In the wind . . .

by John Bishop

The truth about holes

Almost thirty years ago my wife and I were expecting our first child. I was working for organbuilder John Leek in Oberlin, Ohio, and we were in the midst of building an organ for St. Alban's Episcopal Church in Annandale, Virginia. I was drilling the holes in rackboards—those horizontal boards mounted on windchests that support the pipes about six inches above the toeboards.

It wasn't a large organ, only eleven stops on the manuals, so including the Mixture, there were about 760 holes to drill. That's not quite 14 ranks times 56 notes, but some were in the façade, and some others were tubed off the main chests and mounted on the inside walls of the case.

You determine the sizes of the holes using a jig that is a mock-up of a toeboard-rackboard assembly with holes drilled in the rackboard to match all the appropriate drill sizes. You move each pipe among the holes in the jig until you find the right size, then write the drill size on the rackboard by the mark for the pipe hole. That being finished, I had laid out all the marked rackboards on a table near the drill-press and was going through all the boards with each change of the drill-bit. I start with the smallest holes in the remote chance that I might drill one extra hole of a given size. If you make a mistake, it's easier to drill a hole bigger than smaller!

I suppose I would have been using around 30 different bits for this job, starting with something like 7/32″, graduating by 32nds to one inch, by eighths to two inches, and by quarters to three. I guess it took about a day-and-a-half, and all the while I was expecting that call from home. I was sure it wouldn't be on Wednesday. It would have to be Thursday, because that would mean I'd have to cancel choir rehearsal, an ice storm was predicted, and the hospital was an hour away in Cleveland. Sure enough, Michael joined us on Thursday afternoon. A couple days later I went back to finish the rackboards. I have no specific recollection, but I bet there were a few mistakes.

If you'd like to know something about this organ, go to <http://www.stalbansva.org/>, click on "Ministries," then click on "Music." You'll see photos of the organ and its stoplist.

On with the show

The same number of holes must be drilled in the toeboards, the sliders, and the windchest table in order for the notes to play. That makes about 3,200 holes. But wait, I almost forgot to mention that the toeboards were laminated with interior channeling because the spacing of the slider holes is closer together than that of the pipe holes—so add another 780 holes.

We drill holes in the ends of squares and roller arms to accommodate the tracker action. We drill holes in the keyboards for balance and guide pins. We drill thousands of screw holes to hold the whole thing together. In an electro-pneumatic organ there are rows of holes that serve as pouch wells, pitman wells, housings for primary and secondary valves, and miles of channeling drilled through various windchest components to connect the interior of the pouch wells to the atmosphere, allowing pneumatics to exhaust when actions are activated. Counting on my fingers, I guess that there would be something like 7,000 holes in a ten-stop pitman windchest. Really!

You might say that the art of organbuilding is knowing where to put the holes, and what size each should be.

Drill baby, drill!

Just a little bit

There are hundreds of drill-bits in any organbuilding workshop. There are multi-spur bits that have center points for drilling larger holes. There are Forstner bits that are guided by the outside edge rather than by a center point, handy if you need to "stretch" a hole by cutting another half-moon. There are twist drills with 60º bevels on the points for drilling smaller holes such as screw holes. These are also used to drill holes in metal. There are countersinks that chamfer a screw hole so the flat head of a flat-head screw is flush with the surface of the wood. There are airplane bits, which are twist drills 16 or 18 inches long. I don't know why they're called airplane bits. Drilling holes in airplanes wouldn't require a very long bit.

Big multi-spur bits

Multi-spur at work

Any organ shop will sport an impressive rack with rows of bits arranged in order of size. The smallest might be around one-hundredth of an inch, the largest would be something like three inches.

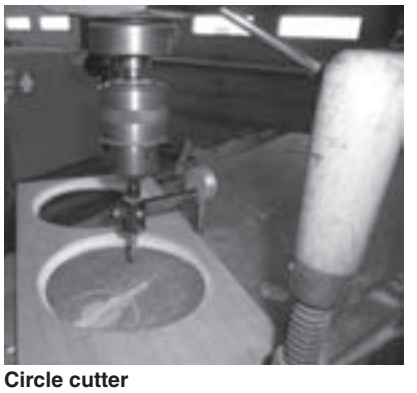
Twist-and-turn

You need a variety of machines to turn those bits. The workbench workhorse is now the rechargeable drill. I have had a long habit of calling the electric hand drill a "drill-motor" much to the annoyance of at least one of my co-workers. In my mind this distinguishes the machine from the bit. You use a drill-motor to turn a drill-bit. I think that if you just say "drill" you could be referring either to the motor or the bit. Let's be specific. I know I got that habit from someone else, but I don't remember who. Terence, I didn't make it up.

