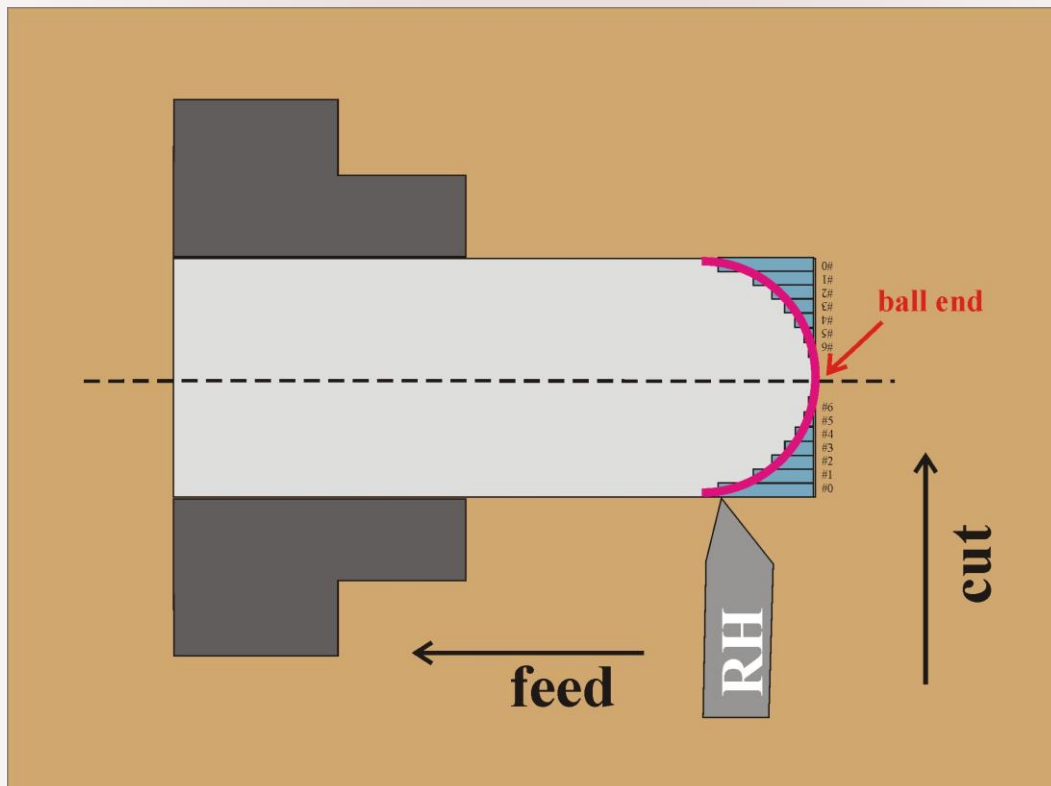


LatheCity

Working Safely with Benchtop Lathes III

# Volume 3 – Poor Man's CNC Lathe

by Uwe Burghaus

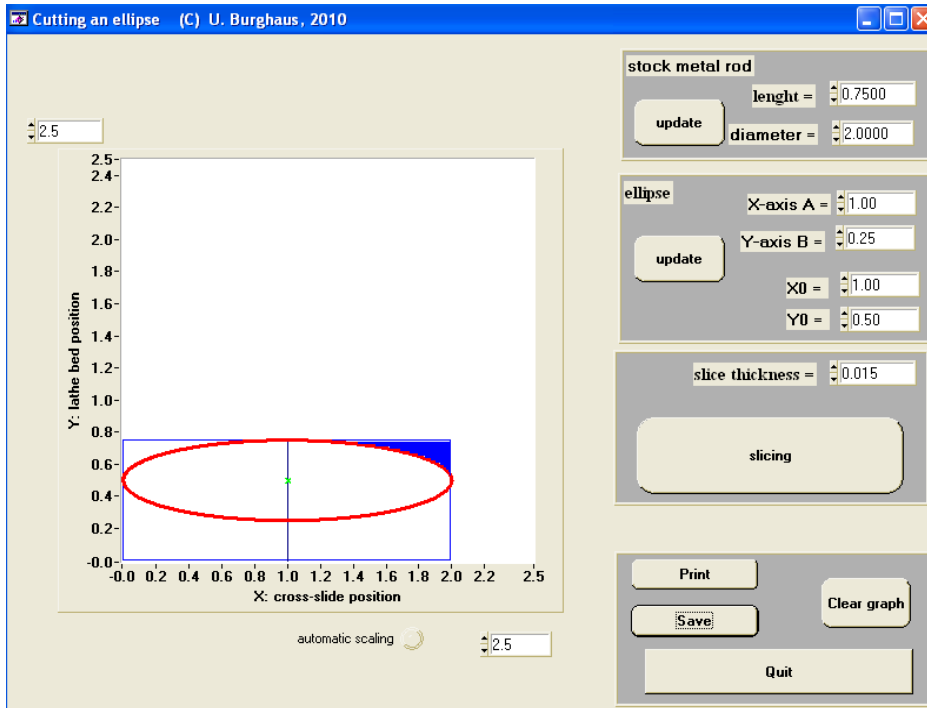


[www.LatheCity.com](http://www.LatheCity.com)





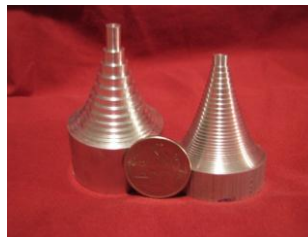
Project examples – special shapes made easily: parabolic and elliptical (UFO) shapes



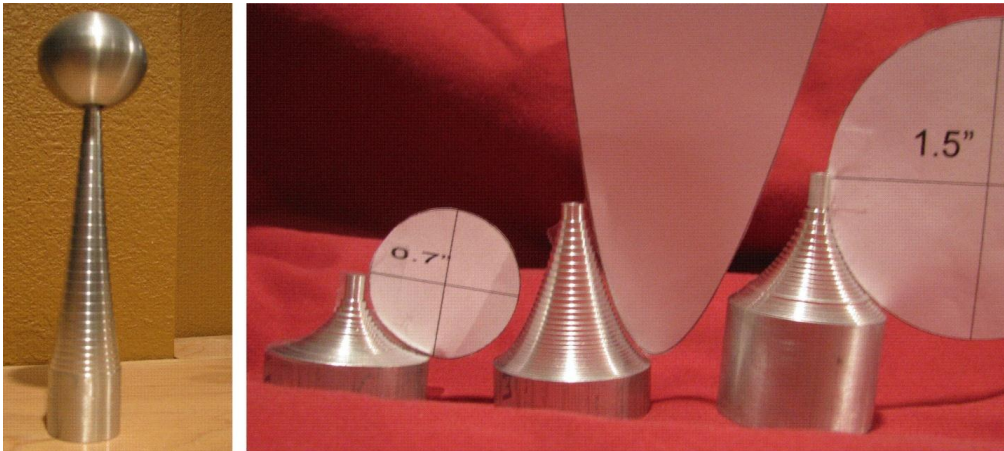
**“Poor man’s” CNC lathe.** Any shape can be approximated by slicing it. Thus, you can cut any shape on a mechanical lathe, small or large, without any accessories. How this works is described in this book. Slicing tables and computer codes are included. A CD with Windows programs for PCs is included.



Project examples: Morse taper #0 and #1



Project examples – special shapes made easily: parabolic shapes



**Project examples:** ball ends, ball shapes, parabolic shapes



**Project examples – spherical shapes**



**Project examples – special shapes made easily:** elliptical ends and artwork projects



**Project examples – special shapes made easily:** Morse taper cut easily and precisely by slicing – engineering project



Lathe City  
Safely Working with Benchtop Lathes III  
Volume 3 – Poor Man's CNC Lathe

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<http://www.lathecity.com/Books/index.html>

Lower right corner.





## Disclaimer

**Metal work.** The book has been written carefully and all projects and procedures have been tested thoroughly. However, as always, the author and publisher cannot guarantee that the procedures are perfect and without any mistakes. In addition, it is impossible to predict and prevent all the possible problems someone may possibly run into when working with a lathe. **Using a motor tool can be dangerous and the proper use is the responsibility of the one who is using the tool.** If you are not perfectly comfortable with working with motor tools, then don't do it! In this case, take a metal working class rather than following a do-it-yourself outline. Or, find a different hobby. I cannot jump in if you make a mistake which results in harming yourself or damaging the tools you use. Don't use damaged tools, perhaps purchased for cheap at a 2<sup>nd</sup> hand store or who knows where. This would be overwhelming to handle in the beginning. Thoughtful work will be your responsibility.

**The author makes no representations or warranties with respect to the accuracy or completeness of the contents.**

**The author is not a professional machinist or engineer. In fact, the author holds a Ph.D. in physics and teaches physical chemistry at a college. Therefore, no information provided herein represents professional advice or best practices in machining. All information is provided to help hobbyists and other non-professionals gain a better understanding of using a mini benchtop lathe for hobby type work.**

**This book features in particular the Sherline lathe. However, none of the statements or procedures may coincide with Sherline Inc.'s opinion or interests.**

The author is not an employee of, or agent for any of the vendors referenced in the text and does not sell or represent any of the third party products discussed.

Web addresses are given without any warranty or guarantee, web sites may be infected by a computer virus and/or may not provide the best service.

Computer codes are provided without any warranty or guarantee of correctness. They are intended for private and non-commercial use only.

**You will perform all operations herein described at your own risk in any regard.**

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## System Requirements

The software is tested for the following operation systems:

- PCs only
- Windows 7
- Microsoft Windows XP (Home Edition, Version 2002, Service Pak 3 or Service Pak 2)
- Windows 98 (32 bit)

The software will not run on EssPC or Macintosh.

We have a demo version on our website. Try it out. If it runs on your computer then the full program versions will also work. The demo versions does not allow to save data files. **Note that we don't accept returns of information products. Once you opened the envelop that includes the CD, it will be yours. This information is available free of charge on our website before purchasing any product.**

## Metric vs. English Unit System

The software, slicing tables, and examples are given in English units and were tested on an English lathe. We did not test any of this on a Metric lathe. However, ball shapes, elliptic shapes, and parabolic shapes should be conserved when changing the unit system. For example, instead of using one inch as the radius one could also use 1 cm, 10 mm, 25.4 mm, or 7 km. The shape should be conserved since the equation for e.g. a sphere simply "scales the trigonometry with the length of the radius". Angles are given in degree.

## Returns

Note that we don't accept returns of information products, as common. Once you opened the envelop that includes the CD, it will be yours. We sell the CD only together with the books mostly for safety reasons.

## Preface - why should you purchase this book?

After becoming familiar with standard lathe operations such as turning, facing, and boring one develops the desire to cut more complicated shapes on a lathe. Making fancy chess pieces, earring, nicknacks, table legs, specialty adapters, Morse taper, ... whatever. A typical compound slide allows one to cut slopes with a precision of about one degree and a radius cutter is available as an accessory for most lathes. However, when using these tools, one realizes fast that the shapes that can be made are still rather limited. Similarly, the precision is quite limited. For example, on most lathes, it's basically hopeless to cut Morse taper without further accessories. In addition, using a radius cutter in hard to machine materials and larger stock sizes is a rather difficult and slow process. Well, obviously a CNC (Compter Numeric Control) lathe is the way to go, but these systems start at about \$2,000 and it takes months to learn how to use these CNC machines efficiently. Computer skills are required.

### *There is a faster and cheaper way to do so:*

As with CNC operations, theoretically any shape can be approximated by slicing it. This works well also as a manual operation on any lathe and does not require more than 10-20 min work for most shapes. The shapes are approximated by turning/facing thin layers off the work piece. How this can be done exactly is describes in detail in this book. **Sofisticated computer skills are not required.** In fact, tabels are included which can be used without even touching a PC. **Basic skills in lathe work are sufficient.** However, windows software tools on a CD come together with this book which allows one to calculate various geometries for any stock size. These programs are very user friendly and not more difficult to use than a text program or an internet browser.

The operations described here also expose one to the general ideas and limitations of CNC operations. Getting a CNC lathe at some point (later) is certainly still an option. The programs included here will also be useful to set up benchtop CNC systems since slicing tables can be stored and perhaps imported in CNC software.

**This volume features again the Sherline lathe.** However, slicing operations that simulate a CNC lathe can be run on any lathe independent of the size or any design details of the lathe. The slicing programs are tested on an English lathe. However, the shapes should be conserved when using a metric system.



