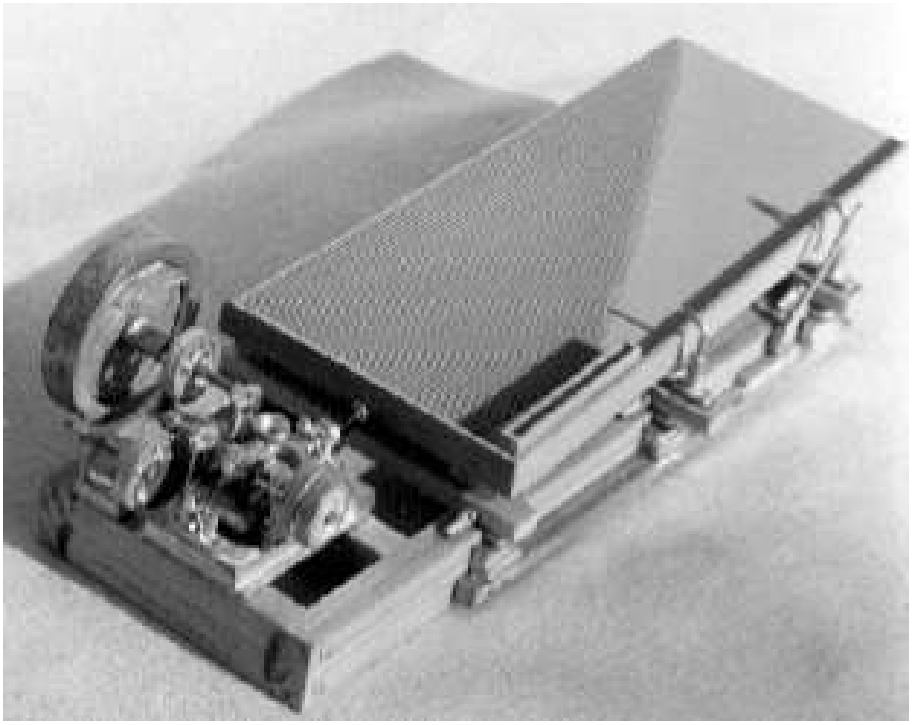
How To Build and Operate
Shaker Tables



Part – III
Table Deck Fabrication

By Gary Weishaupt

Rev 1-5-2010

Deck Fabrication – Part III

Introduction

We briefly covered some aspects of Deck design in Part-II of this series but now we're going to actually build a simple deck system for the prototype table.

We also talked about deck sizes in the previous sections and my personal suggestion for anybody wanting to build a Shaker Table is not to build something that is to small for an economically viable small mining operation. I know that there are several small hobby sized tables on the market that look attractive at first glance but ironically several of these units have rather large carriages that could handle a much larger deck than what is being sold. Sometimes manufacturers build a product aimed at specific markets and for many fabrication outfits the market is huge for products geared towards the week-ender or hobbyist type prospectors. This is an unfortunate situation for the more serious small-scale miners who need commercial quality gear but in smaller sizes yet larger than what would be needed by a typical weekender type operation.

Fortunately several companies of commercial mining equipment also make what are called 'Laboratory sized' tables.

These tables most typically have a deck that measures around 8 square feet of surface area. 24x48-inches is the median but you can also find decks in the 'Lab' range that are 20z60-inches or 30x40-inches depending upon the particular maker. For the first deck on our prototype table we're going to make a working surface that is 24x48-inches only because we can buy pre-cut pieces of plywood in that particular dimension.

I strongly suggest that you don't bother with building a deck that has less than around six square feet of surface area, something roughly around 20x40-inches is about the minimum that can actually be considered a small-production table and even then this is on the lowest end of the scale verging on a hobby type table. There is nothing wrong with small decks but when you get down to this size a Shaker Table become less viable as a fast recovery tool compared to using other methods for separation.

Deck Frame

The deck frame is a pretty simple structure and there are no hard and fast rules for their construction beyond the need to build them as light in weight as possible yet strong enough so that they don't deflect under weight.

Even if you're building a table with a steel chassis the deck and deck frame almost always have to be made from wood in order to keep the weight to a minimum.

For our prototype table we're going to be using 1/2" thick plywood as the deck surface during the development stage. I actually want to use high quality marine grade 3/8" plywood on the final product.

Since we know that our live load on the deck will only be around 10-pounds per square foot (see Part-2) we also know based upon the span tables published by plywood manufacturers that 1/2-inch plywood will span up to 24-inches without deflection under that load. Since we'll eventually be using a thinner top we will be placing the deck frame supports at 16-inches on center.

Figure 1 shows the deck frame construction we're using on this particular table deck.



Figure 1

This is a very rudimentary system consisting of 1x2 stiles and rails laid on the 'flat' with simple butt joints reinforced with joiner 'biscuits'.

The weight of the frame is 3-pounds and the 1/2-inch plywood adds another 11.5 pounds for a total weight of 14.5-pounds. I was hoping to come up with something closer to 10-pounds as the lighter the deck is the faster the table reacts to the impulses imparted by the drive mechanism.

The frame only has to be strong and stiff enough to insure that the deck material remains perfectly flat and this is critical as any warps, waves, hills or valleys in the deck surface make it virtually worthless.

Sometimes it is necessary to build the frame with the structural members set on edge so they have more resistance to bending and on larger decks you might have to build a frame

that has a system of members laid on the flat with additional members laid on edge, which greatly increases stiffness. On very large decks you'll probably have to add steel strong-backs longitudinally to keep the deck surface perfectly level.



Figure 2

Figure 2 illustrates a composite construction system for the frame that has members laid on the flat and reinforced with members set on edge.

Ideally the best decks would be made in a fashion similar to that used for the manufacture of 'hollow-core' doors where there is a lightweight frame with two thin overlays of plywood on each side and the void space is filled with structural rigid foam like the type used in boat-building.

Since this is just a prototype table I didn't go to that extreme and our initial construction system should be more than adequate for this particular application.

The deck and deck frame combination usually comes close to being about 10 to15% of the total table building costs and for this reason many people who have a need for different deck configurations often try to build one frame that they can mount several different deck surfaces to. In my experience this doesn't usually end up being a good idea. I think that in the long run it is better to build a deck surface and deck frame as a single unit that can be interchanged on the suspension frame quickly and easily without the hassle of unscrewing one surface to replace it with another one and then having to reseal all the adjoining edges. For this reason what we'll be showing in the remainder of this section of the article assumes that you'll be building decks and frames that are permanently connected as a composite unit. For small tables like we're building this usually ends up being the cheapest route to follow as well.

With respect to frame construction keep in mind that the suspension frame also provides additional support to the deck assembly on small tables. Figure 3 shows our prototype frame set atop the suspension frame.

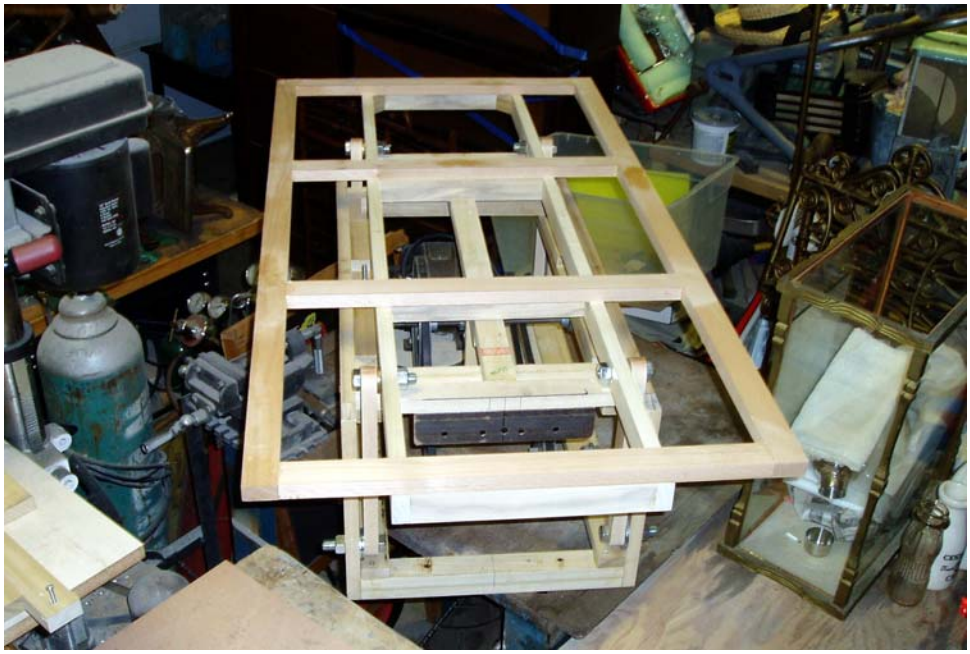


Figure 3

You can see that the longitudinal rails of the suspension frame provide secondary fore and aft support under the intermediate stiles of the deck frame. You can also probably see that I'm running out of room in the garage and starting to compete for space with my wife's areas for her antique repair work operations.