We have electric hand drills with half-inch chucks that can handle the larger

Drill-press pulleys set on almost highest speed

Lots of little bits



Circle cutter

multi-spur bits, but there is a lot of torque involved in drilling large holes, and if you are bearing down on the thing with your shoulder to cut through the wood you run the risk of getting whacked in the chin by the handle of the drill motor when the bit gets caught in the wood. It's never actually happened to me but I've read about it! (But notice I said "when," not "if.")

The workshop workhorse is the drill-press. It's a stand-up machine with a motor at eye level that's connected to the arbor with a series of belts. The belts are arranged on stacks of pulleys—you can move the belts to different-sized pulleys to change the speed of the drill. There's a sheet metal hood over the pulleys to protect the worker. We use slower speeds for drilling through metal—the harder the metal, the slower the speed—and if you're drilling through a piece of steel, it's a good idea to have a can of oil with you to lubricate the hole every few seconds. But be careful not to get oil on the surface of any of your wood pieces, as that will foil your attempts to glue pieces of wood together, or to put nice finishes on the wood when the piece is complete.

There's a spoked handle that you turn to drive the drill-bit into the piece of work. There's a table which is normally square to the drill-bit, but that can be adjusted if you need to drill a hole at an angle. We stand at the drill press, one hand holding the work firmly against the table, the other working the handle to move the drill-bit into the wood. If you have long hair and you're not careful, you can get it caught in the pulleys and lose a tuft. If you have loose clothing or, God forbid, a necktie, you can get reeled violently into the machine like a big dull catfish being reeled into a boat.

Careful of blowout

When you're drilling holes with multi-spur bits, you have to drill from both sides of the wood, or the bit will tear the opposite surface as it goes through the board. It will also tear up the table of the drill-press. So the location of the hole is marked with a smaller bit, say one-eighth, that goes through the board. You drill in a little way with the big bit, then turn the board over and drill from the other side. Doesn't that double the number of holes you're drilling?

The saw, the hole-saw, and nothing but the saw

A hole-saw is a specialty tool that's turned by a drill-motor or drill-press. It's a circular saw blade with the teeth pointing downward, something like an aggressive cookie-cutter. There's a smaller twist drill-bit mounted in the middle that guides the center of the hole. They come in sets graduated by the quarter-inch, nestled inside one another like those Russian *Babushka* dolls. Hole-saws are relatively easy to handle up to six inches in diameter. Bigger than that and they get to be rambunctious. Hole-saws are great for cutting wind holes in reservoirs and windchests. Take a look at this McMaster-Carr page: <http://www.mcmaster.com/#hole-saw-sets/=9qqoqp>.

Circle cutters

If you need a hole larger than three inches, use a circle cutter (http://www.mcmaster.com/#adjustable-hole-cutters/=9qqq0f). It has a twist drill-bit to center the hole, and a cutter mounted on an adjustable arm. You can set these up to cut holes nearly eight inches in diameter. But be sure to set the drill-press on the slowest speed, and use clamps to hold your work piece to the drill-press table. These tools are pretty scary. They can jam in the track they cut, and the holes often burn during drilling. And if you don't tighten the set-screw that fastens the adjustable arm, it can get flung across the shop by the motion of the machine.

Oops

What happens if you put a hole in the wrong place? (Never happened to me.) You can glue in a piece of dowel and cut it flush, but the grain will be running in the opposite direction. Better to use a plug-cutter. With this neat tool you can drill into the face of a piece of wood and produce a cross-grained dowel about an inch long. Drill out your mistake with the correct size bit, and glue in your plug. Sand it off and you'll have a hard time finding it again: <http://www.mcmaster.com/#wood-plug-cutters/=9qqszb>.

The twist

Twist drill bits come in many sizes. I have three basic indexes of twist drill-bits near my drill-press. One goes from one-eighth to one-half an inch, graduated by 64ths. One is an industrial wire-gauge numbered set—the numbers go from 1 (.228″, which is a little less than a quarter-inch) to 80 (.0135″, which is very tiny!). And the third is "letter-gauge" that goes from A (.234″, or .006″ larger than the number 1) to Z (.4130″, or a little smaller than 7/16″).