## Pictograms used in this book



Internet addresses of potentially useful sites. However, web sites may be infected by computer viruses. Use them at your own risk.



Safety notes. It is not my intention to bother you and this book is meant for adults with at least basic machining skills, not for children. Therefore, it's your decision whether you read the safety notes or not. However, don't blame me if you did not take the few minutes to do this and end up in a hospital. **All procedures are performed at your own risk.**



Engineering type notes. You may skip these if you are only interested in the operation of the tool. Remember, though, that knowledge also always provides protection (safety), if you know what you are doing... right.



Summary



Tips and tricks. Some of these may appear rather trivial for an advanced hobby machinist. However, we don't all start at the same level.



LatheCity Books VOLUME 3: POOR MAN’S CNC LATHE (CD included)

# Contents

*This third volume is similar to chapter G of the first volume of “LatheCity”. However, a large number of slicing tables are included here. In addition, this volume comes with a CD, including Windows programs as well as a description (manual) for these programs. Basic skills in lathe work are required, but no sophisticated computer skills.*

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- Abbreviations
- Program codes
- LatheCity





## Safety first



Safety glasses. Use versions with ANSI Z87 label. ANSI is short for American National Standards Institute. Chemistry goggles, as also shown here, are not recommended for metal work, since they may block the vision too much.

Please note that **initially you may be at a higher risk** than folks doing this for living since you will be on your own. Typically hobbyists do not attend safety classes or safety briefings. Therefore, at least read the following.

When it comes to safety the “**buddy system**” is essential. Actually, nobody should work alone with motor tools. This is obviously difficult to organize for a hobbyist. Therefore, you are at a higher risk and have to manage the risk yourself.

However, everyone can learn how to work safely with motor tools. Otherwise I would not offer this type of textbook. In one of the safety briefings I attended, the instructor, a professional machinist, outlined almost proudly how many accidents he had throughout his career ... well ... I still have all my fingers and would like to keep it that way. What about you? Therefore, **READ** the following general safety notes and hints about how to prepare yourself before switching on your lathe. **PLEASE, take this seriously it only takes 20 minutes.**

Specific safety notes for every procedure are part of every subchapter. Naturally the notes in the beginning are more extensive and become shorter towards the end of the book since I assume that you learn safe working practice along with the operation of your motor tools. (In addition, safety concerns are often similar for different procedures.) This is one of the main



goals and part of the title of this hobby machinist book: "Safe working ..."

Working at a public university myself, I have to participate regularly in safety classes and I am at present (2011) in fact the safety liaison for our chemistry department. However, again I am a hobbyist myself when it comes to metal work. I still have all 10 fingers and two eyes, but **there is no legal guarantee that the following notes are complete or even correct. Read the disclaimer note above.**

- **Use goggles / safety glasses.** Chemistry goggles, which are also shown, have the disadvantage that they may block your vision too much which again can generate a safety hazard. You need comfortable glasses and perfect vision. You need to look around. Glasses approved for metal would need to be closed all around the face (at the top, sides, and bottom) and in the U.S. they have the label **ANSI Z87** on them. Some versions additionally block UV light which was interesting to me, since I also work with glass pieces, using glue hardened by a UV lamp. In any case, a UV filter is better for our eyes, I believe.
- At most safety briefings you may come across the term "**situation awareness**", as a general strategy to reduce risks. Knocking over a leg of a storage rack when walking through a metal shop, which carries 500 pounds of steel, would not be it. Heavy footwear is unfortunately very uncommon except in an industrial setting. (We also don't want to overdo it in a hobby shop.)
- Let someone know that you are working in your garage and/or basement. Why? First, you are setting up "**a buddy system**" in doing so. Second, you are making sure that nobody disturbs you at a critical moment, startling you from behind.
- Have a working phone in reach. Check if your cell phone is working properly in your basement. Where is the closest hospital/emergency room? Emergency number in the U.S.



is? Right, 911. At some locations the number may be different.

- Make your shop kid safe. Talk to your kids about the risks. Make sure that they do not sneak around a corner and surprise you when the lathe is running, etc. They often don't see the difference between "playing" and "safe working practices."
- Read the application notes and manuals that came with the tools and/or accessories before starting to use them. Learn the applications and limitations as well as the specific potential hazards of every tool.
- **Don't use a tool for a purpose it was not designed for.**
- Don't modify a tool yourself.
- Don't push a tool beyond the limits it was designed for. A mini metal lathe is designed to work on small metal stock.
- Don't modify the electrical connections of your tools. Electrically ground all tools. If a tool is equipped with a three-prong plug, then it should be plugged into a three-hole receptacle. If an adapter is used to accommodate a two-prong receptacle, the adapter wire must be attached to a ground connection.
- Don't remove safety guards. Keep guards in working order. (I could tell you stories where a student did exactly that to "save time" and lost several fingers in the process. This is not a joke, but I will spare you the details. Fortunately, I was not involved in this accident, in this case, at a chemistry lab abroad ... ) Don't remove safety guards. However, the little safety shields that sometimes come with a lathe provide only very limited protection. Use always goggles, in any case.

- I did read the safety notes.
- I did understand them.
- I did read and accept the disclaimer statement.

- Make it a habit of checking to see that keys and adjusting wrenches are removed from the chuck before turning on any machine/lathe. In the case of a lathe, turn the spindle by

hand before turning on the lathe making sure that it runs freely. Don't underestimate the power and torque generated even by a benchtop lathe. A key left behind in a chuck can easily fly off traveling at a significant speed for 10 ft (3 meters) or more. Full size lathes used to train students professionally are often equipped with **spring lock chuck keys (self ejecting keys)**. These pop out of the chuck when not pushed down, i.e., it's impossible to leave them in the chuck unintentionally. Typically the chuck key would hit the instructor rather than the student running the lathe which may explain why this feature is eagerly installed in training metal shops. (Don't put your nose over the spindle anyhow.) In any case, just kidding I do like all instructors, safety first. Unfortunately, this type of system is typically not available for benchtop lathes, as far as I know.

- Cluttered work areas and benches are a safety hazard. This is indeed true.
- Do not use power tools in damp or wet locations. This can be an issue for garage or basement shops. Solve the problem if it exists at your location.
- Keep work area well illuminated. This is extremely important for safety issues and any proper work. Do you need new glasses?
- All visitors should be kept at a safe distance from the work area.

- Again make your workshop kid proof. Use padlocks, master switches, remove starter keys. This is of particular concern for hobby work, correct (?) I would in principle encourage you to awaken the interests of young adults for practical and creative work. Fortunately, perhaps in this case, many of them prefer to play dull computer games instead. However, teaching young adults to work with metal tools is particularly difficult and a major safety hazard for everyone involved in this process. At least don't do this in the very beginning. You must be very confident yourself, first. Make sure that they are old enough and have no access to the tools alone.
- Again, do not force tools or attachments to do a job for which they were not designed. Use the proper tool for the job.
- Avoid loose clothing, necklaces, gloves, or jewelry that could become caught in moving parts. We all know this, but taking care of it every day is another thing.
- By the same token, fluffy cloth appears to attract small cut off metal pieces like a magnet. They stick deep in the fabric and can scratch you fingers and skin.
- **Wear protective head gear to keep long hair styles away from moving parts!** If you would like to see a sad story in this regard, go to:  
<http://blog.makezine.com/archive/2011/04/yale-student-killed-in-lathe-accident.html>  
<http://www.nature.com/nature/journal/v472/n7343/full/472259a.html>  
It takes milliseconds to pull you into the running chuck if something gets caught in the chuck. A benchtop system is safer in this regard than a full size system, I guess, but ... (A lathe running at 1600 RPM makes 26 RPsec or ~40 milli seconds for one revolution.)
- **Use safety glasses** i.e. goggles designed for metal work. Yes, this is on the list more than once.
- Use a face or dust mask if cutting operation is dusty.

Internet



Full face shield with plastic foil that need to be peeled off.

- When using a metal grinder you will generate sparks. Use a full face shield and goggles for these operations. Make sure not to have lots of cardboard boxes, gas containers for you snow blower / lawnmower, paint, solvents, etc. in your basement or garage hobby shop. The sparks generated by grinders or metal saws can ignite a fire. It may start to burn long after you left the shop ... Full face shields often have a plastic foil on the shield which needs to be peeled off. Otherwise the shield may not be transparent (see Fig.) – just a note in case you didn't realize. (I have seen students running around ...)
- Use clamps or a vise to hold work. It is much safer than using your hand and frees both hands to operate the tool. This is more of an issue for the use of a drill press, milling machine, or saws than for a lathe, but it must be included here.
- Keep your proper footing and balance at all times. Wet floor? Cable? This is dangerous.
- Keep tools sharp and clean for best and safest performance. Follow instructions for lubrication and changing accessories.
- Use only recommended accessories. Read the manual carefully and completely. Use of improper accessories may be hazardous.
- Unplug tool before servicing and when changing accessories such as blades, bits or cutters. Definitely.

**This is a long list, but don't blame me if you did not read it and end up in a hospital.**

- Make sure switch is "OFF" before plugging in a power cord. Double check.
- Again turn spindle by hand before switching the motor of the lathe on. This

ensures that the work piece or chuck jaws will not hit the lathe bed, saddle or cross-slide, and also ensures that they clear the cutting tool.

- It is not recommended that the lathe be used for grinding. The fine dust that results from the grinding operation is hard on bearings and other moving parts of your tool. For the same reason, if the lathe or any other precision tool is kept near an operating grinder, it should be kept covered when not in use. I do occasionally use a polishing sponge (safer than sandpaper) to polish pieces, but I don't overdo it.
- Make sure that all locking and driving attachments are tightened. However, also be careful not to over tighten these adjustments. They should be just tight enough. Over tightening may damage threads or warp parts, thereby reducing accuracy and effectiveness.
- **Don't allow long stock pieces to stick out far in back of the spindle of the lathe.** Long, thin stock that is unsupported and turned at high RPM can suddenly bend and loop around. It will in fact happen ... don't try it out.
- Wear proper safety glasses. All folks working for living in metal shops can unfortunately tell you stories such as this one: a piece of metal hit the backside of glasses (somehow) and the reflected piece hit the eye of the machinist. They had to pull the piece out of his eye in a hospital. This is not a joke. You need safety glasses specified for metal work, even if you wear optical glasses. You need glasses fully closed at the sides, the top, and bottom. Goggles that fit over optical glasses are often not very comfortable and

restrict the vision. These are better than nothing, but you can purchase goggles with optical lenses. If you work every day in your shop, then invest the money to purchase really comfortable and safe glasses. Your eyes are worth the investment.

- This may sound as a talk to a teenage girl/boy, but ... you need proper eye protection before you switch on the lathe for the first time. Safety glasses are perhaps the most important safety feature in a metal shop. Don't start without them with any work on a lathe. Any home improvement store carries them.
- Don't work when you are tired. Rushing home, having a heavy dinner and a few beers, then going down to the basement shop in your house ... obviously not a good idea. Don't do it. Metal work requires your full attention, even if it is a hobby. Just one glass of beer will reduce your reflexes and attention significantly. Being tired has the same effect. **Do it the next day.**
- You may realize that the fingers of the machinist are really close to the spindle when cutting certain shapes, in particular when you eventually polish pieces. The edges of the chuck are sharp and turn at perhaps 1800 RPM. It would cause very serious injuries when hitting the rotating chuck with your fingertips. Sherline also offers a tool post for polishing (P/N 8976) which I did not, however, use myself. Polishing operations on the Sherline lathe are, by the way, not recommended by Sherline, mostly due to issues of metal dust which may end up in the motor controller box causing shorts. In addition, a dust mask is generally required for all sanding/polishing operations. Using a sanding sponge is somewhat safer than using sand paper for polishing since you can even touch the chuck with the sponge and the fingertips are still at an o.k. distance. Sanding sponges are available in any home improvement store.





- One last thing. Please be aware of that you will carry chips (small cut off metal pieces) with you all over your house. Don't ask how – chips stick to everything, somehow. Aluminum chips are rather soft and mostly “harmless”, but steel chips are sharp as raiser blades.

**Never clean up chips with your bare fingers, never.**

- This kind of list can never be complete. Read the disclaimer statement.

