"Make-true" Chuck Conversion

by Tsun Tam

As an owner of the Harbor Freight 9x20 lathe, I am pleased that at least I can afford a lathe but at the same time quite peeved about some of its inadequacies. I have entertained several modifications, some major, some minor and some just to make the lathe 'work' better. I am indebted to John Pitkin who has made my major motor mod a reality. His comments and suggestions were invaluable! Thank you, Captain John! I will detail other modifications and enhancements in a later monograph. For the present, I will detail what I did to my 4-inch OEM chuck.

Forword

There are many terms that I use which may not be part of the official machinist's vernacular. For this I apologize and would appreciate the reader to enlighten me with the proper terms to use.

My Initial impression was that the OEM chuck work as a chuck should - firmly clamp the piece for machining. Foolishly, I neglected to check its runout until I noticed that the pieces I was turning somehow are less that 'perfect.' So I checked the chuck's runout - 12 thousandths!!! I would say that this is a BIT much! So I removed and disassembled the chuck and trued out the backplate's registration boss, front mating surface and the surface which mates with the spindle's end face. Reassembled the chuck and rechecked it - no change! The chuck's boss recessed must be 'off!' and I wasn't about to 'monkey' with that!

Coincidentally, I had purchased two more chucks - a 6-inch 4-jaw independent and a 5-inch 4-jaw self-centering chuck. I needed a greater clamping capacity and the ability to hold irregular shapes. I mounted them on backplates I purchased at www.littlemachineshop.com and their runout were within the chucks' specs, i.e., 3-thousandths. With two good chucks of larger capacities, I can now pay attention to my OEM chuck. I matters little to me if I 'screwed things up' with this chuck. As I see it, it'll be a great learning experience for me!

A chuck feature that is very nice to have is the ability to be trued up. In my heart, I lusted for a Bison, but did not care to spend a small fortune for one, so I researched for a way to adapt an existing chuck with this capability. A British company (http://www.hemingwaykits.com/acatalog/Adjustable_Backplate.html) sells an adjustable backplate adapter that must be machined before the chuck can possess the ability for adjustments. Not a viable choice for me as it would add additional width to the chuck body. Frank Ford (http://www.frets.com/HomeShopTech/Projects/AdjChuck/adjchuck.html) has a beautiful piece on his elegant version of an adjustable chuck but I'm too lazy to do his mod and wanted something done quickly - you know, it's the 'me generation.' Another modification (http://members.optusnet.com.au/moreshedstuff/3JawChuckMod3.html) requires machining an additional collar and rings affixed to the chuck's backplate. This one looks very much like the Hemmingway approach, beautifully orchestrated and very elegant but overly complex (for me) to entertain and my modest chuck doesn't deserve such treatment.

I found a very interesting article in the Houston's "Home Metal Shop Club" journal (Volumn 8, Number 12, December 2003). Joseph Scott has a novel approach for his chuck. Quite doable and

simple to execute. But I chose not to use the Scott method for one reason, I didn't want to have anything exposed on the outside of the chuck body. His has everything I need, no extension to the width of the chuck body, simple to execute and that IT WORKS!

. . . back to the 'drawing board' for me. Then literally, in my dream an idea crept into my consciousness - 3 bolts, 3 grub screws and a bit of machining are all I'd need for my chuck mod! Eureka! Problem analyzed, solution found and now the game's afoot.

The concept

My design requires a bit of machining and some bolts and screws. Nothing else is added to the chuck. For the chuck to be made adjustable, the backplate MUST be used as the datum and be fixed relative to the axis of the lathe spindle. The chuck body is made to be adjustable. To accomplish this task, I need to be able to displace the chuck body in 2-dimension space, i.e., movable axially, relative to its 'fixed' backplate.

On the chuck body, I need some device to be able to push against the backplate or something attached to the backplate. With the design constraint of the OEM chuck there is JUST nothing on the backplate from upon which the chuck body can push. The need for the swarf shield cover barely gives me a tenth of an inch to accept the registration boss on the back plate.

The adjustable Bison chuck uses a number of grub screws on the chuck body as adjustment points. What these screws push against, I haven't a clue as I'm not privilege to the inner workings of the Bison, but reason would say that it HAS TO PUSH AGAINST SOMETHING that is part of the backplate!

Since my design does not allow for any additional spacers or new secondary plate to be introduce to the chuck assembly, I had to devise a bearing surface on the backplate for each adjustment point. I can't make the backplate registration boss thicker and even if I could there would be insufficient space on the chuck body to accept a deeper registration boss. A thick boss WOULD allow me to use it as a bearing surface against which the adjustment screws may push (sorry, not good to end a sentence with a preposition!).

