over. They have set the pressure and gun for that one single process and have no need to change it very often.

As we finish, we will use the same gun for every material and every application and each may need different settings. It just makes sense to have the adjustment right there at the gun.

Another gun I find really useful is a small auto touch-up gun. Mine has a small plastic gravity fed can that holds maybe a half cup of material. I also put a regulator on this gun.

This small touch-up gun is a great way to spray sap stains, equalizer or inert glaze or any other material that is applied to only specific areas. Also, if you take off the atomizer tip and turn the air pressure down to less than 5 pounds, it makes a great spatter gun, saving you the cost of a separate piece of equipment.

Next, I want to address a couple of basic tools, the "schedule" and the "step panel".

A finishing "schedule" is simply a list of the steps needed to apply the finish. It is like the steps in a recipe. Simply follow the steps.

Every furniture finish has a schedule associated with it. The finishes we supply through the eCabinet Systems program each have a schedule.

The number of steps on the schedule is generally the number of steps the finish is said to have. If there are 15 steps shown in the schedule, it is said to be a 15 step finish. This is, however, not exactly how many steps it will take to complete the finish.

Generally, the first step in a finishing schedule is sanding and distressing. After that, each time a clear coat is applied, you will again scuff sand and, for pre-cat or conversion varnish material, you will also need to tack rag the surfaces clean. Sometimes this sanding step is added to each clear coat description in the schedule and sometimes it is not mentioned in the schedule. In either case, you still need to sand each clear coat except the last one. We will talk about this when we address sanding.

A second tool is the "step panel". This is a panel, made of the same material that you are finishing. It shows, in steps, what the finish should look like after each step in the schedule has been completed.

When a finishing supplier develops a custom finish for a furniture company, they supply both a finishing schedule

and a step panel as well as the materials required for that finish. This is part of the service they provide.

For our applications, you will always have a schedule. We may offer step panels for the various finishes if a demand develops but, you can also make your own step panel the first time you apply the finish. After that, you can use it as a reference to make sure subsequent jobs end up with the same finish as the first time.

Whether you buy a step panel or make your own, they become a standard part of the finishing process and many shops use the step panel to help sell the finish to their customers.

A step panel is quite easy to make. Start by applying the first step to the entire panel. Then when it dries, put a 1 ½ to 2 inch piece of tape across the bottom of the panel. Then apply the second step, and when it dries, put a second strip of tape above the first covering a section of the panel that has both steps completed.

Each time a step is completed, place another piece to tape until the finish is complete. Remove all the tape and you have a panel that shows what each step should look like along with the top part of the panel which has the final finish with all steps completed.

The step panel is important because the finish will not look right, possibly it will not even look good, until the final step. If you try to judge how you are doing in the middle of the job, you could make some erroneous adjustments. The step panel says, “make it look like this and it’s OK”.

This is actually a good point for those that are not used to multi-step finishes. A good quality furniture finish has a lot of colors and effects laid on top of one another to achieve the final look. Some of these colors look strange and even wrong as they are being applied. You will find yellows and purples and oranges. As you work on the finish realize you can't judge it for overall looks until it is complete. It won't look good in the middle of the process so don't try to make it look good at that point. Have faith that the final result will be every bit as good as you hoped.

Now we are ready to prepare the surface of the piece for finish. The first step is sanding. We need to sand the entire piece with 170 – 180 grit paper. This should be done just before you start to finish, not the day before, not two hours before. This step needs to be done right before you start to spray.

The purpose of this sanding is to cut off and remove small wood fibers that are standing up and will complicate the finishing process. 170 – 180 grit seems to be the best choice for this process. Coarser grits tend to scratch the surface and will show up in the finish and finer grits tend to lay the fibers down, rather than cut them off. As soon as you coat them, they will stand right back up and make life more difficult.

The reason you want to sand right before you finish is that if you sand and wait, other fibers will relax, raise up and take the place of the ones you just sanded off. The first step is sanding, right before you finish.

At times you may here folks talk about a "blotchy" surface or stain job. This is almost always because they did not sand

right before they started to finish. Every furniture factory I have seen does the sanding just before they put the piece on the finish line. They don't have these problems. About the only place I have heard of this being a problem is in cabinet shops that don't know this trick.

In this sanding process you must round off all edges and corners. This is the first area where the mind set of typical cabinetmakers comes into conflict with good finishing practices. A good cabinetmaker has spent considerable time and effort in creating, maintaining and preserving those sharp, clean edges. Now, you want me to sand them off?

There are actually a couple of reasons they need to be rounded. First, the finish won't adhere to a sharp edge. It tends to pull back from the edge, leaving a white stripe. When you round the edge, the finish adheres properly, and actually tends to pool and sharpen the edge somewhat.

The second reason to round all edges is that it just looks better. People don't like clean, sharp, newly minted furniture. Quality furniture is carefully worn with smooth, soft, pleasing edges. Most people don't realize what they are seeing, but if you show them two pieces of furniture, one with smooth rounded edges and another with crisp sharp edges, they will assume the worn piece is the higher quality more valuable example and the sharp piece is a cheap, low quality imitation.

This is a very important concept because you can make a really nice piece of furniture built with the best woods available look like a low quality import by not rounding and smoothing the corners and edges.

This brings us to the next area which is distressing. If you think it is difficult to get cabinetmakers to sand and properly round edges, just try to get them to properly distress their product.

Distressing adds a feeling of age and quality to a piece and is an important part of most finishes. It is important to understand that distressing is not a haphazard frenzy, beating the piece with chains. Proper distressing is actually an important woodworking skill that must be applied properly.

Some finishes call for light distressing, others moderate or heavy. There are also specific tools used to distress a piece. The finishing schedule will specify which tools to use and to what extent the piece is distressed with each tool. Before we discuss these tools, why do we distress the piece at all?

The reason is that with many finishes, we are trying to make the piece look like it is old. Distressing tries to reproduce nicks and damage and effects of age that normally occur, even for furniture that is well cared for. Many of the finishing steps we apply will try to reproduce the effects of age and use, but without proper distressing these will fall short.