I'd really like to cover all of the bases with respect to small tables like the one we're building but to be honest there is no way I can anticipate what people out there are building so I have to be restricted to the projects I have direct control over for this article. I think most folks can come up with a suitable deck frame without a whole lot of instruction.

Deck Frame Mounts

There are two different ways to mount the Deck Frame to the Suspension Frame depending on whether or not you decide to have the deck slope adjustable at the frame or make changes in slope by adjusting the entire carriage assembly.

On small tables like this one it is much simpler to make changes in the deck slope by adjusting the attitude of the entire carriage assembly by using adjustable 'legs' for the

carriage frame and keeping the deck rigid and perfectly perpendicular to the suspension frame. This is what I personally prefer to do as it keeps things simple.

To mount the deck frame rigidly to the suspension frame you can just cut some brackets from 1.5x1.5x.125-inch aluminum angles, cut to 1.5-inches wide and drill them for some screws. Alternatively you can just go down to the local hardware store and buy some of the cheap steel pre-made angle brackets as shown in Figure 4.

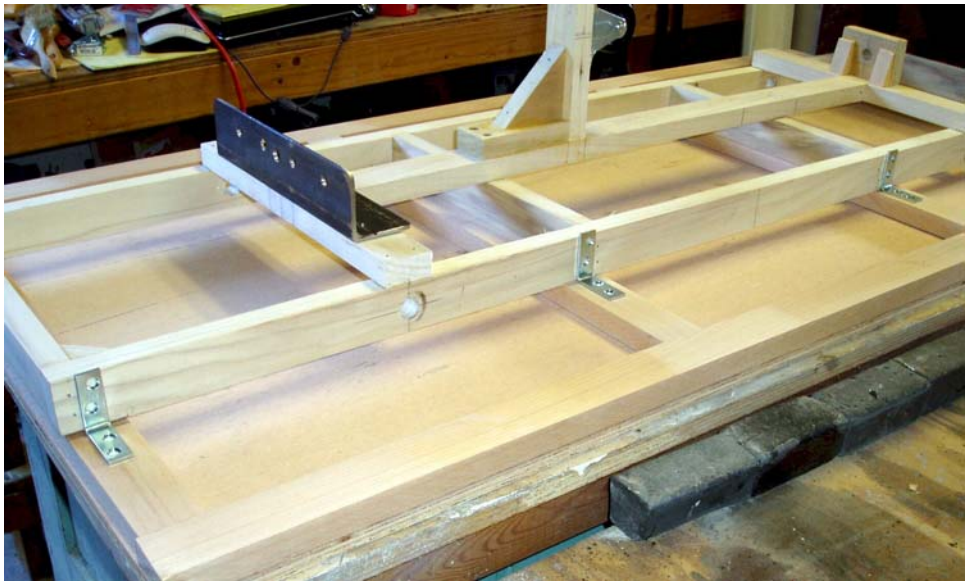


Figure 4

These thin store-bought brackets are not very strong so I recommend that you seriously consider making your own. The object is to tightly anchor the suspension frame to the deck frame at each corner and each intermediate cross member around the perimeter of the frames. If you use thru-bolts instead of screws on the bracket leg that adjoins the deck frame it makes it a lot easier to change decks for different configurations. This is one reason why homemade brackets are a better choice.

If for some reason you decide that the deck slope needs to be adjustable independently of the attitude of the carriage assembly you can add a series of hinges between the deck frame and the suspension frame on the ‘downhill’ side of the frames. Ideally these hinges should be stainless steel or at least galvanized steel but in a pinch you can use the cheap brass hinges sold in most hardware stores. For this table I didn’t want to wait for good stainless hinges ordered online so I bought the usual brass cabinet hinges we’re all familiar with. I don’t recommend that you sue these on a production table as they’ll eventually begin to deform but on a prototype they work quite well.

As with the angle brackets the hinges need to be installed at each corner and on every intermediate cross member between the suspension and deck frames on the downhill side. Figure 5 is s snapshot of the hinges mocked-up between the deck and suspension frames.



Figure 5

It's very easy to get disoriented when you're working with the frames upside down like shown here so double check that you're getting the hinges on the correct side of the frames.

We'll describe how to fabricate the 'slope adjuster bolts' later in this article.

You can always 'hedge your bets' and install hinges on one side of the frame and solid angle brackets on the opposite side so you can switch slope adjustment options at a later time down the road.

Deck Slope Considerations

Shaker Table Decks come in numerous types of configurations and each specific style is designed to be setup within fairly specific slope arrangements. In the following section we'll be using some small diagrams showing various types of deck slopes. The example decks are all based up a deck size of 24x48-inches and the drive (feed) end is always to the right side of the images and the water supply is always along the upper edge of the pictorials. Under the action of the deck movement the material moves form the right hand side of the images towards the left hand, concentrates, end of the deck.

Figure 6 (Deck Style - A1) illustrates a typical Wilfley type deck and you can see the 'elevation' coordinates plotted around the perimeter of the edges.

Note that the dashed lines in these following images represent the 'contour' lines of the tables and are not riffles.

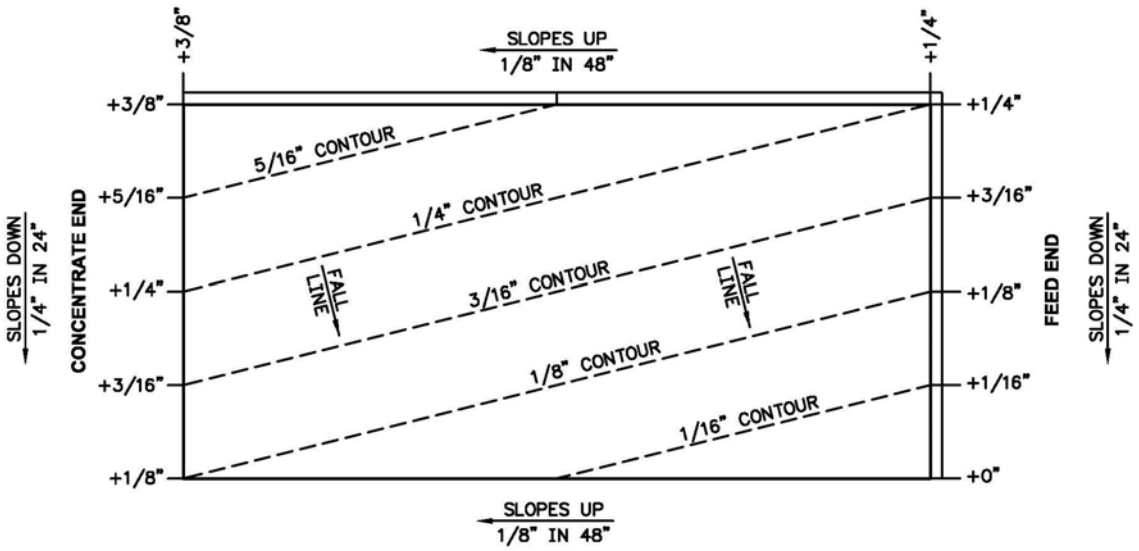


Figure 6 - Deck Style -A1

Note that this table slopes upwards 1/8” at the concentrate side. In other words the discharge end of the table is slightly higher than the feed end. Material is forced to move ‘uphill’ as it migrates down the length of the deck.

There is also a downward 1/4" slope transversely across the deck that the water flow follows. The ‘Fall line” represents the direction of water flow. Note that on these tables the water flow acts slightly against the direction of material flow, which aids in better washing of the slurry.

This deck configuration is extremely effective and works well with almost any riffle arrangement.

Figure 7 (Deck Style–B1) represents a very old form of deck design that has no transverse slope at all but slopes upwards towards the concentrate discharge end 1/8-inch. This style is very similar to that found on modern ‘Wave Tables’.

It is not very popular on general purpose Shaker Tables but it has been included here since they do exist and have certain applications.