**A number of tools come in the meanwhile with LASER or strong light sources build in. Therefore, I added the following.**

- Read and obey the operation instructions from the manufacturer of the LASER (pointer) that came with the LASER (pointer). See the label printed on the LASER pointer and the instructions card. In addition, consider the following.
- A LASER pointer is not a toy. Keep out of reach of children and mentally handicapped people as well as pets.
- Do not stare into LASER light beam. This will cause damage to your eyes.
- Do not direct the LASER light beam towards the eyes of another person or animal.
- Remember that a LASER light beam reflected from an object will be as dangerous as the primary LASER beam.
- Remove batteries if the LASER is not in use for an extended period of time in order to prevent corrosion.
- Do not disassemble or try to repair the LASER pointer. The LASER pointer does not contain replaceable parts.
- Protect against water, dust, heat, and sunlight.
- Do not direct the LASER pointer towards the sky or streets. This can interfere with traffic, airplanes, etc.

Safety notes can also be found on various web sites, a few links are given here:

Internet

[http://www.mini-lathe.com/Mini\\_lathe/lathe\\_safety.htm](http://www.mini-lathe.com/Mini_lathe/lathe_safety.htm)

<http://www.zeraware.com/>

[http://www.americanmachinetools.com/how\\_to\\_use\\_a\\_lathe.htm](http://www.americanmachinetools.com/how_to_use_a_lathe.htm)

[http://www.fricknet.com/lp/safety\\_posters.php?gclid=CPTW6ZfFhaYCFQTNKgodFQolpA](http://www.fricknet.com/lp/safety_posters.php?gclid=CPTW6ZfFhaYCFQTNKgodFQolpA)



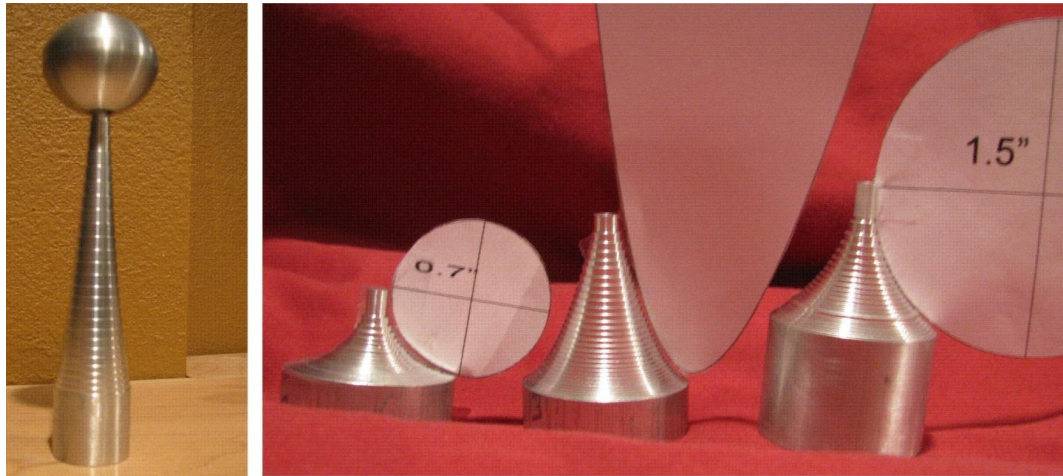
# Part A



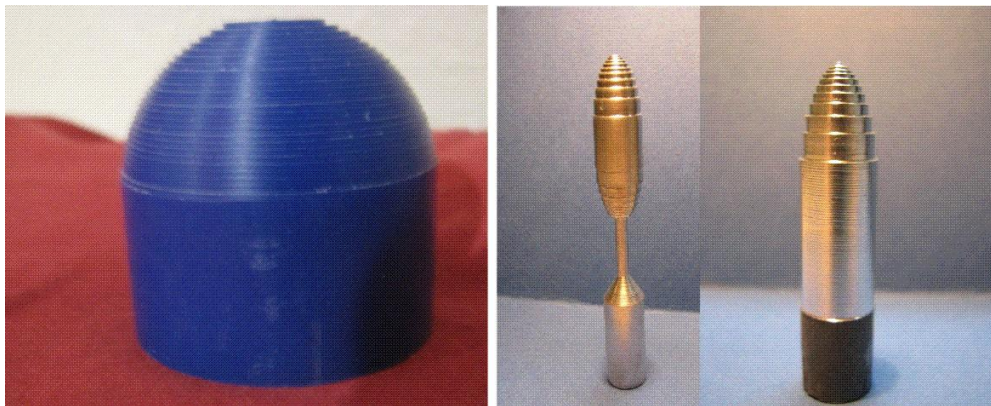
1. How to simulate a CNC lathe with a manual lathe?
2. The project idea is ...
3. Cutting a parabolic shape
  - a) Example of a parabola shape
  - b) Software for this is included ...
  - c) How to calculate the length of the cuts for a parabola shape?
4. Cutting spherical (ball) shapes
  - a) Examples
  - b) Math for this – slice lengths for circle shapes
  - c) Limitations of this approach
5. Cutting an elliptical shape
6. Slicing a Morse taper shape
7. Slicing difficult to cut taper shapes (Morse taper)
8. Summary



## 1. How to simulate a CNC lathe with a manual lathe?

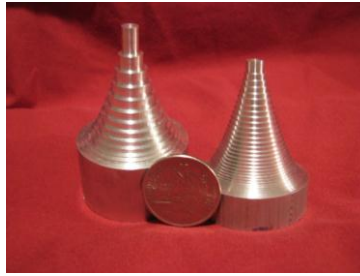


**Fig. 1:** LatheCity towers with fancier shapes. **Left)** The body is a parabola half (made with Sherline's standard lathe starter package by slicing the work piece); the top consists of a sphere. **Right)** Two spherical and one parabolic shape cut in the side of the top end of 1.5" O.D. aluminum rods (using again just the standard lathe package). Just to prove that actual spherical and parabolic shapes have been cut, paper templates are shown. Ball ends can also be made by slicing, without any accessories. For larger diameters, this actually works better and is faster than using a radius cutter. How these shapes can be made is discussed in this booklet.



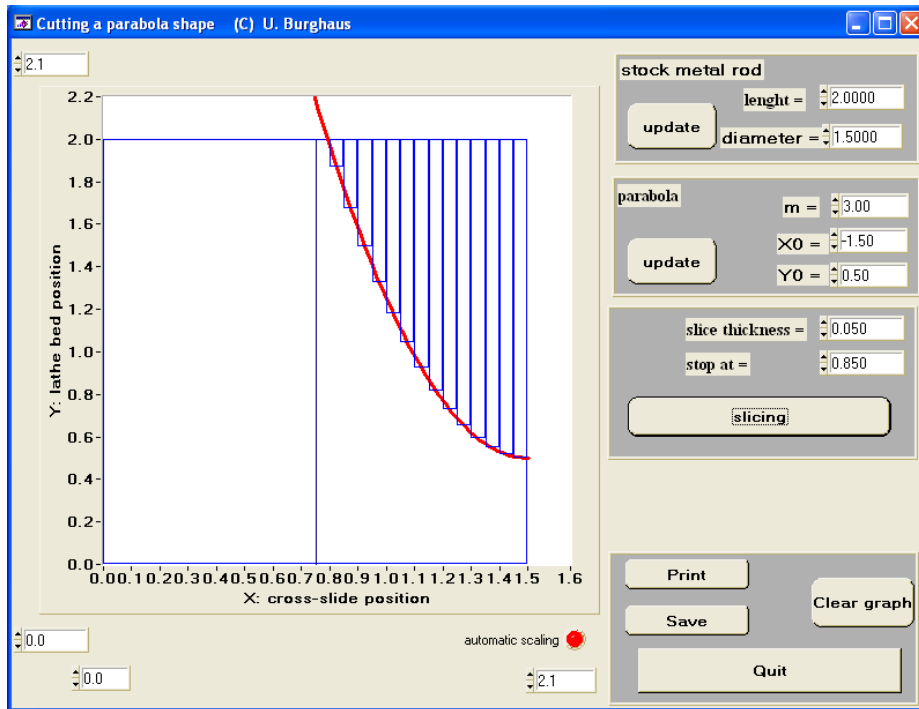
**Fig. 2:** Elliptical/spherical shapes cut by slicing the shapes. **Left)** 2" O.D. half sphere cut in machinable wax with a manual lathe and without any accessories. **Right)** Top half of an ellipse cut in a 0.5" O.D. aluminum round. The good thing, you do not need to be a genius on the lathe to cut fancy shapes by slicing operations. These shapes can often be made with less than 20 cuts on a manual lathe such as Sherline's benchtop lathe. However, this obviously works on any lathe.





**Fig. 4:** Finished parabola shapes. 0.05" (left) and 0.02" (right) thick slices were used. Al round stock of O.D. 1.5" and about 2.3" long were used. Use a live center and 4-jaw independent chuck. (When using 0.05" cuts the chips will wiggle heavily around the stock piece, i.e., cleaning up the chips after every pass is required not to jam the cutting tools. Thus, heavier cuts don't really save time and the shapes look, of course, better using 0.02" or 0.01" thick cuts. The piece on the right hand side can be cut in 15 minutes or so.) (The stock diameter is at the limit of the Sherline lathe in its standard configuration.)

**b) Software for this is available...**



**Fig. 5:** Screen shot of the *Windows* version of the slicing program with is on the CD you purchased.

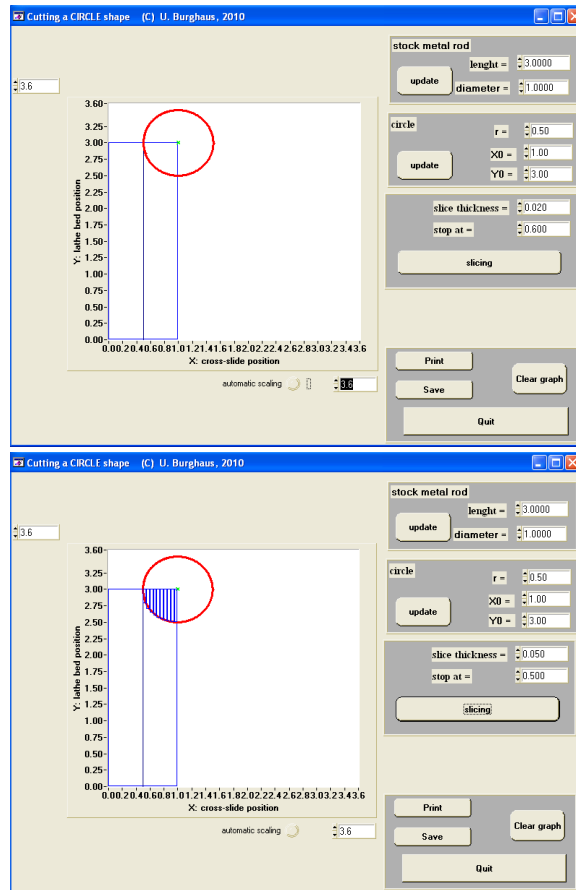


## 4. Cutting spherical shapes

### a) Examples



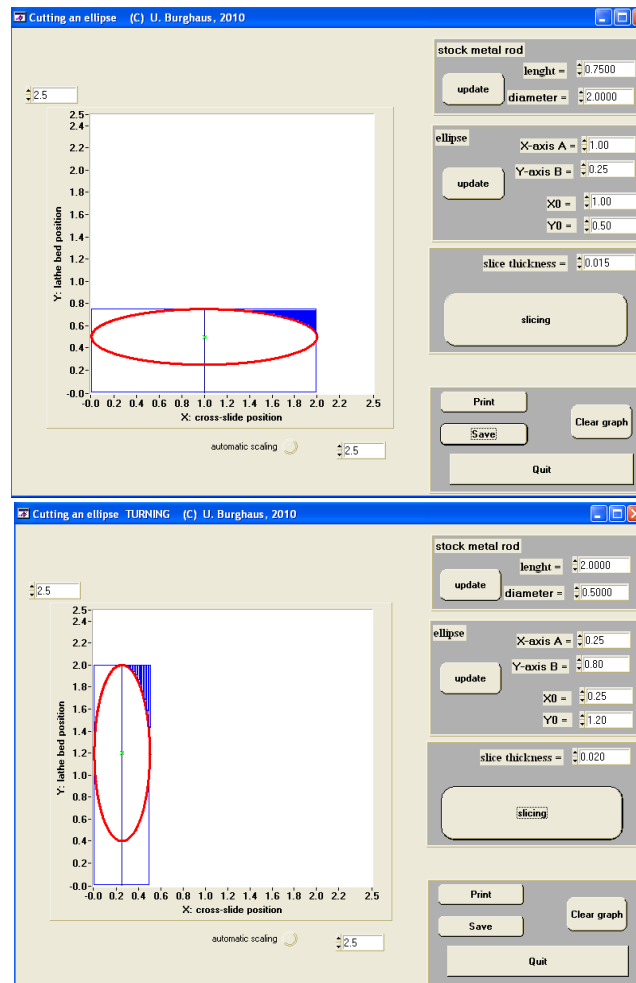
**Fig. 9:** Examples of spherical shapes made by slicing the metal rod using a manual lathe from Sherline. Ball ends can also be made.