Fine furniture is a type of art. It is one of the few things that are considered better and of more value if it is hand made and is old. Even new furniture is considered better and is worth more if it looks like it gracefully aged. The first step in achieving this look is proper distressing.

This is one area where pretty much universally, cabinetmakers have a problem. Nicks, scratches, gouges and

dents are considered signs of poor workmanship by the average cabinetmaker. Taking a piece where these have been carefully avoided and adding them, just goes against the grain. I have seen people that really want a particular look for their product but are unwilling to perform distressing that is vital to the appearance they want.

The bottom line is that if you want a high quality furniture finish you will need to properly distress it. If you do not properly distress your product during the finishing process you will not have an acceptable finish. If you just can't bring yourself to do the distressing, you will limit yourself to a very few types of finish where little or no distressing is used. Most quality finishes, however, have some level of physical distressing.

This is the one area where I almost always hear comments and concerns from cabinetmakers. "I would like that finish but without the distressing." "I don't want to distress it too much". If you really don't want to do the distressing step, you should probably stick to "hardware store" finishes. Otherwise, you will put a lot of effort into a multi-step, industrial furniture finish and the result will be "Cheap" looking.

If you are not sure about distressing your "masterpiece", go ahead and finish a sample piece made of the same material. Distress the tar out of it. Go way beyond what you might normally do and then complete the finish. You will be surprised how really nice the final result is and hopefully it will get you over the natural hesitation.

Recently I put on a training class for some cabinet shops to teach them how to finish furniture. As usual, they were

afraid of distressing. To demonstrate that this is not something to fear, we finished a fancy carved table that had an inch and a half thick solid maple top.

The top was gorgeous. It was flat, smooth with clean sharp edges. Exactly the type of thing you try to make.

First, I took a round over bit on a hand router and rounded all the edges. I wasn't particularly careful doing this and they all assumed I was just not experienced with the router. The edge had a lot of chatter and wasn't very even.

Then I said we need to sand it a bit. I took a heavy duty belt sander and put 50 grit paper on it and began sanding the surface. Of course, it scratched the tar out of it. I paused on the corners and edges as I talked to them and the sander was eating into the top while I talked. I thought some of them were going to faint.

Then as a final step I reached under the table and got out a chain saw and fired it up. Now the reaction was just shock.

I bounced the chain over the top which cut some pretty good grooves into it. At this point they felt the top was ruined.

It was even worse when I took a rasp to not only the top but the fancy carvings and legs.

As we ran through the finishing process, the "damage" began to look better and better. By the end, the top was a masterpiece. It looked just great. We have used this piece at many trade shows and it has always gotten great reviews.

My class was won over. When they saw the final result they lost all fear of distressing. The basic thing to remember is that pretty much anything done before finishing is distressing and anything done after finishing is damage. The finishing process highlights, accents and softens the distressing giving it a really nice “old worn” look.

One final note about distressing. This is a full step in the finishing process and requires some real time and effort. You can’t properly distress a piece in a minute of two. This process will take as long, or longer, than sanding. Plan to spend enough time to get the proper result.

Before we address actual distressing tools, let’s revisit sanding. A DA or belt sander is a great tool to begin the distressing process. If you examine old furniture you will discover that it does not have smooth, flat, milled surfaces. The surfaces are wavy and commonly corners tend to taper in slightly. Reproducing that slight taper on flat surfaces as they meet edges and corners can be done using a DA or a belt sander. The slightly rounded edge is very pleasing and gives an old refined look to the part.

In general, the older you want the piece to look, the more of this effect you need to add.

With our new appreciation of distressing and our sanding finally complete, let’s start with the most basic and useful distressing tool. It is a palm sized stone. This stone should be oblong or triangular shaped and should have relatively sharp edges and points. With this you simply tap the surfaces and edges of the piece. Rotate the stone as you do this so that all the dents are not the same shape.

As you do this, vary the force and angle to get different impressions.

This does a great job of reproducing the dents, bangs and bumps furniture receives during years of use. Typically, this is a background distress that adds character but is not overly prevalent. A few bangs on the face and edge of a door should do unless the finishing schedule calls for a higher level of this technique. These dents will both be highlighted and blended as we continue our finishing operation and take on quite a pleasant appearance. This technique is called “stone”.

A variation of this is called a “chain”. This is generally a piece of broomstick handle with about a six inch diameter loop of coat hanger wire or the like taped securely to the end. This wire has been threaded through an assortment of nuts and washers that are left loose on the wire. I have even seen people grind washers to triangles to create points.

This is used by simply banging the assortment of nuts and washers against the furniture. It also creates bumps and dents, but this time they are kind of varied in shape.

Another distressing tool I call a screw paddle. This is cut from plywood on a band saw. It is a handle about an inch wide and about 12-14 inches long. It widens at one end to about four inches across so it looks kind of like a paddle. A series of screws are run through this wide area so that they all protrude out the same side. I have seen some of these with just a few screws and others with a couple dozen or more.

This tool is used to simulate “worm holes”. Certain species of wood, especially on older furniture, attract insects that bore small holes through the wood. They tend to be grouped together in areas. Banging the screw laden paddle against the furniture a few times creates a realistic hole pattern. Depending on the level of distressing in a particular finish, these areas can appear pretty much anywhere on the piece.

Now, we get into somewhat heaver distressing. A sharp chisel or knife can be used to scratch flat surfaces. These scratches pick up finishing material and are highlighted during the finishing process. You might want to be a little careful with this. Most of the distressing we have done so far looks more pronounced now, than after it is finished. The fine scratches you place with the knife or chisel are almost invisible when you place them but will be highlighted significantly after finishing, so keep this in mind when you are trying to judge the level of distressing you have applied.

A heavy rasp or file can be used to gouge out edges or corners. This looks like a disaster when you first do it, but after layer and layer of finish, with sanding between each, it takes on a really nice refined look.