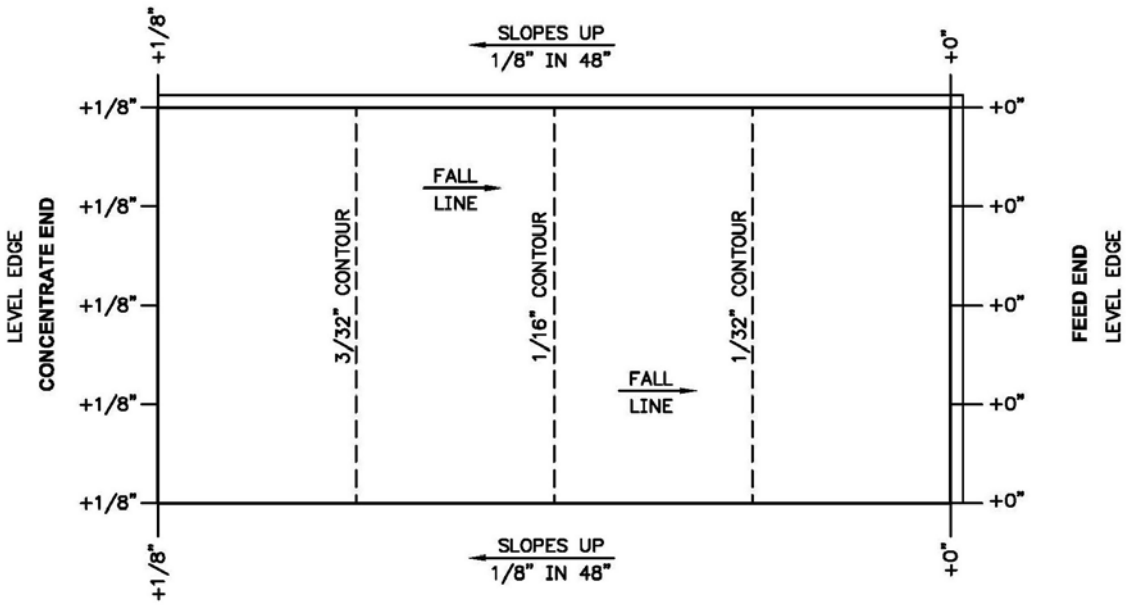


Figure 7 - Deck Style -B1

Figure 8 (Deck Style C-1) depicts a deck that has no longitudinal slope but slopes 1/4-inch only in the transverse direction.

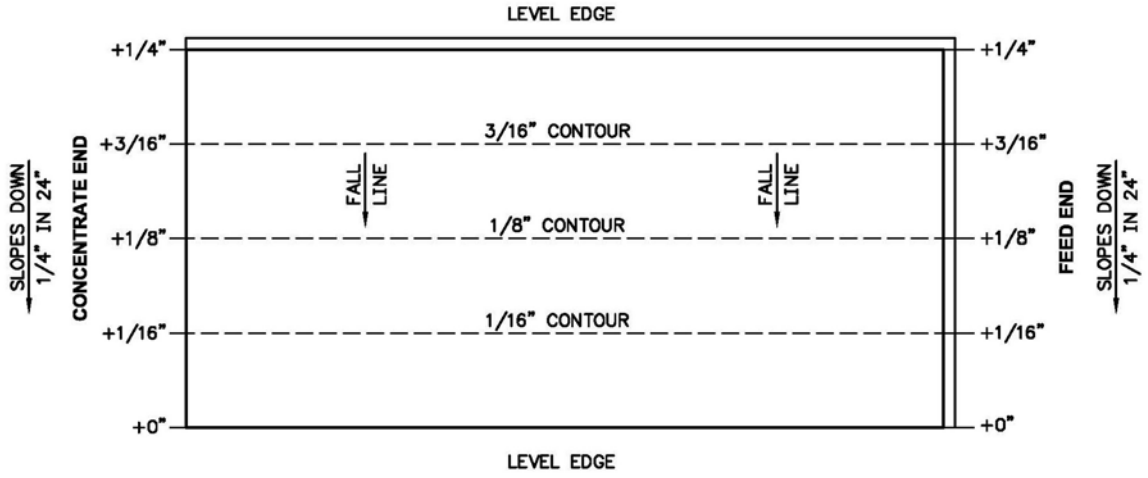


Figure 8 - Deck Style - C1

Figure 9 (Deck Style D1) shows a design where the deck slopes 1/4-inch in the transverse direction and 1/4-inch in the longitudinal direction. This is fairly typical for modern general-purpose decks.

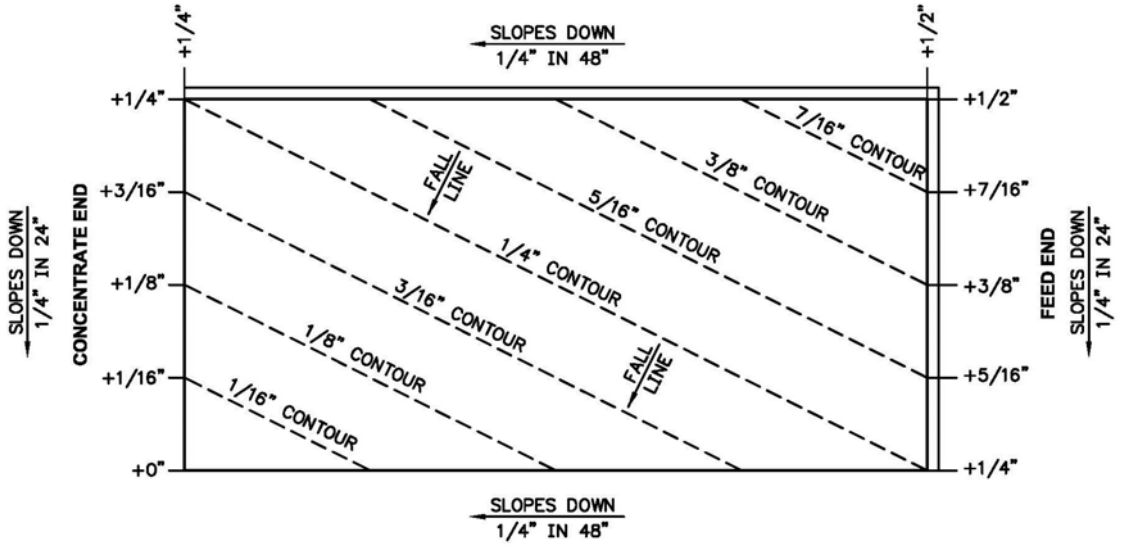


Figure 9 Deck Style - D1

Figure 10 (Deck Style E1) shows a design where the deck slopes 1/4-inch in the transverse direction and 1/8-inch in the longitudinal direction. It is identical to Deck Style D1 except the amount of slope in the long direction has been reduced.

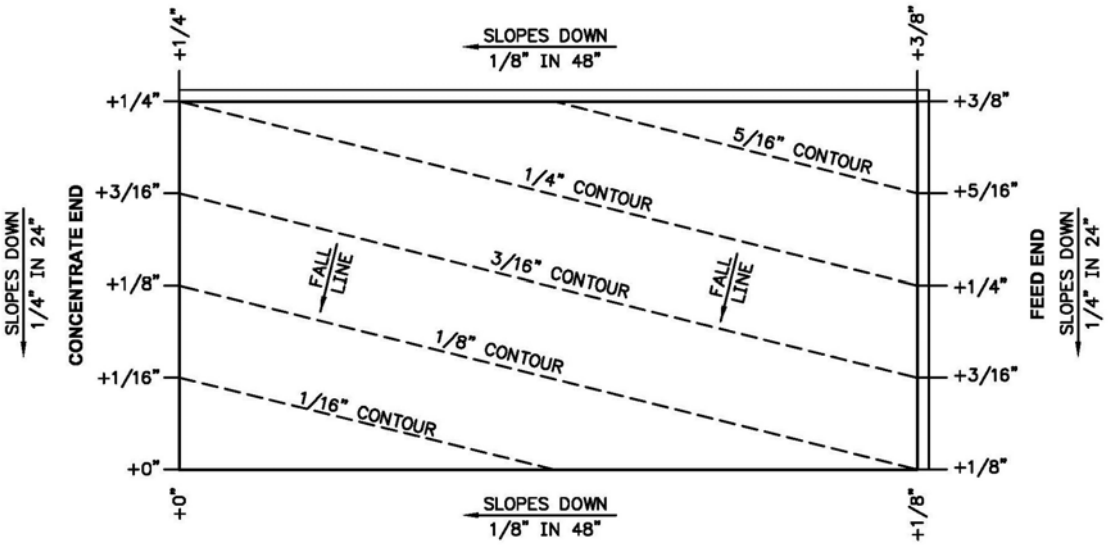


Figure 10 Deck Style - E1

Note the difference in the attitude of the contour lines and the orientation of the Fall Lines between Style D1 and E1.

As mentioned earlier I think that it is a better idea to simply ‘cant’ or ‘skew’ the entire carriage on small tables. Installing standard hardware store ‘adjustable’ leveler legs on the carriage is all that is need to change the table slope. Usually you only need to adjust 3

of the levelers to achieve the proper fall amount and slope direction to get efficient separation.

Hinged decks do have the advantage in that you can gain easy access to the drive mechanism just by lifting the deck that might be a consideration you want to look at.

Riffle Systems

There are two schools of thought about riffle systems on Shaker Tables. One school holds that ‘raised’ riffles perform best while another body holds that incised or ‘routed’ riffles perform better. In reality both types of riffles perform almost identically in the real world in side-by-side deck tests but recessed riffles do seem to have some slight advantage over raised riffles in the recovery of extremely fine gold in some circumstances. It’s up to the builder to decide which way they want to go.

A lot of people are very surprised to find out that many Shaker Tables designed for the recovery of ‘Fine’ gold actually don’t use any riffles to begin with and operate more like a large Miller Table with a perfectly smooth surface. It’s amazing how effective a deck can be without riffles so I strongly suggest that as you’re building your table you start out with a smooth deck system until you get a feel for the characteristics of your particular table.

The use of riffles only becomes important when you’re trying to separate particles that are consistently larger than around 50-mesh in size.