To be effective, the registration boss must be at least 1/4 inch or deeper. I can discard the swarf shield cover, but since all chucks that I've seen have this part, it MUST BE a necessary piece for all chucks to possess. I also don't like the idea of introducing high pressure points on the cast iron backplate. Since I have to keep this shield cover, I can at least remove some material from the 'non-critical' areas. With the clearance spaces milled out, I can introduce some newly constructed projections (that are firmly attached to the backplate) into the new 'cavities' formed by the newly milled clearance spaces on the shield cover and the chuck body.

Given sufficient penetration of these projections, and since they are part of the backplate, they offer the adjustment screws perfect bearing surfaces upon which to push!

Bill of material

3 3/8x16 1-inch bolts (hex recessed) for use as bearing surfaces (aka, bearing-bolts)
3 1/4x28 3/4 inch screws (hex recessed - aka, adjustment screws)

Machine and tools used for the execution

Milling machine
Drill press
tap drill for 3/8x16 bolts
tap drill for 1/4x28 screws
counterbore (3/8 inch)
3/8x16 tap
1/4x28 tap
3/8 inch end mill

Tools for adjustment

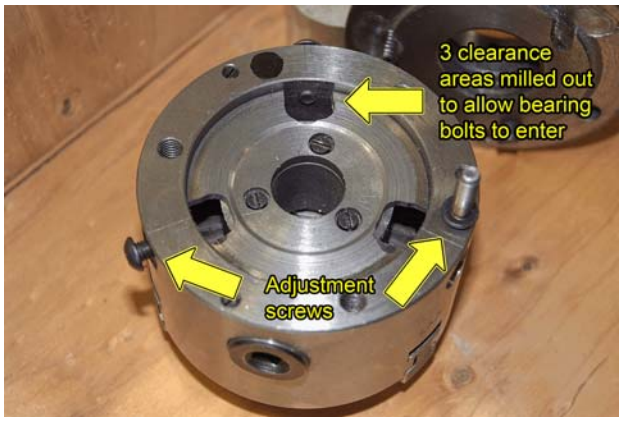
Allen keys for the adjustment screws and the backplate mounting screws. I ground down a right-angle Allen key so I can fit it into the backplate mounting screws for final backplate/chuck tightening.
Dial test indicate with mount to assess runout

The execution

I specifically do not give dimensions as my chuck is probably unique to me and a Grizzly or Enco lathe owner may have a different sized chuck . . . or you may wish to execute my design on a totally different self-centering chuck. Where possible, I would recommend using four rather than three adjustment screws. It'll be much easily to adjust when it comes time to eliminate any runout on your modified chuck.

Step 1
Remove chuck from lathe and disassemble to part the backplate and the swarf shield cover that protects the chuck's internal bevel gears. Since everything is exposed, clean out any debris that may have accumulated inside the chuck cavity.

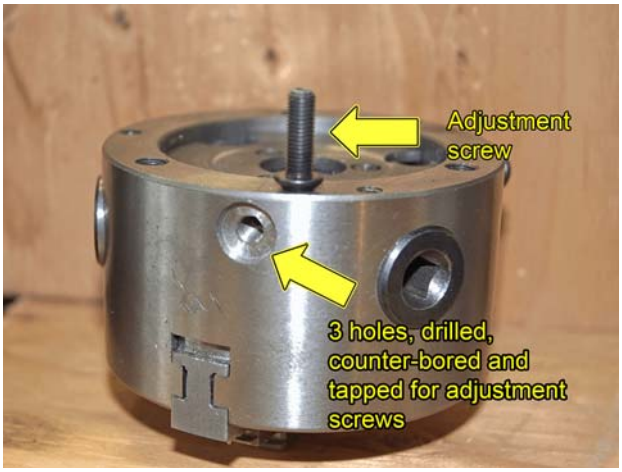
Step 2
Mark the locations on the swarf shield cover where the clearance spaces need to be milled. In my case, the chuck has three-access hole for the chuck key, so I don't have the necessary clearance to locate and machine four adjustment points; I had to settle for three.



Step 3
Clamp the swarf shield cover on the milling machine and mill out an adequate clearance to accept the 3/8x16 bolts. These clearance spaces need not be milled to very accurate dimensions, just sufficiently to allow enough side space for the chuck to move relative to the 'fixed' backplate.

Step 4
Replace the swarf shield cover back on the chuck body and transfer the CENTERS of the milled

spaces to the back surface of the chuck, then transfer these marks to the side of the chuck. Since I have spec'ed out 1/4x28 adjustment screws, I need to have drilled and tapped holes located far enough from the back surface of the chuck body to lend integrity to the adjustment screws. I could have use finer pitched adjustment screws but then their diameters would be too small, e.g., 8x32 or 10x32. 1/4x28 is a good compromise, so mark the locations where the hole are to be drilled.