One extreme example of this was a small walnut wall table we made during a trade show in Mexico. We took one table and simply applied a nice stain and clear coat finish to the clean sharp piece with no rounding or distressing. I took a second identical table and first, using a hand router and an eight inch round over bit, ran it over every edge of the piece leaving no sharp edges at all. Then I took a belt sander with 80 grit paper and tapered all four edges of the table top so that they were about an eighth inch thinner at the corners

than at the center. This tapered back 4-5 inches. I also tapered the edges of the drawers. Then, I took a chain saw and bounced it over the top (while running) to put some deep gouges in the center of the top surface. This is where I got the idea for our training class.

Then, I put a really nice multi step finish on it using glazes and dry brush. It looked gorgeous! Standing side by side, the two tables did not look like the same piece. Both were made of solid walnut but one looked like something you would buy at a deep discount store for $5 and the other looked like a beautiful and valuable antique passed down through many generations.

On certain types of wood, oak for example, you can take a V chisel and gouge out areas with the grain to simulate tear outs. When finished, these look very natural and add to the used, old look.

These are the basics of distressing. It is a careful, deliberate process with a specific look in mind. If you have an emotional problem with distressing your new masterpiece, I again suggest that you take several pieces of the same wood and distress and finish them separately. Really go overboard with some and then finish them. I think you will be surprised at the result. This will give you a good idea of what these look like after finishing and should both give you confidence and remove any remaining fears.

Now we have sanded and distressed our piece, we are ready for the finishing process itself. Before we begin spraying away, let’s try to understand what we are attempting to do with each of the steps.

There are four basic phases to the finishing process. We have just completed the first phase which is preparing the piece. This phase includes sanding and distressing. In phase two we are going to color and balance the wood. This is where we add highlight color and accent the natural color of the material we are using. Then we will seal this with a material generally called a wash coat. This is nothing more than a sealer, cut fifty-fifty with reducer.

The reason we don't use full strength sealer is that we want to seal in the wood stains so that the wood color can no longer be changed but we also want to try to keep from filling the grain and other surface features of the wood. We need these surface features for the third phase.

In phase three we are going to accent the grain and other surface characteristics of the piece. This will also accent any corners and inside edges. This process generally sprays various stains and glaze materials which are then wiped and brushed off. Since it is all but impossible to remove these materials from the cracks, grain and corners, it remains, accenting these features with various colors. This time we use a sealer full strength to seal the accent coat.

In the fourth and final phase, we emphasize the geometry of the piece and artistically add surface details and finish distressing. This phase pulls the piece together and adds touches that would occur normally over many years of exposure to the environment, use and care. This is where the piece really takes on a life of its own. Then we apply one or more top coats and we are done.

Over time you will discover that there are variations to this process. For example, after phase four, you could come

back with a glaze that looks like dust, spray and wipe this and then clear coat again. After spraying the final clear coat you might sand and the polish the final coat to get a smooth, glass like surface. Regardless of the variation, these four phases are the backbone of a high quality furniture finish.

We will look at each of these phases individually, but before we do we need to discuss the types of clear coat we offer, furniture lacquer and pre-cat. Pre-cat is a commonly used name for pre-catalyzed lacquer and there are some fundamental differences between furniture lacquer and pre-cat.

Furniture lacquer is a solvent based material that hardens because solvents that dissolve it evaporate. If you put solvent back on it, it will again soften. It dries through physical evaporation of the solvent.

Lacquer is a fairly easy material to work with and is slightly less expensive than pre-cat. It is quite easy to repair. You will scuff sand between clear coats to smooth the surface, however, it is not generally necessary to completely clean off the sanding dust because the next lacquer coat will dissolve any lacquer dust remaining. I use this to help fill grain by leaving the sanding dust in the grain when working with lacquer.

The downside of furniture lacquer is that it is not as durable as pre-cat material. Because it will soften with solvents, it is not resistant to many household chemicals and can even be damaged by water over a period of time. Because of this, it is best used for furniture that does not experience heavy daily wear or exposure to water or solvents. Items such as bedroom furniture, bookcases, entertainment centers,

occasional tables and the like are examples of where furniture lacquer works well. Items that do experience heavy use or where they come in contact with solvents, chemicals or water such as kitchen or bath cabinets, should use pre-cat.

Pre-cat material hardens through a chemical rather than physical reaction. When exposed to air, the material undergoes a chemical reaction and changes from a liquid to a solid. Once changed to a solid, it cannot be turned back into a liquid. It is therefore resistant to most household chemicals and solvents. This characteristic, however, also affects its use and application.

There is a third type of clear coat that we have chosen not to offer at the beginning of this program called conversion varnish. Conversion varnish also undergoes a chemical rather than a physical reaction, but with conversion varnish you add a second material or catalyst that reacts with the first to create and even more durable surface. There are some complexities to using conversion varnish that we felt made it less desirable at this time.

As with lacquer, you will scuff sand between each coat of pre-cat material, but in this case sanding is a serious requirement. Since a new coat of material does not soften the existing coat, it cannot fuse with and bond with the existing coat. Therefore, you must roughen the surface so that the new coat can mechanically bond to the existing coat. If you spray directly on the shiny, un-sanded surface, there is the possibility that the new coat will not adhere to the existing material and you have problems.

Also, after scuff sanding pre-cat material, you must completely clean off any sanding dust. I recommend using a

tack rag each time you sand. Unlike lacquer, which will melt any dust remaining, pre-cat will not melt the dust so it causes a grainy discolored surface if it is not completely cleaned off.

So, the price we pay for the durability of pre-cat is that it is slightly more expensive and is a bit more involved in the application process.

If you check with finishing suppliers you will find they offer hundreds, if not thousands, of clear coat formulations. For our purposes, this is not really necessary. Many of these are formulated for specific finishing lines to account for flash time, oven temperatures, etc.

For our purposes, we offer a lacquer formulation and a pre-cat formulation, both formulated for air dry, that is no ovens. We do offer them in different sheens, which determines how glossy or shiny the final surface is. You can blend different sheens as needed. For example, you can blend equal amounts of 20 sheen and 40 sheen and obtain 30 sheen. The finishing schedule specifies which sheen top coat to use and that top cost is part of the schedule. Each finishing schedule has the particular sheen that is appropriate for that finish so, unless you are trying to do something special, you do not need to worry about sheen.