Fine gold recovery tables are referred to in the trade as ‘Slime’ tables and they are designed and set up differently than general purpose tables and as mentioned they generally don’t have riffles but in some circumstances, depending upon the characteristics of the slurry, they can be fitted with a riffle set that is relatively widely spaced and very shallow with tapered ends and sometimes even tapered in cross-section.

If you start out by building a smooth deck to begin with you’re going to have the opportunity to observe first hand how and why these tables operate so successfully.

A Shaker Table functions by separating materials by weight. You can run a table dry and it will still segregate particles based upon their weights but once you add water the segregation becomes significantly more effective.

When you add materials to the table deck that material is acted upon by a fore and aft impulse provided by the drive mechanism. Under these impulses heavier materials will begin to separate from lighter particles and particles will begin to form ‘lines’ or ‘bands’ according to their individual particle weights that you can see on the deck surface. These bands will migrate down the deck and eventually fall off the end of the table.

This is exactly how the earliest tables operated. Some guy sat at the end of the table holding a trough to collect the 'good' stuff and then rapidly moved it away to let the 'bad' stuff fall on the ground until the next band of 'good' stuff came down the line.

Slightly later in time some engineer observed that if he slightly elevated the end of the table the heavy 'good' material would just tend to bunch up and accumulate into a thick ribbon along the end edge. This is the principal still used today in what are called 'Water Tables' but those are another design concept we'll talk about later.

With respect to Shaker Tables, when you add another opposing force acting upon these particles the 'lines' or 'bands' will begin to orient them selves diagonally on the surface. On a Shaker Table this opposing force is a relative thin film of flowing water that runs perpendicular to the drive impulse direction. The reason this directionality is important is because it allows us to pick and choose where we want to 'collect' the runoff of materials as they fall off the end or edge of the table deck. Rittinger came up with this revolutionary concept that forever changed the way gravity concentration devices were built.

With this method we no longer needed a full time operator sitting at the end of the table deck as the material will always fall off the deck surface at a specific location and we can just put a bucket under that location.

By slightly changing the slope of the table in both longitudinal and transverse directions we can change the place on the table where separation occurs and also where those separated materials finally drop off the table surface.

Riffles added to a deck top, whether raised or recessed, behave much like riffles in a stream sluice and allow heavier particles to become consolidated next to the edge of the riffle while lighter particles are washed away by water flow. In addition lighter particles lodged behind the riffles are lifted out of position and replaced by heavier particles that work their way below the light materials. A large part of table function relies on this 'replacement' principal and this is a critical aspect in deck riffle designs.

Figure 11 illustrates just a few of the more common types of riffles shown in sectional view. There are numerous permutations and combinations that a person can try. I have seen decks that incorporate both raised and recessed riffles in a single table and decks that look like a section of shiplap siding. Every experienced table operator will have their own unique favorite riffle style and this, perhaps more than anything else, tells a story about Shaker Tables and that is that 'experience' in their use is one of the most important Factors.

These devices are not at all a 'canned' solution to material separation and there is a significant uphill learning curve a person needs to be aware of in order to get the maximum benefit from any particular equipment setup.

Getting a table ‘tuned in’ to a particular run of material takes experience but even the most rudimentary table can be extremely effective in the hands of a skilled operator so with respect to tables in general it is usually necessary to spend the time in learning how to use them properly.

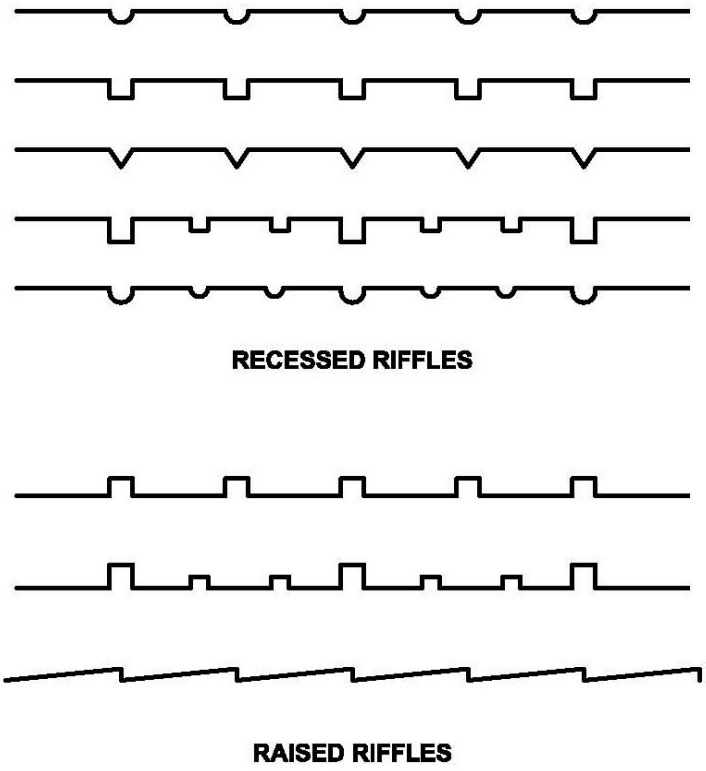


Figure 11

As mentioned earlier these riffles designs are just a few of the various styles and types that you’re likely to run across when you’re investigating Shaker Tables. The cross-sections shown here are the most common.

What can’t be seen in these cross sections however is that all of these riffles typically taper in height or depth from the feed end of the table to the concentrate end of the table. You can taper raised riffles fairly easily just by using a long home made sanding block fitted with course grit paper but getting a taper on recessed riffles requires that you build a special fixture for your router.

Most modern tables are designed to be setup with only a single slope and this is always transverse (across the short dimension of the deck) as see in Figure C1 above and these decks are typically equipped with one of two different riffle patterns as seen in Figure 12 that follows.

The pattern in the lower part of the diagram shows the riffles running parallel to the long dimension of the deck. This pattern is usually better suited for fine gold recovery regardless of how the deck is sloped.

The pattern in the upper part of the diagram shows the riffles set at an angle relative to the table edge. Using these ‘canted’ riffles causes the material captured in the riffles to climb uphill as they move down the table.

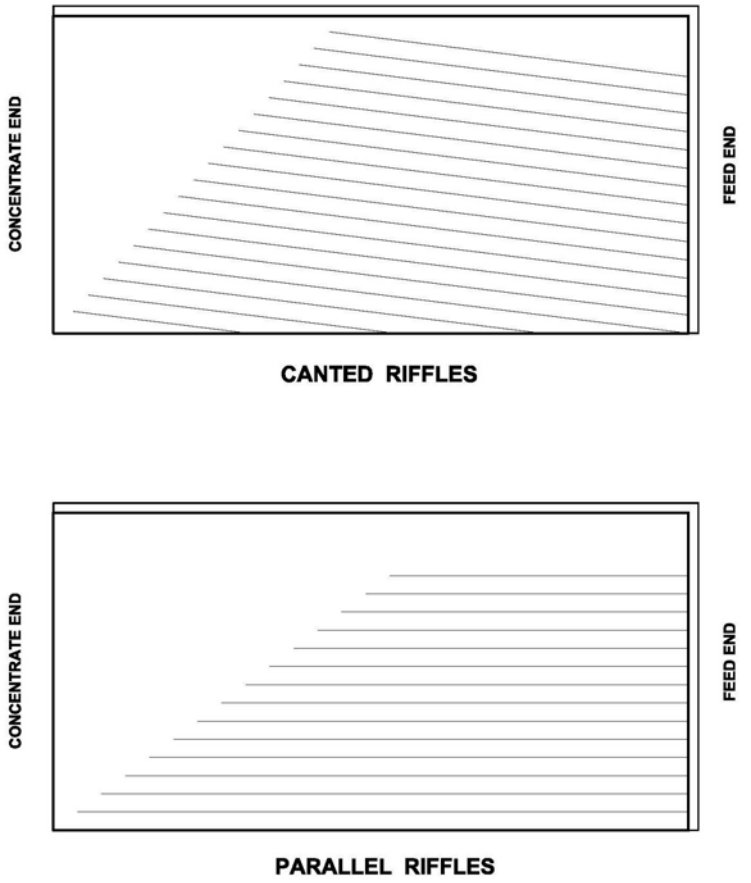


Figure 12

At first glance it may seem hard to understand how canting the riffles in effect changes the transverse downhill slope of the deck but it does and it does so very effectively without having to change the longitudinal slope of the table.

In general decks designed for processing fine materials use either parallel riffles or riffles that have a very shallow cant angle relative to the long edge of the table. As the size of particles to be processed increases the cant angle is typically made steeper and it is not uncommon to see decks that have the riffles running almost diagonally in order to handle course particle slurry like 16-mesh material.

Keep in mind however than you can still process almost any kind of material on a deck using parallel riffles just by changing the slope characteristics of the deck frame so canted riffles are not a requirement needed to improve separation effectiveness, they are just a convenience.