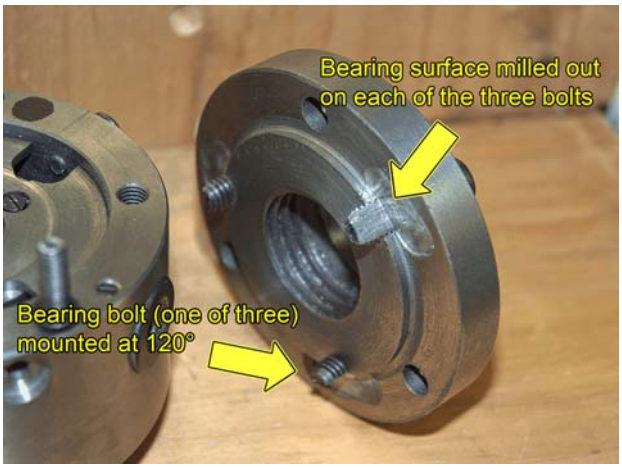
Step 5
Drill and tap the adjustment holes.

Step 6
Counterbore each of these holes about 1/8 inch deep. Why? I can't find 1/4x28 hex-recessed grub screws at my local Ace Hardware store. All I could find are 1/4x28 round head hex-recessed screws. I wanted hex-recessed screws as I prefer to use an Allen key to make my adjustments.

Step 7
Attach just the backplate on the lathe spindle and turn down the registration boss so that it's at least 50-thousandths SMALLER than the mating recessed area on the chuck body. I made mine about 100-thousandths smaller. My OEM backplate and chuck body had a very tight fit as it should have for a properly fitting backplate, but my design requires that the chuck body be 'freely' movable around the fixed backplate.

Step 8
Side Bar:
If these bolts are simply screwed onto the backplate and they are located to enter the clearance cavities of the chuck, their round cylindrical shape would present problems for the adjustment screws; these screws like to bear against flat surfaces. Therefore, each of these bolts will have to have its exposed surface milled down to one-half its bolt diameter. Once milled, these bolts will present flat surfaces to the adjustment screws. So placement for the 'bearing bolt' circle should be careful plotted. I chose hex-recessed bolts because external hex-head bolts would not allow me to position the bearing-bolt circle close enough to the raised threaded portion of the backplate.

Optimally, the milled bearing bolts' flat surfaces should line up with the reduced diameter of the registration boss on the back plate. Make this so; mark the locations for drilling and tapping.

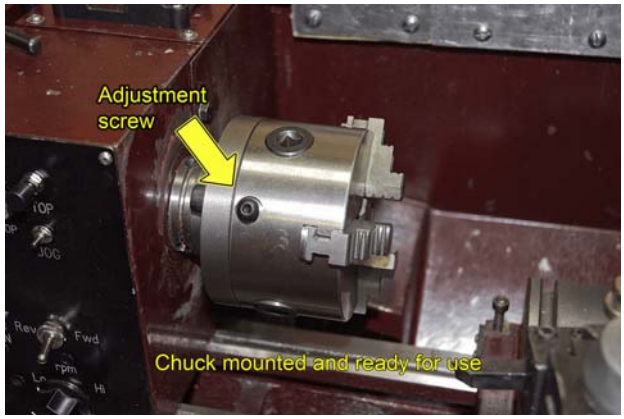


Step 9
Drill and tap the holes for the bearing-bolts; thread in all bearing-bolts.

Step 10
Clamp the bearing-bolted backplate on your milling maching and mill out each of the bearing-bolts so one-half of their exposed surface is flat. When done properly, the flat surfaces SHOULD approximate their alignment with the reduced diameter registration boss.

Step 11
Clean up all the parts and reassemble the chuck making sure that ALL attachment bolts are ONLY hand tight, this includes the adjustment screws as well.

Step 12
Mount the chuck back on the lathe and clamp a piece that is known to be ROUND! The adjustments should be intuitively obvious (I/O - NOT the OTHER I/O or input/output). I coined this term to irritate a very dear friend! When you have completed the adjustments, very very carefully tighten each of the backplate mounting screws - a little at a time until all are tight.



Summary

With my modification, I was able to adjust my chuck to maintain a runout of approximately 2-thousandths using five minutes of effort. I could have done better if I had a truly round test piece. I used a 1-1/4 inch piece of drill rod. Anyway, it is STILL WAY BETTER than my original 12-thousandths runout!

Caution and proviso

You should be aware that the adjustment is ONLY 100% accurate for the test diameter of the clamped piece and you should ALWAYS use the same chuck key hole for clamping your workpiece.

Additonal stuff

I now have a total of four chucks, the OEM, 6-inch 4-jaw independent, 5-inch 4-jaw self-centering and a 4.5-inch 6-jaw (for thin wall tubing) and I frequently change chucks. The last thing I want now is to have my grip loosened when I'm changing chucks and have the chuck crash down on my ways or onto my fingers.

To eliminate way damage, but not necessarily protecting my fingers, I fabricated my way-protector that fits nicely between my parallel set of ways and with the necessary cutouts to clear any protrusions. It also has sides to prevent the unmounted chuck from rolling off the way-protector and then dropping onto my foot!