To accommodate all requirements, we offer each of the furniture finishes in both lacquer and pre-cat. In this way you can get the look you want with either system. We have finished the cabinets for entire kitchens in these furniture finishes and although it takes quite a bit more time than a simple two or three step process, the overall look is just great.

Now let's turn to phase two, coloring the wood.

There are actually a couple of things we are going to try to do at this point. First, we are going to try to create a background color. Depending on the final finish, this could be a yellow, orange, purple or other unlikely color. This is not the final wood color that we will see, it is a background highlight color. Subsequent layers of finish will tone down and modify it. This is a great example of where a step panel is helpful to show what the piece should look like after this step.

This overall color is achieved through the use of penetrating stains or NGR stains. NGR stands for Non Grain Raising. Basically, it stains the material without popping up more of the little fibers that we sanded off before we started.

These materials penetrate into the wood, changing the color while leaving the natural color variations that are already in the wood.

We also need to balance the light and dark areas of the wood. Most wood used today has both sapwood and heartwood. Generally the sapwood is lighter in color and the heartwood is darker.

In the past, master furniture builders would carefully hand select wood to balance color. Generally heartwood would be used and sapwood discarded and even the heartwood would be selected for good color balance. Today, we don't have that luxury and few shops pay any attention to variations in wood color when they build furniture.

Most finishes look best if the overall lightness or darkness of the wood is more or less uniform. Therefore, we will need to balance the shade.

This is done in two ways. If we are trying to achieve a final color that is more like the darker heartwood, we will selectively spray the lighter sapwood with a sap stain. This darkens and balances the sapwood. This is a place where the little touch-up spray gun works very well.

If we are trying to achieve a lighter color, more like the sapwood, we will spray the heartwood with an equalizer. This is generally a brighter color stain that will highlight or brighten the areas sprayed as subsequent layers of finish are applied.

Overall in phase two, we are working with the color of the actual wood. The materials applied penetrate and dye the wood to the color and balance we want. Now we will seal this color so that it can no longer be changed.

This is normally done with a wash coat. A wash coat is typically a clear sealer that has been diluted half and half with reducer. This is sprayed over the entire piece and allowed to dry.

The reason for diluting it is that we want to seal and lock in the background color but do not want to fill in fine grain or surface texture. We will need this grain and texture for phase three.

Once the wash coat has dried, we need to scuff sand it using 320 grit paper. This is a light hand sanding over the entire surface of the piece. If you are using pre-cat schedule, you

will also need to tack rag the surface to remove the dust. With lacquer you should be able to just blow it off.

At this point, depending on the schedule, we may or may not be ready for phase three. We have colored the wood itself, but in a lot of cases, these are strong background colors and we may need to tie the entire piece together with a stain.

Obviously, since this stain is being applied over a clear coat, it will not penetrate into the wood but will provide a somewhat transparent color coat over the entire piece. In most cases, we will brush or wipe the stain in certain areas, sometimes using steel wool to create lighter and darker areas. Generally this is done following the light and dark areas of the wood grain to accent the grain itself.

During this step, we may also add padding stains. These are colored stains that are wiped on certain areas of the wood to add specific color. This is normally done with the corner of a small rag rubbed with the grain.

This is still in phase two since we are still developing the overall color of the piece. There can actually be several stages to this process, sometimes with a wash coat between these stages. There is no set pattern to how these things are done. The finishing schedule determines the steps needed to develop the overall color, which is the focus of phase two.

In phase three, we will be accenting and highlighting the surface texture and geometry of the piece. This is done with a glaze material.

The glaze is a thick, pigmented stain. A pigmented stain is one that has color of its own which sits on the surface and adds its color to the piece. If a pigmented stain is applied over the wood itself, it colors the wood by covering the wood color with its own color on the surface. A lot of the simple stain products available through retail work this way.

We will use the glaze by spraying it on and then wipe and brush it back off. When we do this, it will hang up in the grain and depressions in the wood as well as hang up in the inside corners, accenting them. This is a relatively simple process but you do need to see it being done to understand it.

There is one additional consideration in this process. In addition to accenting the surface texture, the glaze will also somewhat darken and color the entire surface of the piece. There are probably areas, however, that are already too dark and this is a good place to begin adjusting for that. There may also be areas, such as end grain, that will naturally grab the glaze and become too dark. For these areas, there is a material called an inert glaze. Inert glaze, sometimes called neutral glaze, is simply the thick glaze carrier without the pigment. It is clear.

Using the touch up gun, the inert glaze is selectively sprayed on the areas we do not want the pigmented glaze to affect. It soaks into the grain and coats the surface. Then when the pigmented glaze is sprayed over it, virtually all the pigmented glaze is wiped away.

Another technique is to use a rag dipped in inert glaze to wipe an area after the pigmented glaze has been sprayed and wiped. This does a pretty good job of removing glaze in the

areas wiped with the rag and can help balance color and lighten areas that are too dark. In general, however, it is better to apply the inert glaze on these areas before the pigmented glaze is sprayed.

All the steps described here are quite simple once you see them being done. To allow you to see the actual finishing process, we have developed video DVDs that play on a PC or a DVD player showing the applications of each of the finishes we offer. In these DVDs you will see several people performing these functions to get a good idea of individual techniques. From these you will be able to develop techniques of your own that will work for you.

Once the glaze has been applied and wiped and brushed off, we are about done with phase three. Here we will probably spray a full strength sealer, since we no longer need to preserve the fine surface detail. Again, after the sealer dries scuff sand with 320 and tack rag if you are using pre-cat.

We are now into the fourth, and most artistic phase of the process. In this phase we will decorate the piece to add the effects of age and use.

A good way to approach this is to go to an antique store and look at furniture that is truly old. This furniture was probably finished by simply staining and clear coating. The clear coat might have been oil or shellac or lacquer. Originally, it was probably a consistent, even color, but not now.

Over the years, much has happened to the piece. People have used it, rubbed it, polished it and damaged it. The sun

has bleached it and the environment has stressed it. All of these events have changed its look.