Figure 13 illustrates how canted riffles, in effect, cause the materials caught behind the riffles to climb ‘uphill’ even against the normal slope of the table deck. The deck in this illustration slopes 1/4-inch in the transverse direction and has no slope in the longitudinal direction. The dashed lines represent the deck ‘contour’ lines and the gray lines represent a set of canted riffles. In this case the angle of the riffles is 7-degrees relative to the lower edge of the table.

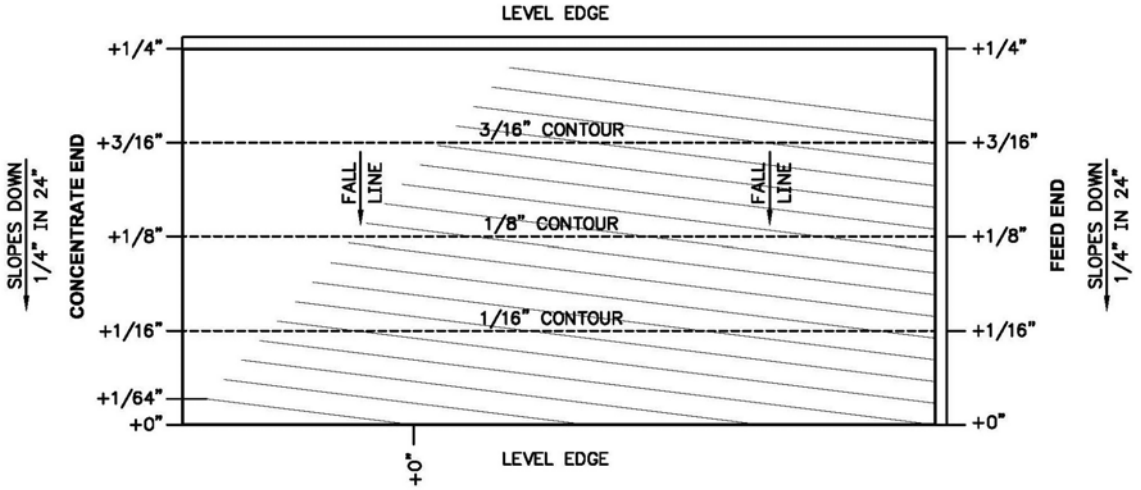


Figure 13

If you look closely at the lowermost riffle I have added two ‘elevation’ measurements at each end of the riffle. One shows the start of the riffle at elevation ‘0-inches’ but as you continue along the riffle you’ll see that at the ‘outfall’ end the elevation is 1/64 of an inch even though the deck is perfectly level longitudinally.

Canted riffles work extremely well on larger particles since the bigger a particle is the more it reacts to the energy imparted by the bumping impulse supplied by the drive mechanism. Smaller particle are not affected as much by the transfer of this kinetic energy and need to be moved along more by gravity and the force of the water flow so as the heavy materials in the slurry become smaller in physical particle size the shallower riffle slopes become more important.

If you want to use a set of canted riffles on your deck the 7-degree slope is a good place to start if you’re processing a variety of different material sizes.

Deck Slope Adjusters

If you do insist on having a hinged table deck one of the quickest and easiest ways to make adjusters is to use what are called ‘hanger screws’ or sometimes ‘headless dowel screws’. These screws have a wood thread on one end and a machine screw thread on the

other end. For projects where you're using wood and metal parts in a composite manner they can't be beat for versatility. These screws come a huge variety of lengths, different diameters and different thread configurations and most good hardware stores carry at least the more common lengths.

Figure 12 shows the screws I picked up to illustrate the adjusters and these are threaded 5/16-18 on the machine end and for #14 wood screw thread on the other end.



Figure 14

Figure 13 shows how these screws are set into spacer blocks added to the deck frame. The machine thread portion of the screws protrudes into an oversized hole bored in a small bracket from angle iron (or aluminum).

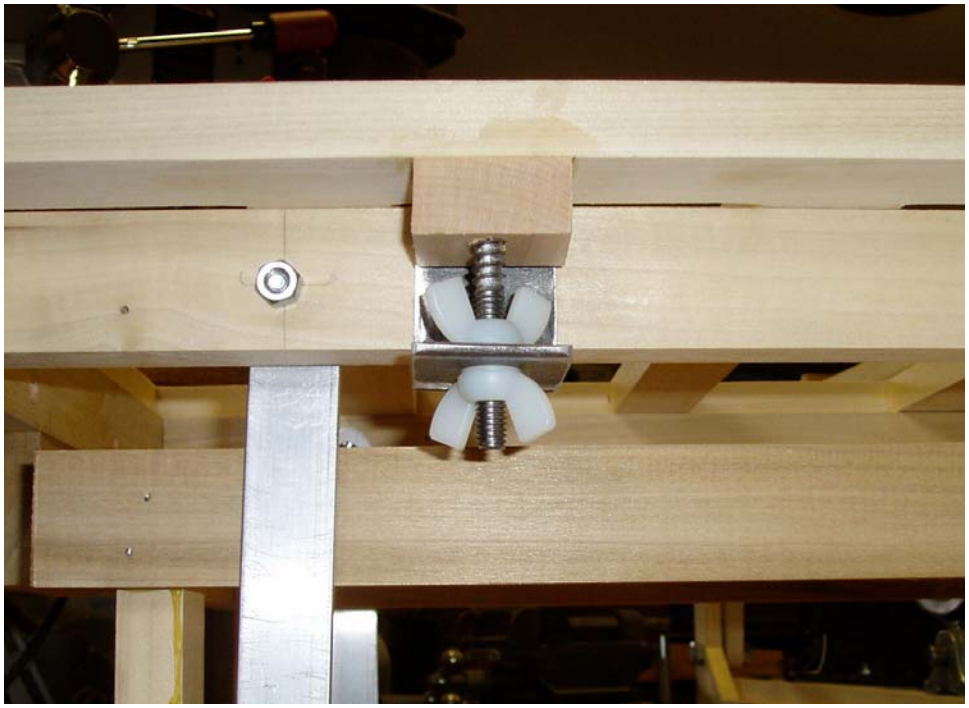


Figure 15

You need one of these brackets at each end and also spaced about 24-inches apart along the edge of the deck frame. I like using the nylon wing nuts as they don't loosen from vibration and they make it very easy to change the slope of the deck.

Figure 14 illustrates one of the adjusters screwed all the way up which gives the deck about 1/2-inch of cross slope which is the maximum you'd ever need even on a large table.



Figure 16

You can build adjusters that are a lot more sophisticated than these but for a small budget type project these work extremely well and are easy to make.

At this point we're going to jump ahead a little and talk about finishing since in order to do a proper job on the riffles you really need to have the deck sealed and smoothed before you add the riffles. It's almost impossible to get a good deck surface after the riffles have been added even if your routing in recessed riffles.

Deck Preparation and Waterproofing

This is worse part of building a Shaker Table and it takes the most time to do properly and is especially hard to do during the colder months of the year but it's absolutely critically important and taking shortcuts here are not something to consider.

Even if your using some kind of HDPE plastic overlay on your deck the substrate still has to be made waterproof. In fact every single component of the table has to be waterproofed so this is a good time to remove all of the hardware from the carriage and set all of the wood parts out to get a base coat of penetrating sealer and at least two topcoats of finish material.

Needless to say the sealers and topcoats you intend to use need to be truly water proof and not just water resistant.

Here in California most of the old traditional materials are now illegal so we've got to use the new water-based low VOC products and most of these are fairly worthless in my personal opinion but Min-Wax makes a new product they call 'Wipe-On Poly' that is actually pretty remarkable if you use it as a sealer and not as a topcoat.

This polyurethane is extremely thin; almost the viscosity of water, and it easily soaks deeply into wood. It doesn't dry to fast, which is the down side to the product. You're supposed to wipe it on but I usually pour it onto the surface and then spread it around with a brush and wait awhile until most is absorbed and then wipe the surface with a rag. It actually does penetrate very deeply and if you look at the edge of a piece of wood you can see the material moving down into the grain by at least 1/16 of an inch which is really very good for a sealer.

Three coats of this stuff is usually enough for the frame parts but the deck surface will typically need around four coats before it's ready to be sanded and filled.

You don't need to fill the frame parts since they don't have to be smooth so after the initial sealer has finally dried you can just add a few coats of spray clear coat or paint topcoat on the structural members. The deck needs a lot more work before it's finished since it has to be smooth so we need to add wood grain filler.

The best grain filler comes from Brownell's Gunsmith supply but most good carpentry supply outfits sell high quality fillers online. The object of using the filler is to make the deck surface perfectly smooth with no grain showing. Basically we're trying to create an almost glass-like surface from a porous and irregular wood surface. If you've made your own Miller Table from a piece of plywood you already know what a chore this can be.

Grain fillers are just a relatively thin 'mud' made from microscopic particles of pumice, chalk, talc, clays and a variety of solvents to promote drying. Lots of fine sawdust mixed with linseed or tung oil makes a very good home made filler.