**Fig. 10:** Windows program for calculating the slice length of spherical shapes. This works for any diameter, i.e., you don't use pre-prepared tables, but would calculate the exact geometry needed for a given project. The program saves a data table which can also be printed. These programs are quite user-friendly.

# E

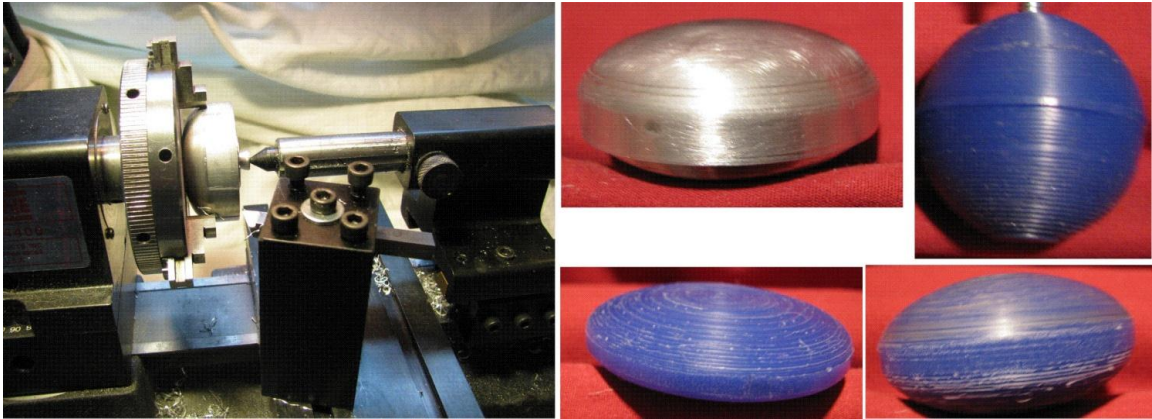
## 5. Cutting an elliptical shape



**Fig. 12:** Slicing an elliptical shape. This procedure works with any mechanical lathe, large or small, without any accessories. **Left)** Facing cuts from the front face using a LH (left hand) cutter. **Right)** Turning cuts from the side using a RH (right hand) cutter. You would use the version which results in the smaller number of slices (cuts) to approximate the shapes.



**Fig. 13:** "Cutting a UFO" as a facing operation. An O.D. 1" Al round was used. The work piece was drilled and tapped ( $\frac{1}{4}$ "-20 screw), in order to cut an elliptical shape in both sides using a  $\frac{1}{4}$ " bolt. That piece has about the size of a US quarter and just landed.

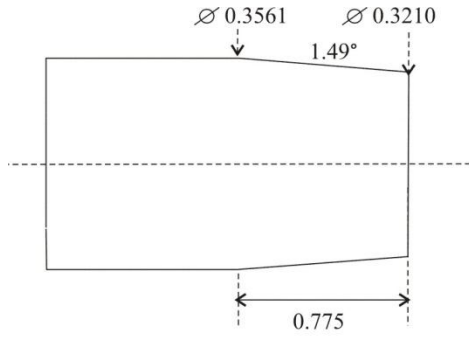


**Fig. 14:** **Left)** Cutting an elliptical shape in O.D. 1-3/4" Al round, as a facing operation with a LH cutter. Here, I used some of the raiser block accessories, which are described in the 2<sup>nd</sup> vol. The stock is long enough and the ellipse flat enough to directly clamp it on both sides, using a center to support it. (This may not be good working practice for these stock sizes, but it did work for me.) **Top center)** The finished product, an ellipse with 1.75" (=2\*A) and 0.8" (=2\*B) long axes. **Bottom right)** Two elliptical shapes with different B parameters, i.e., flat and more spherical shapes. A full sphere (A=B) with O.D. 2" is also shown for comparison. These shapes are cut from machinable wax which is simply faster to test out geometries. However, slicing operations allow you to make larger diameter pieces easily, even in stainless steel on a benchtop lathe. (The Sherline system is depicted on the left, however, this certainly works with any lathe.)

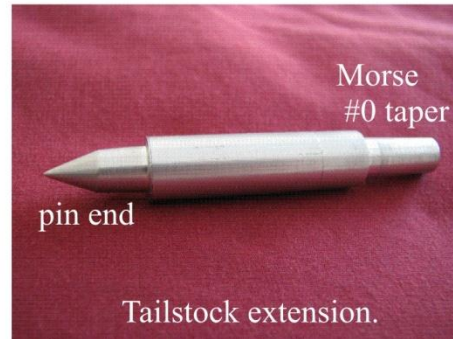


**Fig. 15:** **Left)** Cigar shapes made from a small diameter, O.D. 0.5", Al round using a manual benchtop lathe. Here turning cuts are used. **Right)** This also looks good as an earring when scaling it down.

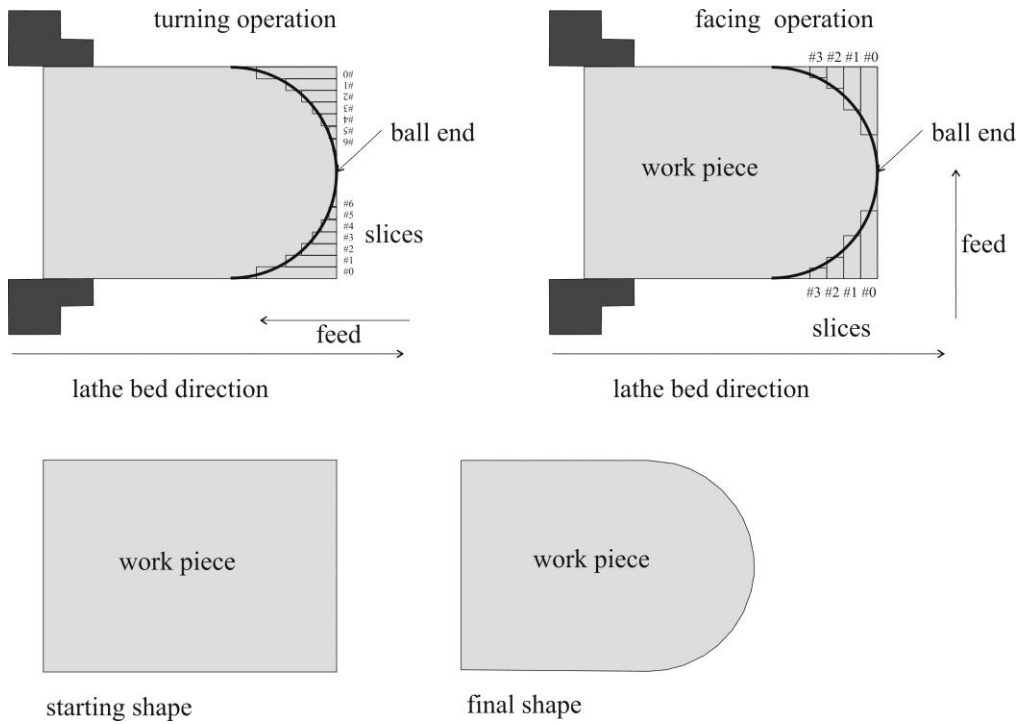
## E 6. Slicing difficult to cut taper shapes (Morse taper)



**Fig. 16:** Morse #0 taper shape.



## Σ 8. Summary



**Fig. 17:** Emulating a CNC lathe. Any shape can be approximated by slicing it.





# Part B



## 9. If you don't like PCs – black-on-white: more slicing tables

The slicing tables and programs are tested on an English lathe. However, the shapes should be conserved when cutting them with a Metric lathe. The Morse taper program saves English and Metric slicing length.



# Ball ends-facing



# Ball ends-turning Morse taper

# Part C



## 10. How to use the *Windows* software tools?

- 10.1 Included software / programs and installation
- 10.2 Turning parabolic shapes
- 10.3 user interface
- 10.4 Turning ball ends
- 10.5 Turning elliptical ends/shapes
- 10.6 Turning “inverted” ball ends – spheres cut in the side
- 10.7 Facing ball ends
- 10.8 Facing elliptical shapes / ends
- 10.9 Turing taper
- 10.10 Turning Morse taper
- 10.11 Summary / customer service



## 10. How to use the *Windows* software tools?

### 10.1 Included software / programs and installation

The CD includes the following programs to allow slicing various shapes:

- Parabolic shapes (see p. 31)
- Spherical and elliptical ends (p. 39)
- Spherical and elliptical side shapes (p. 39)
- Taper shapes (p. 49)
- Morse taper (p. 49)

These are *Windows* programs running on PCs. The programs may not run properly on other operation systems.

**Getting started.** Shown below are screen plots of these programs together with brief descriptions about how to use this software and what kind of geometries can be calculated. The basic idea of slicing shapes is illustrated in Fig. 17. **Read Part A of this booklet before starting to use the software – it's for your safety.** The programs calculate slicing tables which can be stored and/or printed. The software is quite user-friendly. Playing around with it may just be good enough – some notes are given below. Perhaps, try to reproduce one of the slicing tables given in Part A of this book and make one of these shapes as your first project.



STOP

**Tip:**

The simplest shapes to machine are perhaps the parabolic shapes. Therefore, you may get started with these.

**Turning vs. facing.** Turning or facing operations can be used (see Fig. 17). However, facing operations don't make much sense for parabolic and taper shapes. Therefore, for these shapes, only programs for turning-slicing are included. However, two programs are included for cutting elliptical shapes: turning-slicing and facing-slicing software. A circle is a special case of an ellipse. Therefore, the ellipse program also allows one to calculate the cuts for circle shapes including ball ends. Another program is included for cutting spherical shapes in the side of a work piece. Two taper-slicing programs are included. One allows to cut generic taper and required to set the large diameter, small diameter, and taper length. The other one will automatically set the parameters for a Morse taper depending on the number of the Morse taper. That program also allows to customize the length of a Morse taper. For Jacobs taper etc. use the taper program and set the parameters manually.



STOP

Generally, preferred is the slicing operation that results in the fewest cuts. However, other concerns such as the stability of the machining operation can determine if turning or facing cuts are better suited. On a small lathe turning operations allow for larger cutting depth. In any case, use a live or dead center to support the work at both ends. This is safer and results in higher precision (see Vol. 1 of the LatheCity book



series). Try out the procedures using soft materials such as plastics or machinable wax. The procedures work even for steel and for larger diameter work pieces which is one of the advantages of slices shapes opposed to using a circle cutter. However, this requires advanced machining skills and carbide cutting tools. The best turning tools for difficult to machine materials are inserted tip carbide cutters (see Vol. 2 of the LatheCity book series).



**Installing the software.** Note that we don't accept returns of information products. Once you opened the envelop that includes the CD, it will be yours. The books and CD are only sold together. (Also e.g. Wal-Mart or your grocery store doesn't accept returns such as "the movie was not that great, let me return it" or "the cake was too sweet ...")

The following files are on the CD

**Quick installation**

- Folder *Circles* with *Circles.exe* and *TDS.UIR*
- Folder *Ellipses Facing* with *Elliptical facing.exe* and *TDS.UIR*
- Folder *Ellipses Turning* with *Circles.exe* and *TDS.UIR*
- Folder *MorseTaper* with *Circles.exe* and *TDS.UIR*
- Folder *Parabola* with *Circles.exe* and *TDS.UIR*
- Folder *Taper* with *Circles.exe* and *TDS.UIR*
- Most of these folders also include a subfolder *Example Tabs* with some example slicing tables. However, not all of these have actually been tested on a lathe.
- *Readme* file
- *Copyright* note file
- *Disclaimer* file
- *Safety booklet*

**Standard installation**

- *Ellipse turning* folder with *EllipseT.001*, *EllipseT.002*, *setup*
- *Taper turning* folder with *Taper.001*, *Taper.002*, *setup*
- etc. 6 folders

The quick installation folder includes the slicing software as exe (executable) files whereas the standard installation folder includes installation programs which will generate exe files for the slicing programs.