Focus on some of the effects. Hands rubbing on edges have rounded the edges. Oil from those hands have stained and darkened the edges. The piece has gotten dirty and been cleaned and polished. The center open areas have been polished to the point that they have become lighter in color. Recesses, areas around the hardware and corners that are not as accessible did not get cleaned quite as thoroughly. They are darker in color, blending into the lighter areas. On carvings, the inside areas are darker and probably have gray dust ground into them. The tops of carvings might have gotten worn light but, they also may have been rubbed and touched with oils and hands which would have darkened them.

The finish might be crazed or checked. In some areas, you might have rubbed all the way through the finish, reveling the light color wood underneath. Perhaps the piece has been painted several times, each time a different color. Now, we have worn through the top coat or coats to revel the colors underneath. Insects and flies may have left little black spots. Water splashed in it may have caused small water stains or the finish may have unevenly deteriorated.

Damage, scratches and abrasions have darkened with subsequent applications of oil and wax and hand rubbing. Dings and dent have been filled in over the years with polish and dirt.

All of these things add to the character or patina of the piece. We are now in the phase in which we will try to reproduce these effects without requiring decades of use. In

this area, I will try to cover some of the more common techniques.

Probably the most powerful tool for doing this is called “dry brush”. This uses essentially the same glaze material used earlier, but the application technique is quite different. Also, the dry brush glaze may be a different color than the primary glaze depending on the finishing schedule.

The basic technique for dry brush is to fold a rag and place it in a flat container. I like to use the top of a gallon paint can, turned over. This provides a simple flat carrier with a lip around to keep the material from dripping out. Place the rag in the center and pour some dry brush glaze on the rag to soak it. After awhile, the solvents will evaporate leaving a somewhat dry pigment on the cloth. This somewhat dry pigment is what we are going to apply. This somewhat dry pigment is where the name “dry brush” came from.

The process uses two brushes, a 2” brush to apply the material and a 5” to 6” brush to smooth it out an blend it.

There are several techniques for applying dry brush depending on what you are trying to do. We are going to use the dry brush to add the light and dark variations caused by use. We will darken the outside areas of panels, inside corners, behind hardware and pulls, and any other areas that would have naturally darkened with age.

Start by dabbing the small brush into the rag containing the material to pick up a little material on the tip of the brush. Then, dab the brush into a corner to place the material and brush the material to blend it out a little. This applies a little dry pigment material to the piece. Then use the large brush

to blend and even the material. Then repeat the process until all the areas you want darker have been darkened.

This is not a precise process. It is done quickly with a certain amount of flair and some relatively bold brushing. After you have worked on the piece for awhile, stand well back and look at the shadowing you have created. You will see areas that you might want to touch up or lighten. You can generally lighten an area using a fine steel wool.

After you have completed the shadowing you want with the dry brush, you can then accent the edges. Here, you simply snap the end of the brush over the edges, darkening and accenting the edge. There might be a little material trailing inward from the edge, which is OK, but you generally want to keep this accent to the edges themselves.

This process really gives a three-dimensional feel to the piece. People in the business call it “getting credit” for the edges.

At this point, the piece will have taken on a nice look, however, the dry brush material becomes somewhat flat as it dries so the piece will have a flat dull look. Again, this is OK since the top coats will add gloss or sheen and really bring out the work you have been doing.

Now, there are some additional steps that can be done.

Spatter is a material that is spattered on the piece to simulate various effects. Tight dark spots, called fly specks, are sometimes used. Other spatter may be much more subtle. Some are thin and spread out to simulate water stains or material break down.

There is a specific gun called a spatter gun that does a great job of applying spatter. They are not particularly expensive and if you are going to do a lot of finishing you should probably get one.

I use the touch up gun. Take the front cover off the nozzle and turn the pressure down to about 5-6 PSI. Practice on some large cardboard panels, adjusting the flow and pressure until you get the effect you are looking for. When applying spatter this way, you will stand back 6 – 10 feet from the part during the spatter process.

Another approach that does work but takes some time is using a tooth brush. Dip the brush into the spatter material and then run your thumb over the bristles to spatter the material. Again, practice on a cardboard panel before you attack your piece.

There is another effect, called “cow tails”, that might be added at this point. To do this you need to create a cow tail tool.

The traditional way to make a cow tail tool is to take a small mop, cut off the handle to about a foot long and removing all but a dozen or so of the mop strands. Then, dip the mop into lacquer, raise it up and while it is drying, pull the strands apart so they don’t stick together. Then repeat the process over and over and over.

The result is a mop with a series of hard, almost ceramic like tendrils hanging down. This is used to apply the cow tails. The cow tail material is a thick, dark material similar to dry brush. Dip the cow tail tool into the material and let

the excess drip off. Then, tap the top of the tool onto the piece, causing a series of black streaks in random directions.

Another approach that is quite a bit quicker is to mix up some fiberglass (polyester) resin in a cup and dunk the mop into it. Then as it cures keep the individual strand apart. This may take two dips to build up but is much faster than the old fashioned approach.

By the way, be careful with the cups of resin as they cure. This is an exothermic reaction which releases heat as it cures. It is also a reaction that occurs faster at higher temperatures. See where this is going?

The reaction can run away, creating a lot of heat. I have seen batches actually catch fire when too much catalyst has been added, so be alert.

Again, this is a little more difficult to explain that to actually do. Watch our videos on any finishing schedule that requires this process to see exactly how it is done.

We are now ready for the top coat. If you are using lacquer, I would suggest two or three top coats with scuff sanding on all coats except the last one. For pre-cat, I like to use at least two coats, again with scuff sanding and tack rag between them.

This final clear coat really brings the finish alive. The colors, shadowing and distressing really pop out as the top coat is applied. This is also the first time you get to see what you have really created. This is my favorite part of the process.

As you can see there are quite a few steps to this. Over time, it becomes a type of art form and, as we all know, really fine art sells for really high prices. Furniture artfully finished also sells for a premium. You can apply finishes in your shop that cannot be reproduced in a factory. This makes your products special and gives you a real advantage in selling premium pieces.