Trying to properly fill a big 2 by 4-foot piece of plywood all in a single step is next to impossible so the best method is to divide the deck surface up into an imaginary 8x8-inch grid and work in only a single grid cell until the grain in that cell is completely filled then more into the next grid and repeat the process. Filling is an iterative process where you fill, sand, fill, sand, fill and then sand some more. The number of 'layers' needed to completely fill the pores and grain of the wood depends upon how 'open' the grain is on the piece of wood you're using for the project.

You can do some online research to get step by step instructions on how to apply the filler but remember that when sanding a filled surface it is best not to use an electric sander as they create to much heat from friction so hand-sanding is the best route. Also sand across the direction of the grain and not parallel to it as we've all been taught in the past. Use a relatively fine grit paper and only sand deep enough to just barely break through the surface of the uppermost layer of finish.

Once the surface is completely filled and sanded smooth I typically add three or four more coats of polyurethane as a working topcoat. Sand the last coat with 320-grit paper until it takes on a dull sheen. I call this layer of finish a ‘work’ coat because we’ll still be adding raised riffles or routing-in recessed riffles after we’ve built up and prepared a good deck surface.

Keep in mind that running slurry down a table is akin to basically ‘sanding’ the deck surface with fine pumice every time it’s operated. For this reason many people prefer to use one of the spray-on two-part epoxy type finishes for the final few work coats. For a production table I think this is a good idea but for something that’ll only be used seasonally for a few years the urethane holds up well and is easy to refurbish if needed.

Now we’re ready to make some riffles.

This is the point where most Shaker Table projects get abandoned since building the final riffled deck takes a lot of time and detail work most people aren’t willing to contend with. This is why I kind of get a chuckle from web site forum posts where people are asking for Table Plans since I know that most people don’t really have the fortitude to actually build a table from start to finish no matter how easy engineers try to make things. A Shaker Table is actually not a very complicated device compared to most mining equipment and almost anybody with a rudimentary set of tools can put one together in relatively short order if they stick with it. From start to finish I’ve got less than 100 hours into this particular project and a lot of that time was simply waiting around for glue to cure or finishes to dry.

How Riffles Work

Riffles on tables, whether they are raised or recessed are part of the ‘cleaning’ system and work in conjunction with the sheet of flowing wash water to move light weight materials away from the heavier materials that accumulate behind (or inside) the riffles. They behave exactly the same as expanded metal mesh behaves in a stream sluice or high-banker.

Unlike riffles in a sluice however shaker table riffles also are used as material conveyors that permit heavy particles to follow the path of the riffle down the length of the table to their eventual discharge point.

All of the ‘flat’ spaces on the table surface are referred to as ‘cleaning planes’ including the flat spaces between riffles. It is on these cleaning planes that the actual stratification and separation of the particles occur. The ‘flat’ space in the immediate area of the concentrate feeder, even though it is technically part of the cleaning plane, is called the ‘roughing plane’ since in this area the initial stratification and separation begins to occur.

All of the separation and concentration occurs in these planes and in general tables need a relatively wide spacing of the riffles in proportion to their height so there is adequate flat

areas for the cleaning to take place. A ratio of plane area width to riffle height (or recessed depth) is typically 6:1.

Figure 17 illustrates the basic table configuration and shows the division of particles as they move down the deck trapped by the riffle system. The dashed lines represent the 'zones' where particles of different specify gravity tend to become segregated.

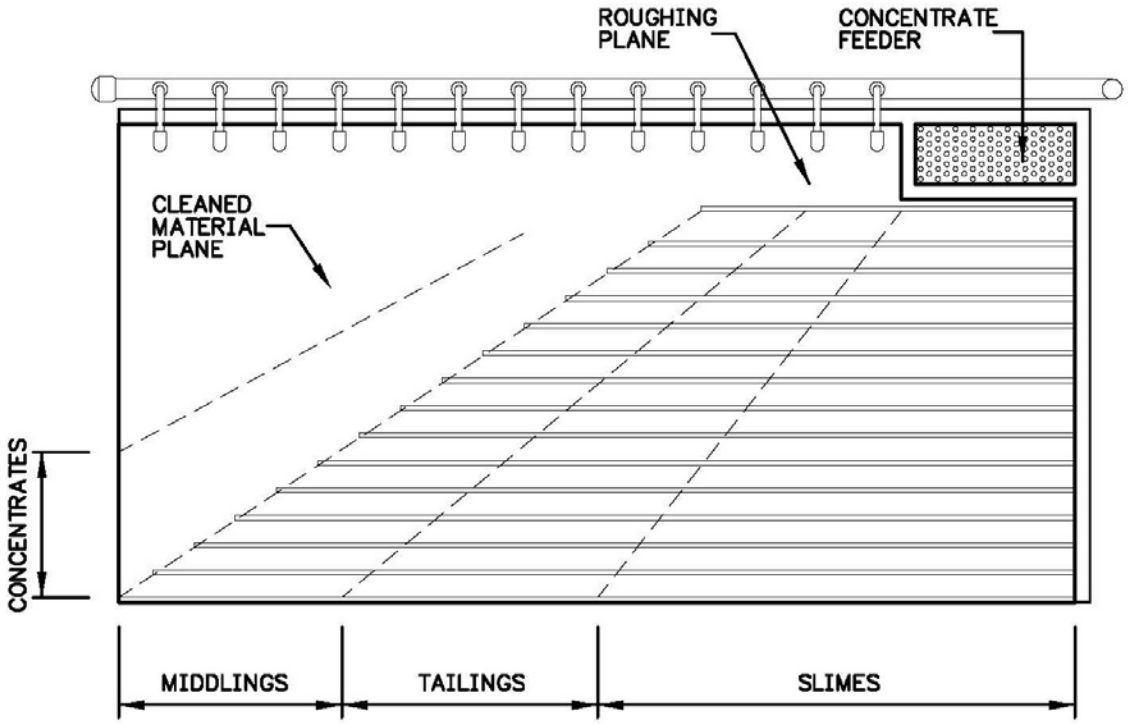


Figure 17

Partitioned collection troughs, called Launders, are placed along the discharge end and edge of the table to capture the runoff.

What can't be seen in a diagram like this the process of 'replacement' that was mentioned earlier. This replacement process is one of the critical aspects of tables that separate them from other types of concentration devices. Heavy particles tend to settle in behind a riffle and displace the lighter particles that are then lifted higher and swept away by the water sheet. As a result each riffle in effect acts like a small 'enrichment' zone. This process is extremely hard to describe in words but you'll immediately understand what is happening the first time you run a batch of material on your own prototype table.

The downside to this process is that tables really do need a relatively rich mixture of heavy materials in proportion to light materials in order to function properly. Some experts put the minimum range of heavy to light particles at a 20% ratio while others estimate that a properly setup table can perform well with slurry having only a 10% ratio

so the real minimum mixture is probably somewhere in between these two values. A table will function however running a slurry with as little as a 0.5% ratio but it will not be as effective as other devices.

Raised vs. Recessed Riffles

Earlier I noted that it is generally assumed that recessed types of riffles perform better than raised riffles with respect to the concentration of fine heavy materials, hence 'fine gold', but table design experts are far from agreeing to this finding. In fact most of the claims for the superiority of recessed riffles come from small manufacturers and not the larger table makers. Any time I see the words 'new', 'improved', 'superior' or especially, 'computer simulated', with respect to riffle designs I get suspicious.

The terms 'new or improved' usually mean 'easier and cheaper' to manufacturer rather than meaning that the so-called 'new and improved' design actually performs any better than the 'old' design. This is especially true of riffle designs. There has been a trend towards recessed riffles only because they are cheap and easy for the smaller manufacturers to build compared to raised riffles.

I can cut-in 15 tapered recessed riffles with the router in less than five minutes but it takes about 4 hours to build and install 15 tapered raised riffles. Which set is 'better' depends on how you are 'measuring' performance in comparison to cost-effectiveness from a manufacturing standpoint.

I do have to admit however that there does seem to be a certain range within which recessed riffles perform better but this range appears to be for concentrating particles in the 50 to 80-mesh spectrum for some reason. Outside of this range raised riffles perform more consistently and based upon my personal experience raised riffles perform better over a broader spectrum of feed material characteristics.

There is an old two part saying in the industry that goes: "Never let the equipment dictate the process". And then "Always let the material dictate the equipment".

This is especially true for tables where we need to have various decks that are custom made to suit the material being processed.

This is easy to do with table decks but almost impossible to do with other kinds of concentration equipment which is why tables are still so popular today even though Shaker Table technology is over a hundred and fifty years old.

If you look at equipment from a cost-effectiveness standpoint Shaker Tables almost always come out on top since even a fancy manufactured unit is generally significantly less expensive than other concentration hardware such as jigs, centrifuges, spiral concentrators, water tables and similar gear. This is the primary reason most small to

medium operations usually start with a table until they start making some money to expand their operations with other types of concentration equipment.

Building your own Shaker Table is usually the most cost effective way that most small-time operations are able to become profitable enough to move into a larger scale of operations without breaking the bank account.