**Quick installation (Windows 7):** Use the files in the quick installation folder. The quick installation will work only if you have the required dll (dynamic link library) files on

your PC. This may not be the case. Therefore, try out quickly the quick installation. If it does not work use the standard installation which is described next. Quick installation works with *Windows 7*, but not with older *Windows* versions.

You can run the programs in the quick installation folder on the CD or copy the files on your computer. If you copy the files on your PC (note that this is a single user single PC license) then don't change the file names and keep the folders as they are. Double click on the exe files, e.g., double click on circles.exe which will start the program. The TDS.uir file must be in the same subdirectory as the exe files. One can see the file extension (.exe, .uir) when using *details* in the *view menu*.

All programs will start up with **default parameters** which will result in a meaningful result. Push the update buttons to generate the graph, the slicing buttons to graph and calculate the sliced shape. More details are given below.



**Standard installation (*Windows 7* and “all” other *Windows* versions):** Use the files in the standard installation folder. For each of the programs, installation software is on the CD with generates *Windows* exe (executable) files. You will find several folders on the CD (standard installation folder) which include these installation programs. You can start the installation with the software on the CD or copy these files on your PC (note that this is a single user single PC license). If you copy these folders onto your PC, then do not change the file names.

Open one of the folders. In each of the folders, you will find three files labeled as *xyz.001*, *xyz.002*, *setup.exe*. (*xyz* denotes circle, ellipse, ...) Double click on the *setup.exe* file. This will start the installation process. Follow the instructions on the screen, it's a fast and simple procedure. (You have not to change the CD/disk.)

In addition, a de-installation program will be installed. You can reinstall the software if needed. Double clicking on the generated exe file will start the slicing program.

All programs will start up with default parameters which will result in a meaningful result. Push the update buttons to generate the graph, the slicing buttons to graph and calculate the sliced shape. More details are given below.

If you restart the PC after installation, the slicing programs will show up in the *Windows* “all programs” list. (On older *Windows* versions, that works also without a restart.)

**System Requirements.** The software is tested for the following operation systems:

- PCs only
- *Windows 7*
- Microsoft *Windows XP* (Home Edition, Version 2002, Service Pak 3 or Service Pak 2)
- *Windows 98* (32 bits)



The software will not run on EssPC or Macintosh unless you have *Windows* running.

**We have a demo version on our website. Try it out. If it runs on your computer then the full program versions will also work.** The demo version does not allow to save data files. **Note that we don't accept returns of information products. Once you opened the envelop that includes the CD, it will be yours.**

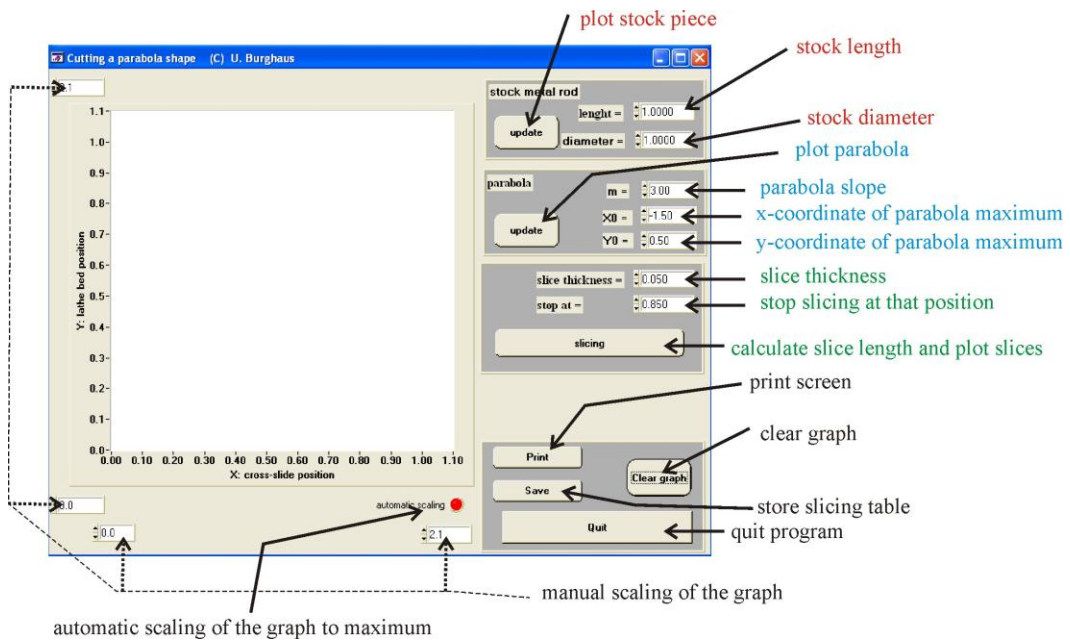
**English vs. Metric.** The software, slicing tables, and examples are given in English units and were tested on an English lathe only. We did not test any of this on a Metric lathe. However, ball shapes, elliptic shapes, and parabolic shapes should be conserved when changing the unit system. For example, instead of using one inch as the radius one could also use 1 cm, 10 mm, 25.4 mm, or 7 km. The shape should be conserved since the equation for e.g. a circle simply "scales the trigonometry with the length of the radius". A slice length of 1.5 could be 1.5 cm or 1.5 inches, depending on what units you used to measure the stock piece. Angles are given in degree.

For the Morse taper program we convert the slicing table directly into mm. Thus, inches and mm are given. Here, the English slicing table is simply converted into the Metric system. (However, the Morse taper definition is anyhow an ANSI definition, i.e., a US norm.)

**Tip:**

**Ball ends.** For machining ball ends use one of the ellipse program and set x-axes A = x-axes B = radius. Further notes are given below.

## 10.2 Turning parabolic shapes



**Fig. S1:** Calculating turning slicing length for a parabola shape. Described is what the various buttons do.

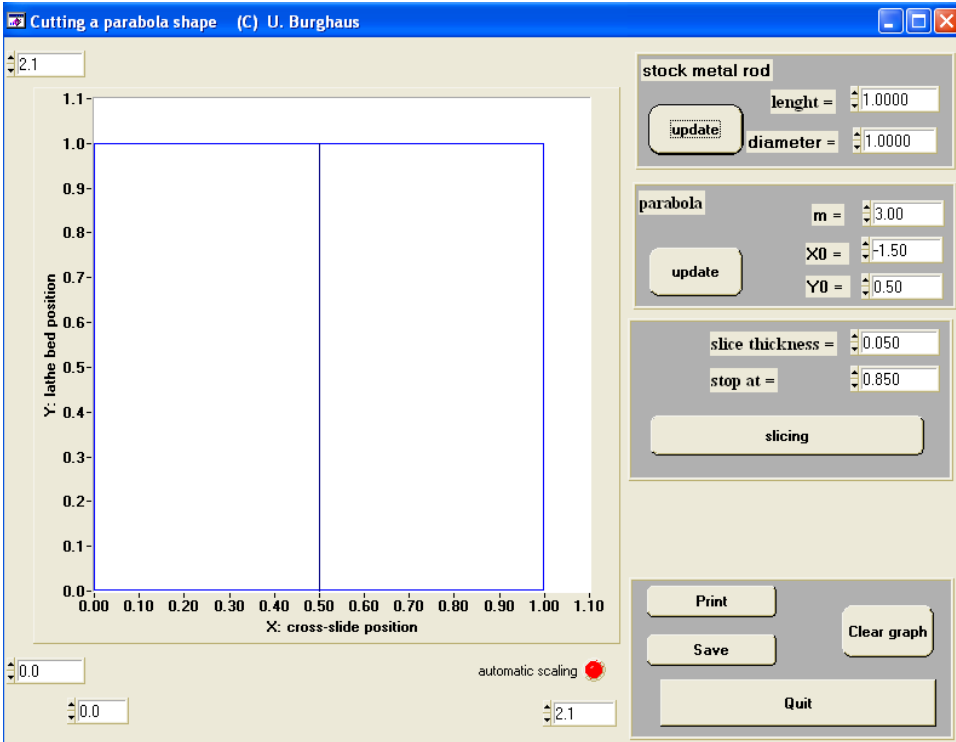


Fig. S2: Step 1. Drawing the stock metal rod for a length of 1" and diameter of 1".

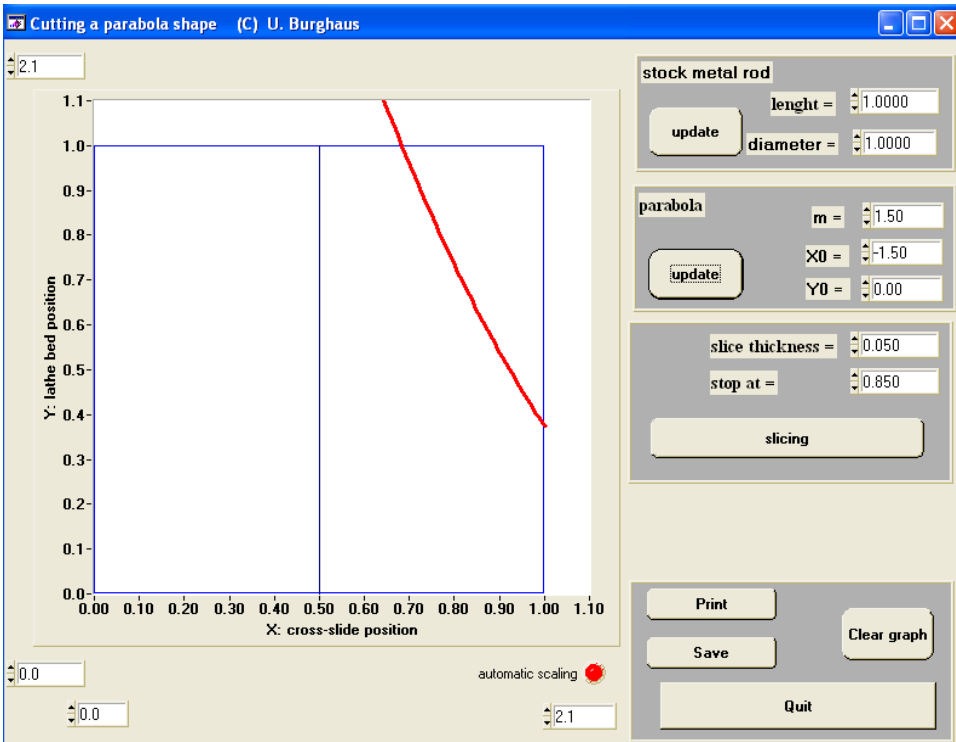


Fig. S3: Step 2. Drawing a parabola onto the stock metal rod.  $m = 1.5$ ;  $x_0 = -1.5$ ;  $y_0 = 0$ . (The  $X_0$  and  $Y_0$  are the coordinates of the minimum of the parabola which are outside of the scale on this plot.) You don't need to know math, just play with the parameters and plot the shapes.

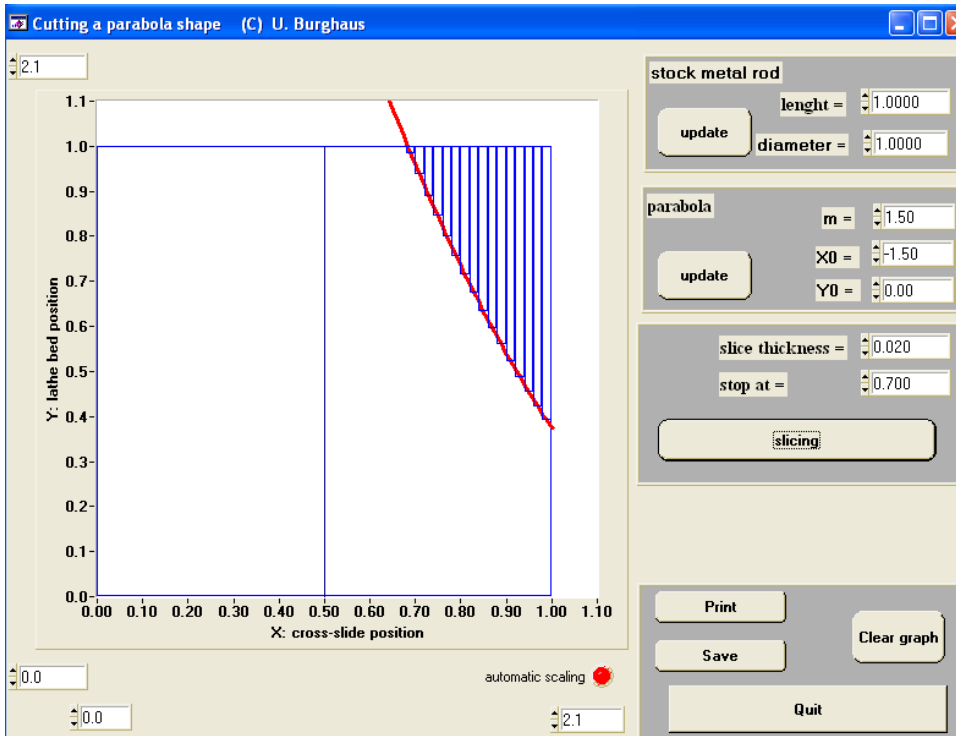


Fig. S4: Step 3. Calculate and plot the slices. Thickness = 0.02", stop at 0.7" Further examples and parameters are discussed in Part A of this book.