We try to keep the finishes we offer to 15 to 20 steps and most can be applied over a day or so. There are finishing schedules that run 30 to 50 steps and take a month or more to apply. As you add additional steps beyond the basics, the effect achieved by each step gets more and more subtle. The additional steps from a three to five step finish to a 15 step finish are rather dramatic. Additional steps and work further enhance the piece but we start to get into an area where very few people will either see of appreciate the extra. That being said, I know of shops that build really high end furniture for the truly wealthy and this is the type of finish they apply. They also sell a headboard for $35,000 - $40,000.

In our program, a truly nice finish is quite important, perhaps even essential. It separates your product from the “factory made” and gives your customers a reason to come to you and have it custom made.

Chapter 6
The Future of Furniture Technology

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This is a difficult area to address. Trying to guess what the future might bring is always risky. It is all but impossible to predict where technology will take us in the short term, much less in the longer term.

Despite this difficulty, it is also important to have some vision and at least an idea of what we might expect in the future, especially if we are going to commit to some of these fundamental concepts and directions. It would be nice to at least have some idea where these new ideas might be taking us. So with this in mind, I will try to talk about where this is all going and what we might expect as things evolve.

I will also talk about our vision for this industry, as well as our vision of how the technology can change this industry. In addition to trying to run a business, make money and feed our families, we are also trying to re-invigorate a dying industry. We are looking for ways to create a structure and an environment that will restore and perhaps even enhance the fading furniture business. We think we can do this while making thousands if not tens of thousands of small shops wildly successful.

I know it is a little presumptuous for a small company in the corn fields of Southern Indiana to think they can change an entire industry. Sometimes it appears to be an almost impossible task, and maybe it won't happen, but it doesn't hurt to try. Someone has to do something and I don't see a

lot of folks out there trying to bring furniture manufacturing back to the US. We have a vision of how this can be done and it would be just wrong to not try to make it happen.

The real risk involved in doing this is primarily to our ego. If it is successful we will be seen as visionary and brilliant. If it is not successful we will be seen as foolish, silly and naive. I once heard that the difference between a calculated risk and a really stupid decision was strictly the result. I think this may apply here.

When trying to examine the future and what may happen, the first basic concept is that no one is really directing things. We are developing the software and maintaining the network but long ago, we passed the point where our knowledge of the practices and requirements of the industry was exhausted. We are now working primarily from feedback from members of the network.

We have tried to establish totally open communications and have vowed to be totally and completely honest in our responses, even if those responses put us in a bad light. The open communications we have developed seems to have worked and provides us with constant feedback, suggestions, complaints and ideas. We take these and combine them with our understanding of the possibilities of current technologies and our vision of where we are trying to go and use the mix to develop and enhance the program for those that are actually using it.

We are lucky in that we are in constant communications with many elements of the industries we work in and can combine ideas from quite diverse sources into directions for the program that can benefit everyone.

To make this all work, however, we must bend to the will of the people that are participating in the program. This also means that we don't exactly know where the program will go because we don't get to make that decision.

That being said, we can see some trends and directions that are emerging and these are what we will discuss in this chapter.

This is like exploring a new land in a fog. You more or less know the direction you want to go and you can see about a quarter mile ahead. When you move up a quarter mile you can see another quarter mile.

In this environment you cannot plan your entire trip, you can only plan the next quarter mile. After that you may have to adjust depending on what you find.

With this in mind we can look a quarter mile ahead and perhaps conjecture what might be beyond that but, because it is in a fog, we can only predict the next quarter mile with any certainty.

Let's start with programming. I firmly believe that at some point in the future, actual programming will be a thing of the past. Programming for almost anything will be virtually automatic.

If you have a part you want to program you will show the part to the machine and it will make it for you.

I know this sounds like science fiction, but we are a lot closer to this than you might think. We have been working on ways to do this as we try to develop programs to cut

wood carvings that we then rent. There are some technical hurdles that must be overcome to make this whole process totally automatic, but we believe it can be done with today's technology. Then we must find ways to make this lower in cost. Some day, every CNC router will have the ability to automatically scan a part and create a program to reproduce the part with very little human interface.

If you don't have a sample, it could be possible to just draw the part on a piece of paper, have the machine scan it and then cut it. In this way, parts with complex curves could be programmed quickly and easily.

As far as programming furniture and cabinets using cabinet design software, I see things splitting into two camps. There will be a group, perhaps a large group of power users that use ever more powerful features of the eCabinet Systems design software to create whole libraries of products that others can download and use. This will be further enhanced by professional designers that offer their designs through the professional design program.

The second group, I believe by far the largest group, will use designs that others offer rather than become expert in the use of the design software package. Over time they will learn how to make modifications to these designs but, overall, they will not really program much.

If the design offerings become large enough, virtually anything you might ever want to build could be available for download. It is entirely possible that thousands, even tens of thousands of designs could be available if the program became large enough.

This whole approach relies on an economic driving force. People using the designs will need to purchase through the program to provide compensation to those that are working to develop and offer the designs. If those using the designs comply with the spirit and intentions of this program, everyone will win.

This is where it becomes difficult to guess what will happen. I generally have a fairly positive view of most people and tend to believe they will do what they agree to do. In this case, they are agreeing to purchase the items needed to build a shared design through the eCabinet Systems program. Those that create and post these designs will receive a portion of the profit associated with these purchases.

As this is being written, we are waiting for the next version of the software which will include the ability to track these designs to determine which designs generate orders. In this way we can properly compensate those that develop the design libraries.

We are currently contemplating a small fee to actually download the cabinet libraries, which we will share with the developer of the library. The real goal, however, is to get those using the designs to buy their components through the program and all we have to assure this is their word. We are going to ask those using the shared designs to agree to purchase as much as possible through the program.

This is an area I really can’t predict. If Members don’t purchase through the program we will lose a major benefit of grouping together. On the other hand, if we can become a major outlet for industry suppliers, all members of the

program can enjoy better, more competitive prices for everything they buy. The design sharing program should be a major boost to this because purchasing is not really as voluntary as the rest of the program. To use the design, you must agree to buy as many components needed to build the job as possible through the program. If those using the designs are good to their word, we will all benefit. We don't want this to be too onerous but, if you have a choice, you should buy through eCabinet Systems.

What can we do if someone just simply ignores the agreement to buy? What if they just use the software and the shared designs to build jobs and don't ever buy anything?