Raised Riffle Fabrication

Earlier I mentioned that it is a good idea to build and use a deck that didn't have any riffles at all. If you did this then you now have a very good understanding of how particles behave as they move down a deck surface and are cleaned by the action of the wash water film. Even if you only made a few runs of material on a smooth deck you've gained a tremendous amount of knowledge about how various deck slopes affect the behavior of the slurry.

The next step is to build some raised riffles to add to your existing deck. The reason I recommend raised riffles in lieu of recessed (routed) riffles is because raised riffles actually do perform better when a person is running a wide variety of different sizes and types of concentrates. They are much harder and more difficult to make and install than recessed riffles but unless you already have a lot of table experience they will deliver the biggest bang for the buck on a home-built deck.

For most small decks, up to around 10 square feet in area 1/4x1/4-inch riffles are the typical size. In many cases these riffles are not tapered but I strongly suggest that you use tapered riffles on any deck.

You can buy pre-cut wood riffle material in this size from a variety of online and local sources if you look for 'hobby supplies'. Almost any Hobby Shop will carry an inventory of square dowels used for model building. Most of the time these dowels will be 'Basswood' or 'Balsa' wood.

Don't even begin to consider Balsa wood for riffles. Basswood however is a fairly nice material to work with since it has a 'neutral' type of grain and is easily worked and reasonably strong and dense. If at all possible try to obtain your 1/4-inch square dowels made from 'Poplar'. This material is less commonly available and harder to find but excellent for riffle stock. Sometimes you can find hardwood square dowels at antique furniture restoration supply houses in Maple or Cherry wood.

Figure 18 shows three different square dowels. The one on the left is Balsa wood, the one in the middle is Poplar and the one on the right is Basswood. All of these were available at our local Hobby shop. We bought the Poplar and Basswood for this project.

If you have a table saw you might consider ripping your own sections from 'Port Orford Cedar' as this is the ultimate riffle material for a wood deck.



Figure 18

One problem with commercially available square dowels is that they are seldom available in anything much longer than 36-inches and most stores only stock 24-inch lengths so we need to join together these short sections in order to make the longer riffles needed on most medium sized decks.

The way to make longer riffles is to join two short sections using a ‘scarf joint’. Most of the wood workers reading this are already very familiar with this procedure.

The objective is to create a very long angular cut in both pieces to be joined so as to have the maximum amount of surface area in the joint for gluing. This creates a very strong joint as opposed to simply butting the two pieces of wood together.

If you want to make the joint stronger you can drill the ends of the pieces to be connected prior to making the scarf cut and then after the cut is made you can insert a small section cut from wood toothpicks to form a type of ‘mini-dowel’ but this usually isn’t necessary if you’re using a good quality adhesive.

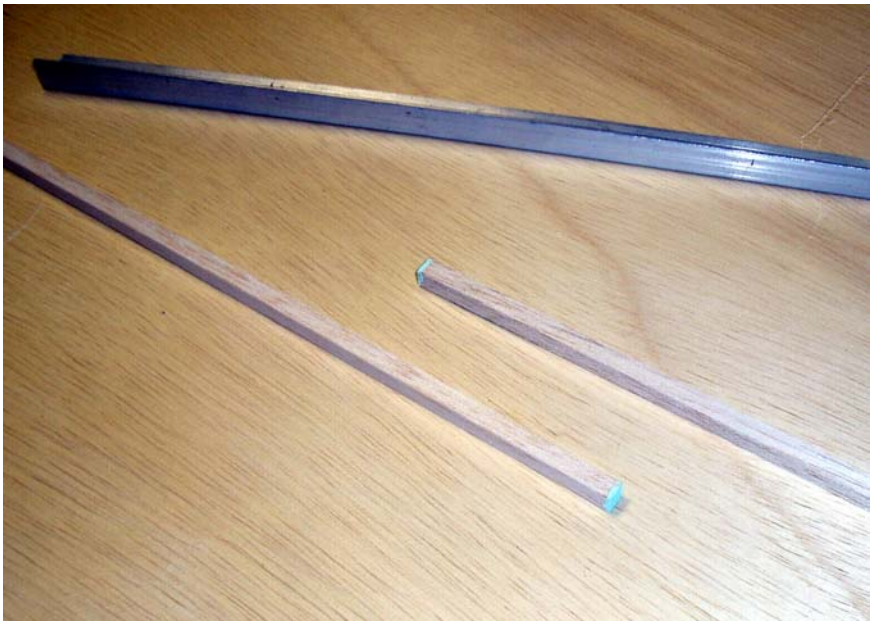


Figure 19

Figure 19 shows the two short pieces of wood that we want to join in order to have a longer piece of material for a typical riffle. The piece of aluminum angle in the background we'll be using as a straightedge in order to make a nice straight cut in the wood.

To make a good joint you need to make an angled cut that is about four times as long as the thickness of the material to be joined.

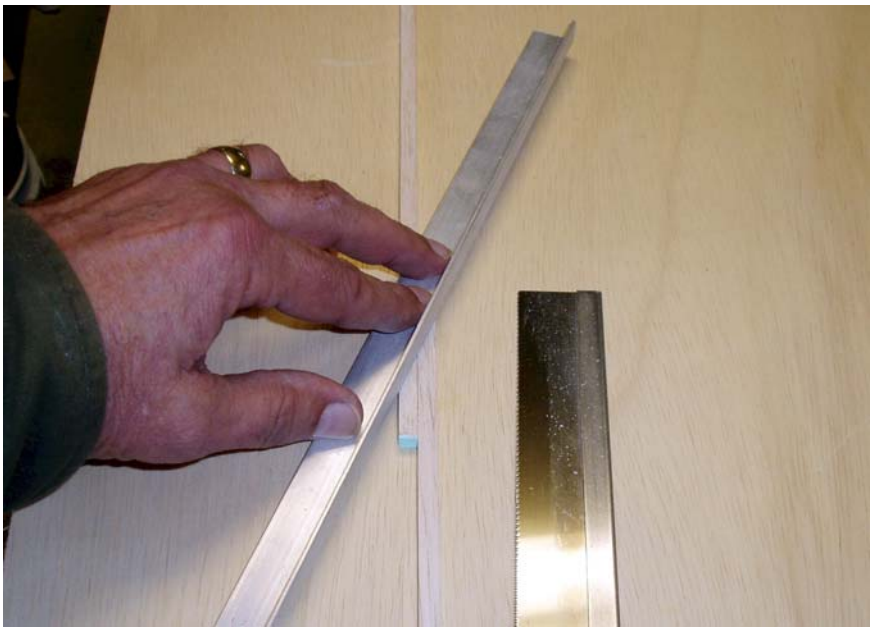


Figure 20

Figure 21 shows the results of that type of cut.



Figure 21

Join the two pieces together using a good waterproof glue and if necessary add some long pieces of blocking behind the clamps to insure that the two sections are aligned both longitudinally and transversely until the glue cures.



Figure 22

The joint as shown in Figure 22 becomes almost invisible and in most cases if good glue is used the connection is actually stronger than the native sections of the wood that was joined.

The best performing raised riffles are tapered in height from the feed end of the table to the concentrate end of the deck. Using raised riffles that are tapered in height increases table effectiveness by about 50% compared to using un-tapered riffles and in most cases tapered raised riffles perform about on par with recessed riffles with respect to ultra-fine gold recovery so I urge the reader to spend the extra time tapering their riffle system.

Making tapered rifles isn't hard but it is time consuming if you do the job right. I normally start out by using a small block plane to make the first rough cuts along the length of the riffle.

The taper doesn't need to be mathematically precise as this is far from being rocket science and almost any taper that is reasonably consistent and uniform is more than adequate.

After making the initial taper with the plane I switch over to using a sanding block to make the final long sweeps to leave a nice long smooth taper to the stick of wood.

I usually leave at least 1/32-inch of thickness at the end of any riffle since as the deck is refinished over time this end will eventually get sanded to a feather edge.



Figure 23

Figure 23 illustrates a typical tapered riffle prior to installation on the deck and note that the end has not been tapered down to a featheredge. The riffle shown here is sitting on it's side but its rolled over when it's installed so don't get confused. The taper is always in the height of the riffle and not its width.

In the 'old days' the riffles were attached to the deck with small brads or screws but today it's common to just glue them in place since it's actually cheaper and more cost effective to build a completely new deck from scratch than to refurbish an existing worn-out deck by just replacing the riffles. You can install them any way that suits your particular requirements.

If you're going to be installing the riffles on the deck with glue I suggest that you line up all of the riffles on a piece of cardboard and give them a heavy coating of urethane on the top and side surfaces. Keep the bottom clear of any finish so that the glue can bond directly into the grain of the wood.

If you'll be attaching the riffles with brads or screws then all four sides need to be completely sealed with whatever finish product you're using.

Prior to installing the riffles I usually attach the deck to the deck frame by using screws set-in from the under-side of the frame as shown in Figure 23.