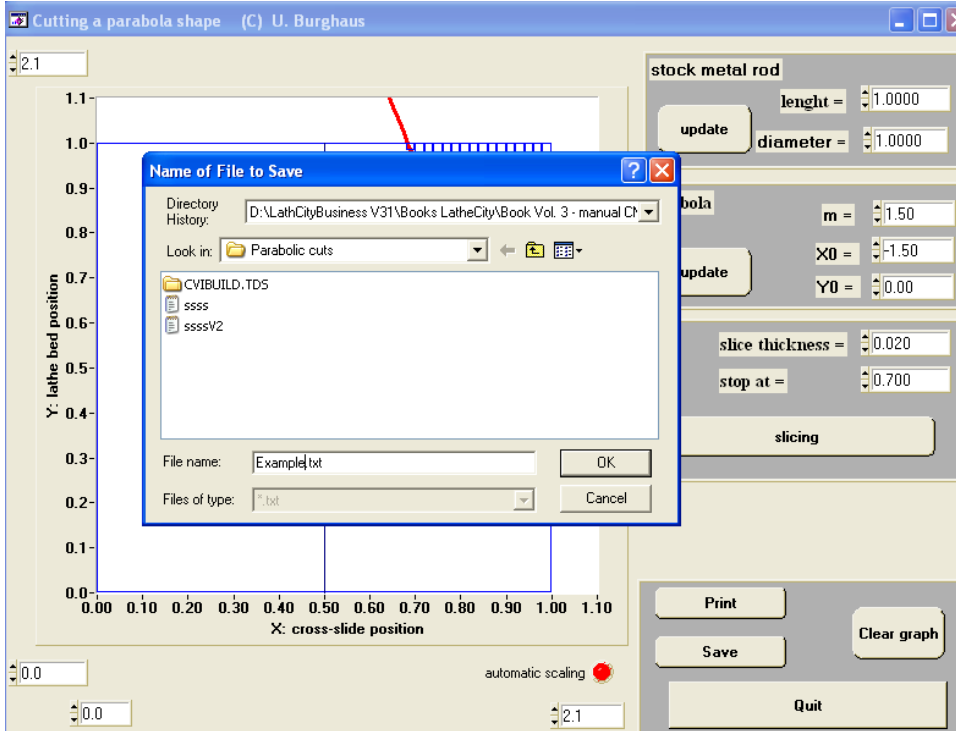
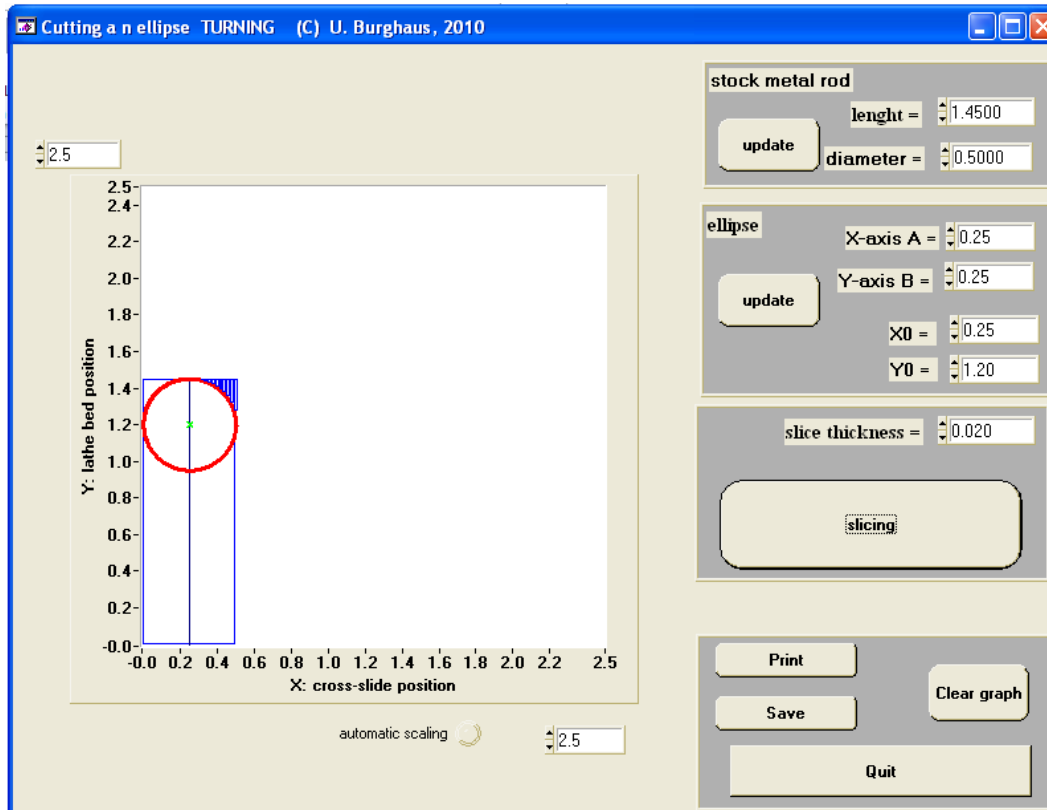


Fig. S5: Saving the slicing table. Select a location on your PC and type in the file name.



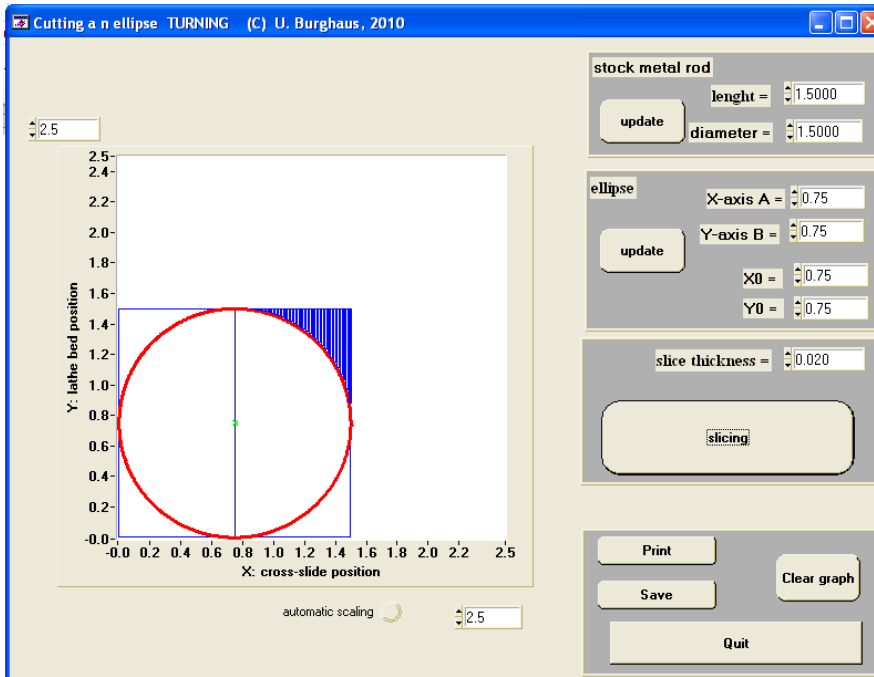
## 10.3 User interface

### 10.4 Turning ball ends

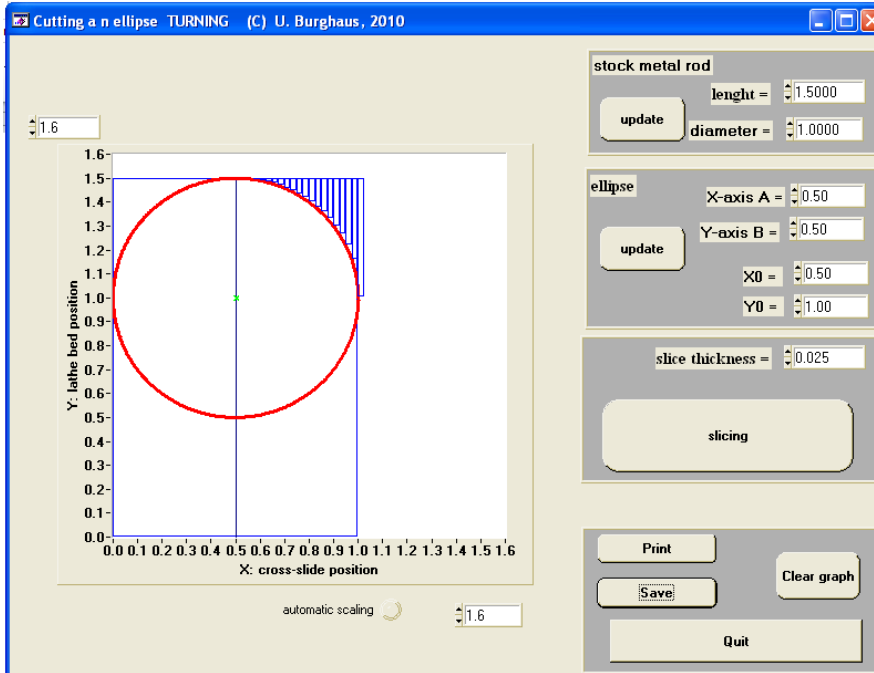


**Fig. S6:** Use the *turn ellipses* program. For  $A=B$  spherical (ball) shapes are generated. That one here would not make much sense to machine by slicing, since it can perhaps be better cut using a radius cutter. However, if one want to cut this type of shape in stainless steel, slicing may be the only way to do so on a benchtop lathe.





**Fig. S7:** Assume you want to cut a ball end with a radius of 0.75" which is close to the size limit of e.g. Sherline's (standard) system. Therefore, do this carefully and use soft materials. Anyway, a stock length of 1.5" with a diameter of 1.5" would theoretically work, which equals the diameter of the sphere. Set  $A = B = 0.75$ " as the radius. Set the center of the sphere at the center of the rod,  $X0=Y0=0.75$ . If you can actually machine this or not depends on your lathe and your skills. Be careful. The last two examples indicate the limits of this procedure for a tabletop system.



**Fig. S8:** That O.D. 1.0" ball end is more realistic for a benchtop lathe. The slice thickness used here would only work for soft materials on a benchtop system.

### 10.5 Turning elliptical ends/shapes

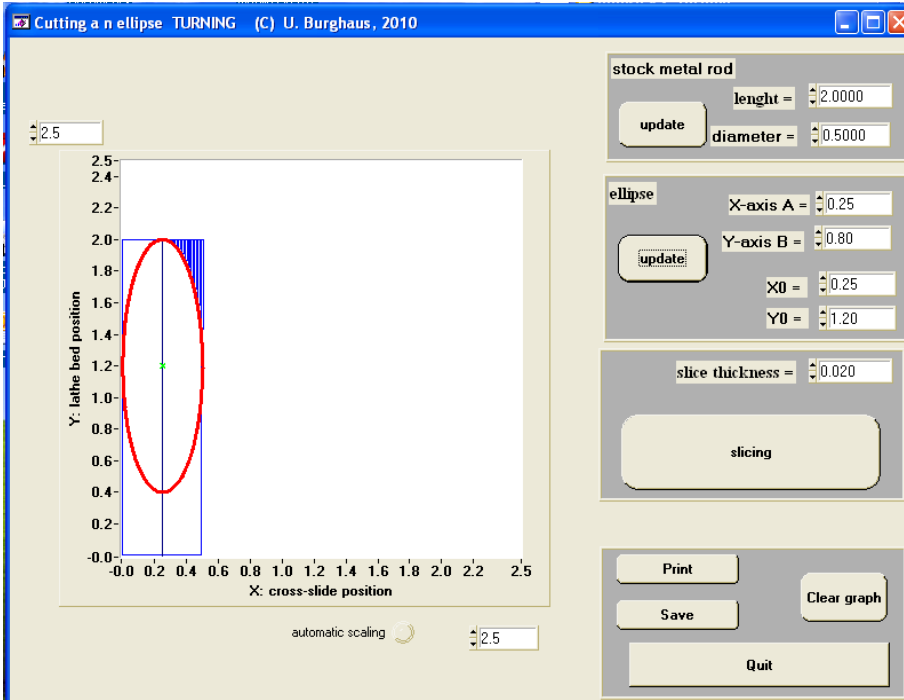


Fig. S9: Use the *turn ellipses* program.