Attached to the eCabinet Systems software is a license agreement. Even though we send you a copy of the software and you install and run it, it does not belong to you. It belongs to us. When you sign up for the program we give you a license to use the software for free. This is a valid license and even though it is free, you cannot legally use the software without the license.

We also state that we are under no obligation to provide the software to anybody and that we can refuse to supply or renew a license to anyone that we believe is detrimental to the program. Anyone that blatantly does not follow through with something they specifically agree to do is clearly a determent to the program.

One method of enforcing this agreement is to exclude the offending party from the program. We can't do much about past violations but we can fix it so they cannot continue.

We are both reasonable and rational in our business dealings and if someone is complying with the spirit of this agreement we are satisfied. However, if someone blatantly lies and then makes no attempt to support the program or their fellow members while using their work and experience, they do not belong in the cooperative.

This is especially true because they are agreeing to support the program in return for the convenience of using someone else's designs and experience. If they really don't want to buy from us, they can simply design their own cabinets and nobody has a problem. There is and never will be a requirement to use these shared designs but if you decide you want to use these libraries, there is a requirement to first purchase the designs and then to purchase everything you can through the program to compensate those that developed the design libraries.

It is vital that this cycle of compensation be established because it provides the incentive needed to bring to everyone the creativity and expertise of members that will create and offer product designs.

I believe this can work and it could very well change the flavor and texture of not only our program but also the industry.

One method we use to try to determine weaknesses of our products is to listen carefully to what our competitors are saying about us to prospective customers. Generally, they will zero in on the most serious weakness of your product and product offering and if you listen to them, it provides a guide to the areas you should be trying to improve.

When our program first started, there were a lot of areas where they could do things we could not and they pointed those out enthusiastically. As we addressed more and more of these areas, they found fewer and fewer deficiencies and we began to offer capabilities and features they were not able to duplicate.

At this point, they began focusing on the fact that, although the software was very powerful, it was also complex and took a lot of time to learn. They claimed their software was much easier to use, and in some cases it was.

The reason that some systems are easier to use is that they are based on libraries of cabinets. To use it, you simply accessed the cabinet you wanted, perhaps resized it and use it. These library based systems are easy to use because you really don't have any fundamental design freedom. What you see is what you get.

We wanted all the design freedom we could get and we wanted the ability to design things no one else could. To get that, we need a lot more commands and a lot more features and commands and features make software complex.

At the same time, there are a lot of shops that don't need or want all those features. They simply want to make their cabinets, their way with the lowest level of effort possible. These are valid requirements and we either needed to find a way to accommodate them or abandon that segment of the market.

The approach we decided on is design sharing.

We could have emulated the library software guys and created some standard libraries of cabinets that members could use but then we would run into the same constraints that other have encountered. A single organization can only do so much. They are limited by the number of people they have working on the program.

As people using library software want changes to some of the details of how cabinets are made, they must communicate these changes to the software company. The programmers must then work with the client to incorporate these changes into the software. It is a slow process and if a lot of different shops want a lot of different changes, it tends to bog down.

There must also be some method of paying for these changes. The software company may decide to incorporate these changes to make their software more desirable for future sales. They may also charge each client for specific changes they want. In either case, if the software company is going to stay in business, someone needs to pay for this development.

We can take a different approach because we pay for things in a different manner. We can use the sale of components through the program to provide compensation to members, who are actual cabinet and furniture makers, to design and offer libraries of cabinets to other members.

This is the best of both worlds. If all you need are some library cabinets, there could be numerous libraries of cabinet designs available that were developed by real cabinet and furniture makers, not software code writers. By working at

this high level, the software is easy to use and should satisfy those who want a simple straightforward approach.

With this also comes the ability to modify things if you need to. You no longer need to rely on the software company to make simple changes, you can do them yourself.

This does require that you get a bit more involved with the software, but you can limit this to the specific areas you are interested in, still keeping thing relatively simple. Over time you will learn more and more about the software, getting as involved or remaining as uninvolved as you like.

If this works the way I believe it will, it will change the composition of members of the program dramatically. It should also expand the overall value of the program as the number of people actually creating things that others can use increases well beyond our own limited software development team.

Another area that could cause profound changes to the industry is the concept of CNC program rentals for carving designs.

Today, as this is being written, really smooth integration of carvings into furniture is almost exclusively through major furniture manufacturers. They have the resources to pay for original master carvings and then have them reproduced in quantity for use on their products. In this way they get exactly what they want in the correct overall size that they need.

Everyone else is relegated to using some standard appliqués or posts that are offered for sale to the general industry. In

this case, what you see is what you get. If the size isn't right you either have to figure out how to make it work or do without.

Custom cabinets do not have nearly the volume needed to generate original carvings for their applications and generally need more design freedom than is available from catalog carvings. As a result, few carvings are used in custom kitchen designs beyond carved corbels.

The ability to rent CNC programs and produce elaborate carvings, and even more important the ability to make these in different sizes, could dramatically change all this.

As I write this, the carving program has been established and a minimum starting library of a hundred or so carvings has been added. The core technology that allows carving rental is in place and works. We have several shops that have already begun using these programs and they are successfully carving parts.

We use the CNC control system to monitor this program. Using the control, you can purchase carving credits online with a credit card. The actual CNC carving programs can either be downloaded or you can get them on a CD. These programs are encoded and won't run without the proper credit.

When you begin executing one of these programs, the system checks that you have enough credits to pay for the rental. At some point during execution, your system is charged for the program. We try to make this charge point far enough into the program that any flaws or voids in the stock are apparent. If you stop the program before the

charge point, you can restart it again without any additional fee. Once the charge point has been reached, you need to pay the rental fee again if you want to restart the program.

After all this you might think the rental fees are high. In fact, they are rather low. Carvings from the library are typically a few dollars. Simple parts may be a dollar. More complex parts can be two to five.

Let's look forward and see what the carving program might look like in the future.

First, we can assume that eventually it will become a huge resource. At that time there are thousands upon thousands of carving programs available. These include virtually every type of part from doors and drawers to posts, finials and feet. Every kind of carving from every era for every application is available.