Figure 24

I use number 8 screws spaced about 6-inches on center to attach the deck. Once it is initially secured it's a good idea to flip the assembly right side up and check to see that the surface is perfectly flat by using a steel or aluminum straightedge on the surface. Since the plywood it relatively flexible you can shim the low spots with thin strips of aluminum sheeting and if you have some high spots you can sand down the offending areas on the deck frame. It should go without saying that the objective is to have a deck surface that's as flat as a pool table top. Better quality marine grade plywood is usually as flat as a pancake and shouldn't cause you any problems. The deck we built for this prototype cost $8 and was about as bad as any that you'll likely run into but even then it did not require any major work to get a good flat surface.

When building a deck I usually set aside a small scrap of plywood that I use to check my finish materials on to be sure that the products I'm using are compatible with one another. I'll use this same test piece to make sure that the adhesive I plan on using to attach the riffles will form a good solid bond. Attach a small section of your proposed riffle material on the test piece and let it dry overnight. If all goes well you shouldn't be able to remove the strip of riffle unless you give it a pretty good tap with a hammer. If it breaks away just under some yanking with your fingers then you'll need to use brads along with the glue to get a good bond with the deck.

I used Weldwood 'TiteBond II' for this deck and in my tests the small test riffle actually broke and sheared in half leaving behind it's lower few grains of wood still bonded to the deck surface so with the particular combination of urethane finish I used it was very compatible with the adhesive.

Once all of the riffles have been tapered they can be installed on the deck surface either with adhesive or brads.

I've found that this process is fairly easy if you have access to a long straightedge to use as a guide for installing your longest riffle first. I use an aluminum straightedge from a 'drywall' square. Once you have that first riffle in place the rest are easy to install and keep properly aligned.



Figure 25

Figure 25 shows our deck with the first two longest riffles being installed while Figure 26 is a closer view of what we're doing.



Figure 26

You can see my straightedges on the deck in the background and two pieces of 1.5-inch wide maple that I'm using as spacers put between the riffles as they are glued down. To hold the riffles down onto the deck surface I'm using 'push-pins', sometimes called 'map-pins' and some lead 'ducks' as weights. You can use anything for weights. I've used pieces of scrap steel, small sledgehammer heads, full buckets of paint or almost anything that's heavy and has at least one flat surface.

The key to this process is to insure that each riffle is installed perfectly straight from end to end and pushed all the way down onto the deck surface so the adhesive makes a complete bond without any voids.

Installing the riffles on a typical table should take at least 4 hours and six hours is not uncommon. If you're doing it in less time it is a pretty good indication that you're taking some shortcuts that you'll regret down the road.

If you're using an adhesive like' Titebond' or even regular old 'Elmers' carpentry glue you'll find that the adhesive will ooze out from under the riffle when it's pressed down onto the surface of the deck. Don't try to clean this excess material away until the glue begins to set. Under average conditions the glue will begin to 'skin' in about 30-minutes after application. There is a point between when the excess adhesive begins to skin and when it actually starts to cure that it looses it's adhesion to the deck surface and can be cleanly scraped away in ribbons very easily using a plastic scraper or putty knife.

If you look closely at Figure 26 you can see a small piece of yellow colored plastic that's just below the box of pushpins. That object is a segment I cut from one of the plastic 'spreaders' that are sold along with 'Bondo' brand body filler.

As you're installing the riffles you'll find that the glue is skinned and ready to be scraped away after you've already installed the next few riffles so the process of 'cleaning' the excess adhesive is somewhat sequential. I use the plastic scraper to remove the 'softer' excess and then wait awhile for the secondary curing to take place on the freshly exposed surface of the excess material. Once that begins to harden I'll switch over to using the putty knife to scrape away the final film of adhesive to get a knife-edge finish between the deck surface and the edge of the riffle.

This may seem like a trivial thing to be doing but it's actually very important that the edge of the riffle where it meets the deck surface be as sharp and uniform along its length as possible.

After you've installed you first set of tapered raised riffles you'll appreciate why many manufacturers have decided that cheap routed recessed riffles are 'better'.

Figure 27 shows our prototype deck with the tapered riffles finally installed. The discoloration in the plywood was there from the beginning and is a spot where the factory surface sander broke through the outer skin lamination.



Figure 27

Figure 28 is a better view of the riffle system.



Figure 28

Once the adhesive has cured and been scraped away I usually give the deck at least three more coats of urethane so that the deck surface and the riffles are completely sealed as an almost monolithic unit. If at all possible let the assembly cure and dry for about a week before starting to do the final finish work. This is a good time to do the final work on the suspension carriage and drive mechanism or just get back into the field and do some prospecting.

Once the finish has dried to a good hard surface its time to do the next stage of sanding.

At this point I normally use the pumice-impregnated foam sanding pads sold at most hardware stores. These pads come in a variety of grit grades and wide variety of ‘shapes’ to meet specific tasks. Sanding the broad open surfaces isn’t much of a problem but you’ll have to cut the pads into widths that will fit between the riffles. I typically make a wood ‘block’ to put behind the pads.



Figure 29

The goal here is to sand down all of the surfaces as smooth as possible. This includes sanding down not only the broad flat areas but also the upper and side surfaces of the riffles as well. The objective is to have a surface on all of the areas of the deck and the three exposed sides of the riffles that are as smooth as a baby’s bottom.

Once this sanding operation has been accomplished I normally spray on another two to three coast of urethane to re-seal all of the exposed bare wood surfaces. This sanding and sealing operation might take several steps before you have a surface that is totally waterproof but it is a critical step in deck preparation.

The next stage of surface preparation consists of spraying on the initial coating of surface primer. The primer that you use has to be ‘sandable’ meaning that it has to lacquer based but this also means that the primer by itself is not actually waterproof.

Over the years I've found that two primers work on tabletops. The first is the regular old 'Bondo' brand 'Easy' primer that is very cheap and available almost anywhere and the second is 'Sikkens; brand auto primer that is very expensive and only available through auto body supply houses. Both products work very well in a wet environment even though they aren't supposed to be waterproof.

For this deck we're using the Bondo brand primer since this is a 'budget' type of project but even though this product is considered by many to be marginal I've had very good results with using it for many years on Miller Tables.

Figure 30 illustrates the deck with the first coat of primer applied.



Figure 30

Normally I try to use three primer coats and fully sand the deck between each coat using 320 and lastly, 400-grit sandpaper. The final coat is so smooth that it looks like a piece of gray colored glass.

I've used all types of paint products for the final finish and still have not found any one product to be better than the others. More often than not I'll just spray two coats of clear urethane over the primer. I've also used the so-called 'chalkboard' paint, spar varnish and lately a product called 'appliance' paint.

I've had good results using this appliance paint on small boats and it does dry to a fairly hard surface in less than half an hour and if properly applied the surface is glass smooth.

For a longer-lasting production deck I strongly suggest that you take it to a paint shop and have a guy do a two-part epoxy paint job. The material I recommend is called ‘Awlgrip’ which is a polyester urethane finish designed for use on aircraft and boats but regular old ’Imron’ works well and almost every painter knows how to use it.

Figure 31 shows our prototype deck with the last coat of ‘appliance’ paint drying. If you look at the right side of the snapshot you can see the ‘flash’ line where the material is curing. This paint dries very fast and does end up being a fairly hard surface finish but it is not to forgiving so you do need to spray up some test pieces to learn about its characteristics. Spraying it in several thin coats seems to work best but each coat must be applied within 45-minutes of applying the previous coat or the new coat won’t bond.



Figure 31

Using this paint is about as close as you can come to getting a real epoxy finish on a table deck at home using rattle cans.

In reality you really don’t need to go to the levels of finish that we’ve show here if you’re building a true prototype deck that you might scrap down the road but you still have to make the deck waterproof enough so that it will last for at least a couple of dozen runs of material. It takes a few days of using a new deck to work out it’s kinks and figuring out what kind of slopes and stroke lengths work best with any particular classification of raw product.

To be honest at this stage of this project I regret using such a cheap piece of plywood for the deck surface since the finish work we had to do was far in excess of what we would

have done had we had a better piece of wood to work with. Sometimes it pays to spend a little more money on the front end so as to save some time and money on the back end.

On the other hand if you're just interested in seeing the difference between several different riffle arrangements then it might be a good idea to make up a bunch of decks using really cheap 3/8-inch plywood and run them without bothering to do any finish work at all.

The deck shown here ended up costing us just under $42 and that included the plywood, the wood for the frame, screws, glue, sandpaper, and foam sanding pads, sealers, primers, clear urethane and three cans of appliance paint. This figure would only have gone up by about another $15 if we had opted for a quality piece of marine grade plywood.

If we had built it as a true experimental deck using 3/8-inch plywood and only spraying on one or two coats of sealer it would have cost about half of that amount.

When you consider how valuable a table is and the overall cost of buying or building one the higher cost figure for a better deck seems a little insignificant even if you end up throwing away one or two prototype decks.

Deck Accessories

About all that's left to finish up the Shaker Table is to add the splashboards, drip strips, launders, material feed trough and the water supply piping.

We'll get to these tasks a little later this month as we add to this section.

Part-III will be continued with the fabrication of a 'Gemini' style table deck …….

If you want to contact me my email address is gww25@pacbell.net.

Happy Prospecting,

Gary