### 10.6 Turning “inverted” ball ends – spheres cut in the side

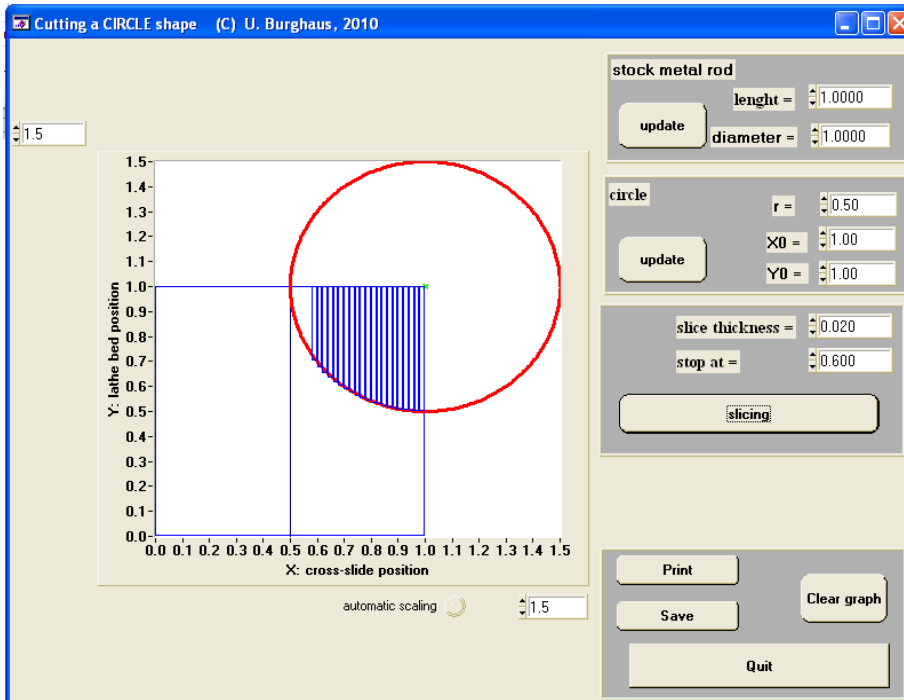


Fig. S10: Use the *circle shapes* program for these geometries. Again this is a turning operation. This is similar to the first example about cutting parabolic shapes.

### 10.7 Facing ball ends

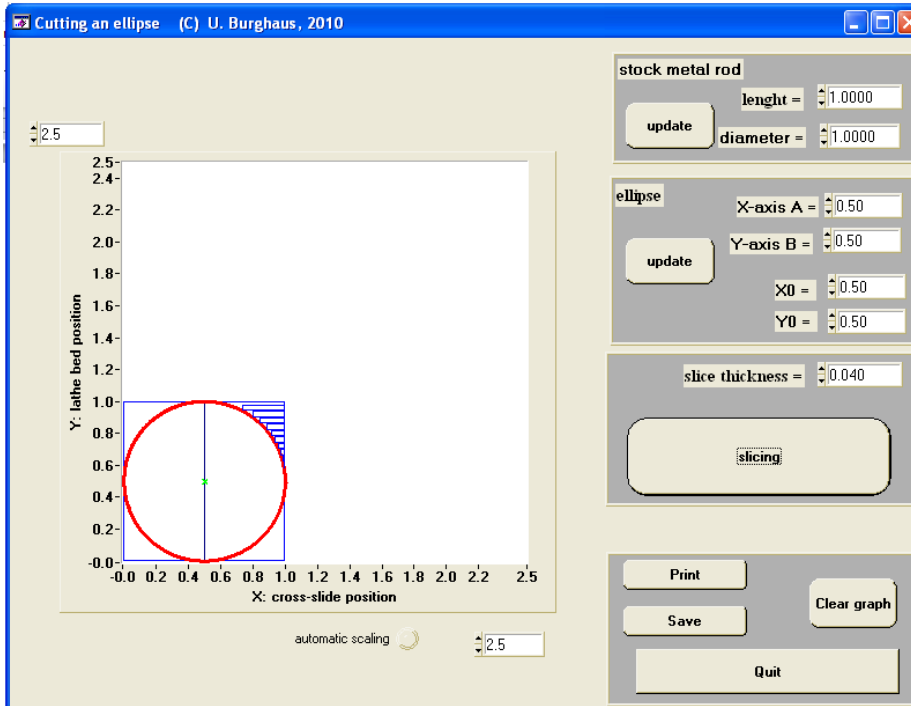


Fig. S11: Use the *facing ellipses* program and set A=B=radius.

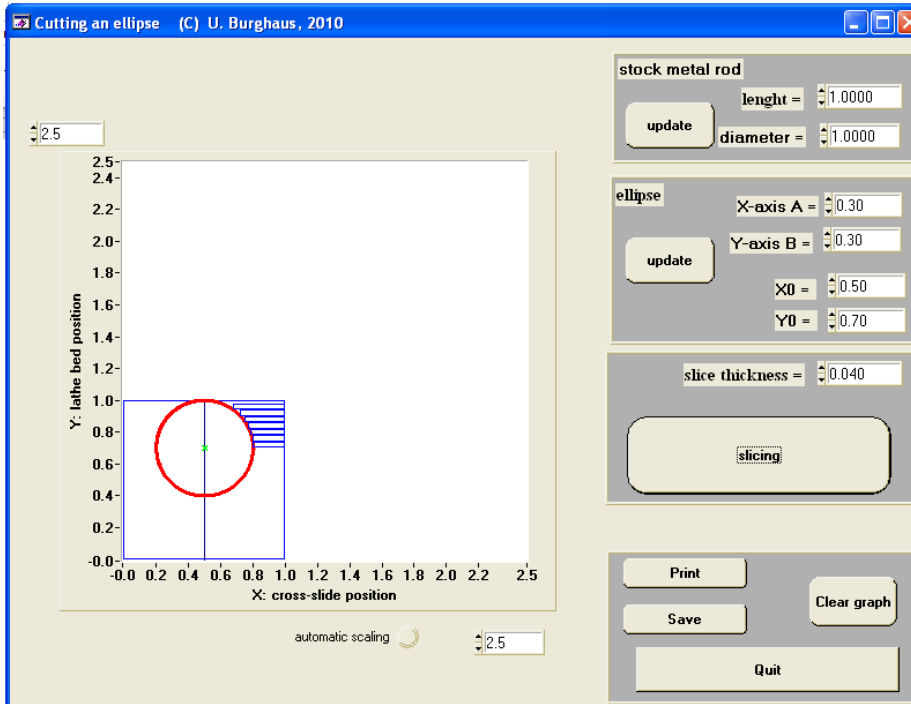


Fig. S12: Use the *facing ellipses* program and set A=B=radius. A partial ball end is generated. One would need to use a much smaller slice thickness for a real machining operation on a small lathe. Larger slice thicknesses are used here solely for a graphical illustration.



## 10.8 Facing elliptical shapes / ends

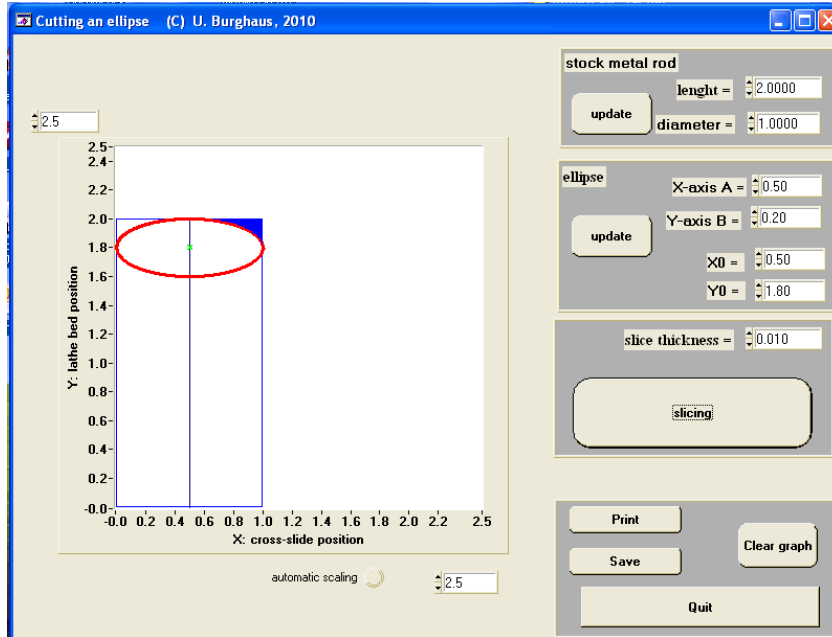


Fig. S13: Use the *turn ellipses* program.

## 10.9 Turning taper

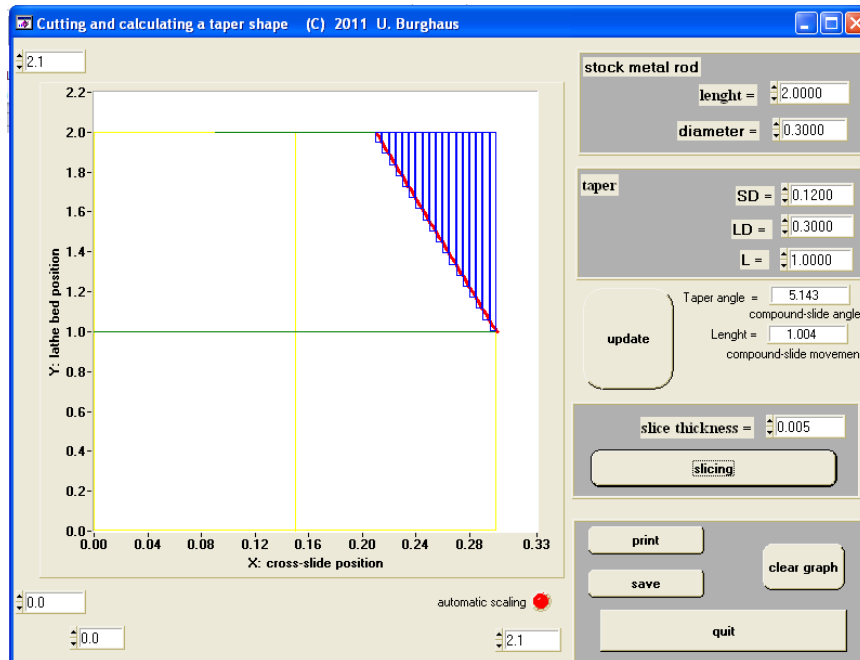


Fig. S14: Use the *turn taper* program. One could set the parameters in this program to cut Morse taper, but that would be rather tedious. Therefore, we included another program for these (see below). SD / LD: small / large diameters. L: taper length along the lathe bed (also called run, see Vol. 1). The calculated length is the length of the slope, or the length a compound slide would actually move. That program also calculates the taper angle.