In this world, it becomes easy to add carving details to your custom work. If you want to build an 18th century American kitchen, with a simple search you can list dozens or hundreds of appropriate carvings that you can use. Many of these carvings came directly from us, but many others have been contributed by other members who share in the rental fee.

Here again, we are using a financial incentive to get people to contribute to the overall resources that everyone in the program uses. If this works in design sharing it should also work in carving program rental.

From today's perspective it is difficult to guess what the overall impact of this fundamental change to the current

practices might eventually be. The change might even migrate into traditional furniture manufacturing.

Let's look at creating a new design and building the initial samples. Let's say a furniture manufacturer needs a Queen Ann leg. All Queen Ann legs are pretty much the same with pretty subtle differences, if any at all.

Instead of having yet another Queen Ann leg pattern carved for the new design, they can look through dozens of currently available designs. They can change the length and thickness and play around until they have pretty much what they want.

Rent the program for a few bucks and in a short time they have the legs they need for the sample. Contrast this to potentially weeks waiting for an initial model to be hand made and then even more delay to have it duplicated on a multi-spindle carving machine.

With the new technology, the new design could be built the same day it was conceived and at a tiny fraction of the overall cost. This will likely result in a lot more models and more design diversity.

Perhaps they can't find exactly what they want. There are designs that are close but none is exactly right. Go ahead and grab a design that is pretty close. Execute the roughing pass to get the basic shape you want and then have your master carver finish it off to the exact final result you want. The result is the same as if it were all done by hand but the time required is much less. The cost is much less.

This concept, once there is a reasonable library of programs available, will change the basic economics of the entire process. Whenever basic changes occur, an industry tends to morph to incorporate the new reality into their products and operations.

Again, it is difficult to determine what specifically will happen but, with the wholesale availability of carvings, we can assume that they will become a more common element of custom cabinets and furniture than they have been in the past. Some shops will begin using them and use them as a competitive advantage. Soon, others will be forced to also include them just to compete and eventually they become an accepted part of virtually everyone's product.

Although there is not clear path available today, we can also assume that eventually users will be able to change more than a carvings size. Technology will allow you to combine elements from different carvings into new designs.

We plan to start this process by offering not only complete carvings but also individual design elements from those carvings as separate files. For example, if we have a carving of a flower with leaves, in addition to offering the complete carving we might also offer a file of just the flower and another of just the leaves.

You can then carve just the flower into a part and then perhaps use leaves from another carving and carve those into the same part giving you an entirely new design.

A typical bed post consists of several features. There is a base, then a transition, then a vase, then another transition then a fluted area and finally a finial. We will offer the

entire post as a single program but we will also offer each of the elements as separate programs.
In this way, someone can combine a base from one post with a vase from another and a fluted section from another and create a completely new post. Add to this the ability to change the height and diameter of each of the sections individually and you have an entirely new design tool.

Design flexibility tends to increase diversity. We can reasonably expect more variety, and perhaps substantially more variety in the design of cabinet and furniture once a high level of flexibility is available and it is easy to do. This should release creativity.

This could be especially true of professional designers in the professional design program. Most designers have file cabinet after file cabinet full of designs that they really like, but that may appeal to too small a segment of the market for any high volume furniture company to accept. These designs, some brilliant, are languishing unused today. It is very possible that a profitable outlet for these designs could develop through the professional design program. This would not only release the pent up designs but would also encourage bolder designs and more creativity.

A technical design and support business, separate from the professional design program, will likely develop around this type of capability because design flexibility not only gives you the ability to design truly beautiful products, it also gives you the ability to design truly ugly products.

In this new world, a demand will likely develop for people that can tell the difference between truly pretty and truly ugly. These people may do the work to create new designs

and offer them to individual shops. The design process could be shortened, allowing a single designer to work for dozens or hundreds of shops, creating individual unique offerings that are not posted for everyone else. A whole new category of designer could develop, focused on one-up individual designs using the new technology and custom manufacturing capability.

As I said, when you change the basic economic structure of a business, all kinds of unexpected changes follow.

I believe that in general, modern technology will make everything more diverse and custom. Web sites you visit will be customized for you. Already my TV uses an electronic box to figure out what I like to watch and then runs around hundreds of channels looking for and recording things it thinks I might like. In one sense, my TV is custom made for my viewing preferences.

We will see more and more of this as technology advances and finds its way into more and more of our lives. It is reasonable then to expect that custom made home furnishings could become the norm, rather than the exception. The things small shops do today could become the way everything is done in the future.

This offers an opportunity that could be amazing. I am talking about a fundamental change in the industry. Many industries have undergone fundamental changes and the results have been pretty consistent. When a basic change occurs to an established industry, the current companies that dominate the industry ignore the changes going on all around them until it is too late. They then either fail or become an unimportant part of the newly revitalized

industry. They are replaced by new companies that pioneered the new technology that changed everything. These new companies then become the establishment and prosper until the next big change where they fail and are replaced by even newer companies.

This overall process offers tremendous opportunities for custom shops today. Those woodworkers that are struggling with software and trying to learn to use CNC routers and participating in cooperatives are the pioneers in what could become a major new industry. They could very well be the ones that benefit as technology changes the basic structure.

Because of the way this structure is evolving, I do not believe the new industry will coagulate into a few big companies, as most have in the past. Because the new structure removes much of the disadvantage of being small, I expect that shops will remain smaller and operate more independently than other industries.

Individuals will make as much money personally as if they were part of highly successful large companies, they will just do it on a different scale. They will be part of a big organization, the cooperative network, but they will function more independently with more power over their own fate. They will be part of the Capitalistic Corporation that I talked about earlier.

I would like to believe that they will also be happier and less frustrated than people working for larger companies and being directed by others.

America was built by gutsy, independent people doing their own thing. Over and over again they recognized and seized

emerging opportunities, creating the most successful economy in the history of mankind. I see this kind of basic change happening in our industry. I don't know exactly what the changes will be or exactly what impact they will have but I do see them as an opportunity.

If you are in the custom business, I hope you also see the opportunity and that you are able to seize the opportunity and prosper. What an exciting time!