I have a chart hanging on the wall nearby that shows all three sets graduated by thousands-of-an-inch. If you're going to drill axle holes in action parts you choose the material you're going to use for the axle (let's say it's .0808″ phosphorous bronze wire), then choose a drill-bit that's just a little larger. The 3/32″ bit is way too big at .0938″. The #45 bit is .082″ and the #44 bit is .086″. Here the choice would be between the #45 and the #44, so I'd drill one of each and try the wire in the hole. But wait! I have one more trick—a set of metric twist drill-bits graduated by tenths-of-a-millimeter. The 2.2-millimeter bit is .0866″. That's .0006″ larger than the #44 but I bet it's too large. The 2.1-millimeter bit is .0827″. That's only .0019″ larger than the wire—would be a pretty close fit—probably too tight.

If you'd like a glimpse at what these sets of bits look like, go to <http://www.mcmaster.com/#catalog/116/2416/=9qg6xs>. This is page 2416 of the catalogue of McMaster-Carr Industrial Supply Company, an absolute heaven for the serious hardware shopper. The "Combination Set" at the top of the page has the 64ths to 1/2″, numbers 1–60, and 1–13mm graduated by half-millimeters——total of 114 bits for $286.54. But be reasonable—this is not the perfect Father's Day gift for every home handyman. A simple set that goes from 1/8″ to 1/2″ graduated by 32nds to 1/4″ and 16ths to 1/2″ will be plenty, available for about twenty bucks from your Home Depot or Lowe's store. (I prefer the DeWalt sets.)

Why the fuss?

You might wonder why I would spend so much energy choosing the right drill-bit, and spending so much money to have at hand an appropriate variety of bits from which to choose. (I bet I have more than $5,000 worth of drill-bits.)

A pipe organ is a musical instrument. It's a work of art. It's a work of liturgical art. It's a very special creation. But look inside an organ—any type of organ—and you see machinery. You see thousands of parts and pieces all hung together to make a whole. Some organs look downright industrial inside. That defines a conflict. How can a ten-ton pile of industrial equipment be considered artwork?

The answer is simple. If it's built to exacting specifications so the sense of the machine melts into the magic of musical response to the fingers and feet of the musician, then it's artwork. No question, there is such a thing as a pipe organ that's little more than a machine, but that is not the ideal which our great artist-organbuilders strive to achieve.

If I spend an extra hour making sure that the axle-holes I drill in the set of squares I'm making are exactly the right size, then that keyboard action will feel good to the organists' fingers, there will be no slop or wobble in the feel of the keys, and the machine I'm making will not impose itself between the musician and the music. (Squares are those bits of tracker action that allow the action to turn corners.)

And remember, if I'm making squares for an organ, I'm making enough of them for each note on the keyboard, and if it's a larger organ with several keyboards and actions that turn several corners, I might be making 500 squares for the single instrument. While I'm doing that, as long as I think there will be another organ to build, I might as well make a bigger batch—let's say I'll spend a week making 2,500 squares. Each has an axle hole, and each has an action hole at the ends of its two arms. That's 7,500 holes. And those holes are so small that I'll produce only enough sawdust to fill a coffee can. (I don't know why I say *sawdust* when I'm talking about drilling holes, but I've never heard anyone say *drilldust*, and neither has my spellchecker.)

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The other day I was in a meeting with people from a church who are in the very early stages of dreaming about acquiring a pipe organ. One fellow was really surprised by the cost of organ building—"how can it possibly cost that much to build an organ? You're going to have to convince me." I answered him by talking about thousands of person-hours, tons of expensive materials, a workshop equipped with a wide variety of industrial machinery and tools, and collective lifetimes of careful learning and experience forming our staff.

I also told the group that the moment the doubters in a congregation finally really understand why organbuilding is so expensive is the day the new organ is delivered to the church, and the entire sanctuary is filled with exquisitely crafted parts. I've been present for the delivery of many new pipe organs, and I've often heard the comment, "Now I see why it cost so much."

As I drove away from that church, my mind took me on this romp about fussing with drill-bits, a reflection on the care, thought, precision, and resourcefulness that I so admire amongst my colleague organbuilders. So I ran back to my hotel room and started to write. I can do the same with lots of other kinds of tools. Want to come see my saws? ■