## 10.10 Turning Morse taper

The program uses the following definition which is for full length Morse tapers:

taper	LD	SD	L	angle
#0	0.3561	0.2520	2.00	1.4908
#1	0.4750	0.3690	2.13	1.4287
#2	0.7000	0.5720	2.56	1.4307
#3	0.9380	0.7780	3.19	1.4377
#4	1.2310	1.0200	4.06	1.4876
#5	1.7480	1.4750	5.19	1.5073
#6	2.4940	2.1160	7.25	1.4933
#7	3.2700	2.7500	10.00	1.4894

Tab. S1: LD: large diameter; SD: small diameter; L: length

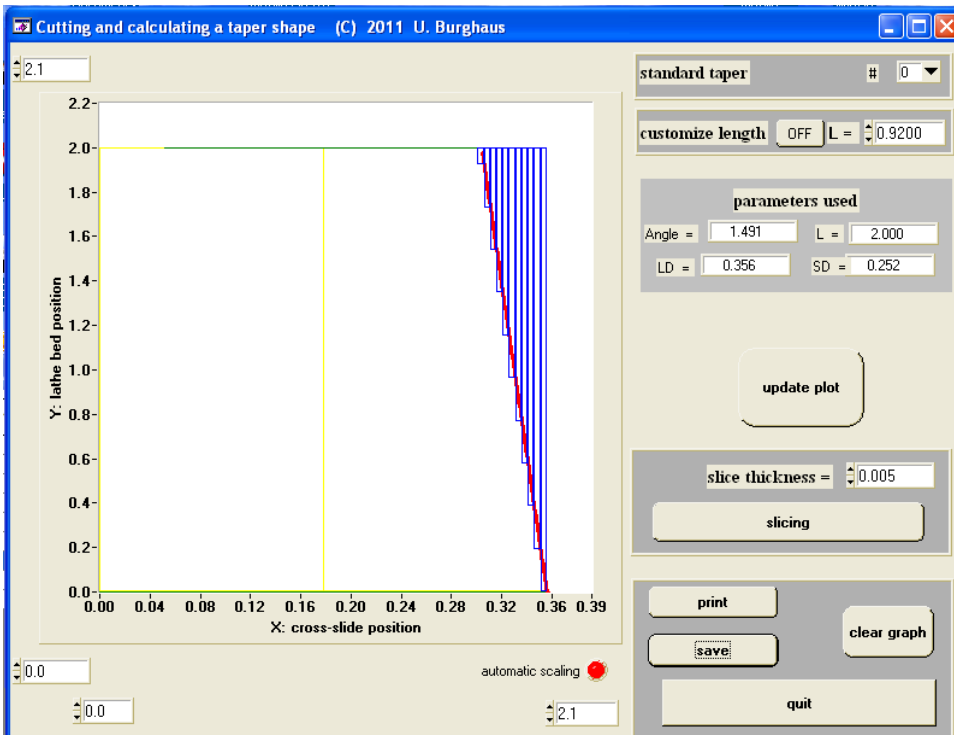


Fig. S15: Use the *turn Morse taper* program. Turning a standard Morse #0 taper by slicing. Note that the *customize length* button is turned off.

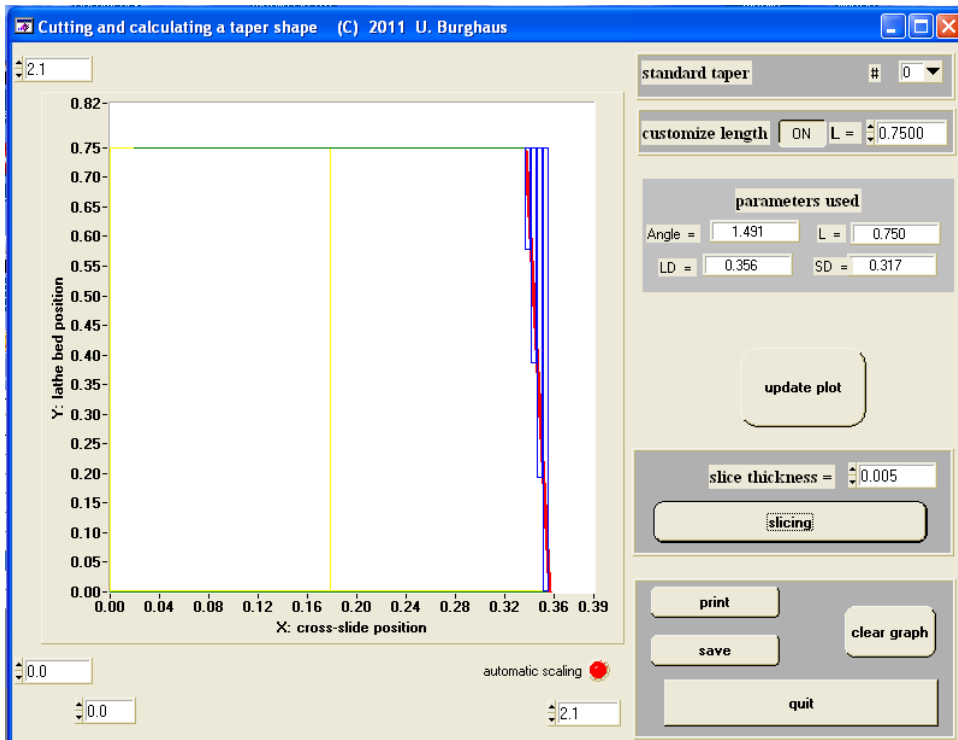


Fig. S16: Use the *turn Morse taper* program. Reduced length Morse #0 taper.

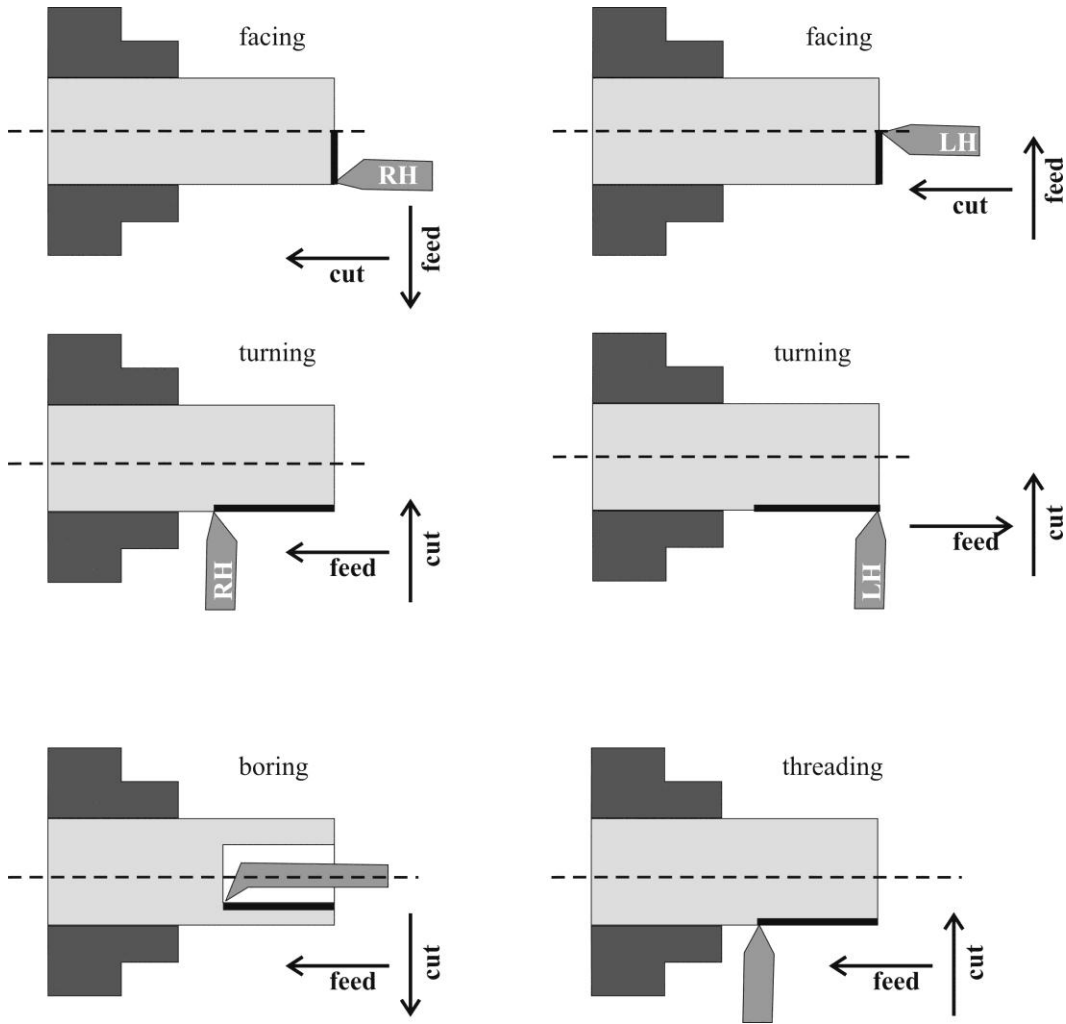


# Appendix

- **Summary of basic lathe operations**
- **Abbreviations**
- **Program codes**
- **LatheCity**







A summary of standard lathe operations is depicted. Engineering type drawings are shown. These types of images are used in operation plans which detail the process used to manufacture a given part. The tool is shown in the final position of the cut. The surface worked on is highlighted by a bold line. The dark shapes symbolize the chuck. The light grey part is the work piece. Note the label LH and RH for left hand and right hand cutters, respectively. The dark grey shape is the cutter. RH cutters have a tip at the left. The dashed line is the center line of the work piece.



**LatheCity.** Uwe Burghaus, born in West Berlin, Germany, obtained his education in Physics and Physical Chemistry at the Free University of Berlin. He obtained a PhD in 1995, after conducting his graduate studies in surface science at the Fritz-Haber Institute of the Max Planck Society in Berlin. After postdoctoral positions in Genoa (Italy) and Santa Barbara (USA) he went back to Germany to complete a habilitation/tenure in Physical Chemistry. Now at North Dakota State University, he started to establish a surface chemistry group in 2003 and obtained tenure in 2009. His group is currently focusing on studies about nanostructured catalysts.

His hobbies include machining furniture from metal and glass as well as occasionally manufacturing pieces for his research group by himself. He is not a professional machinist by training. However, his hobby developed into a small part-time business in 2012. **LatheCity** currently sells books about metal working including software tools and accessories as well as affordable jewelry: everything that's fun to make and may find customers. The strength of the business is custom designed pieces including accessories of scientific instruments.





Tailstock Accessories



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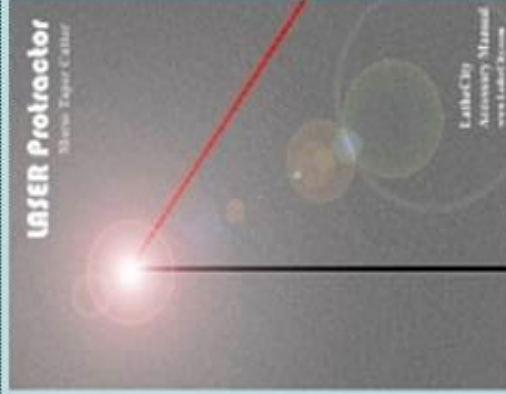
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**LASER Protractor** - Sherline Compatible  
Cutting Easily Morse Taper  
One can cut Morse Taper easily even on a small home shop lathe. Since labor costs are not an issue for hobby type work, you can make these accessories by yourself for close to zero dollars. All you need to do is setting the cutting angle precisely enough. Our LASER protractor is exactly doing this for you, making the entire process a piece of cake. Cutting a perfectly fitting Morse taper takes 10 min / piece. Actually, we are crazy offering this kind of tool, but it will cost you.



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- **Impact socket tool holder** for tailstock / mill.

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**Synopsis.** After becoming familiar with standard lathe operations one develops the desire to cut complex shapes on a lathe: fancy chess pieces, earing, knickknacks, table legs, specialty adapters, Morse taper, ... A CNC (Computer Numeric Control) lathe is the way to go, but these systems start at about \$2,000 and it takes months to learn how to use these machines efficiently. Computer skills are required. **For hobbyists, there is a faster and cheaper way to do so:**

As with CNC operations, any shape can be approximated by slicing it. This works also as a manual operation on any lathe and does not require more than 10-20 min for most shapes. How that works is described in this book, which includes a CD with windows programs. **Sophisticated computer skills are not required.** In fact, tables are additionally included which can be used without even touching a PC.

Demonstrated is how to cut ball ends, elliptical ends, taper, Morse

taper, and parabolic/spherical shapes in the side of a rod.

**This volume features again the Sherline lathe.** However, slicing operations that simulate a CNC lathe can be run on any lathe independent of the size or any design details of the lathe.

The author is not a professional machinist or engineer. In fact, the author holds a PhD in physics and teaches physical chemistry at a college. The author is a hobby machinist, as you probably are. Therefore, no information provided herein represents professional advice or best practices in machining. All information is provided to help hobbyists and other non-professionals gain a better understanding of using a miniature benchtop / tabletop lathe for hobby type work.

**System requirements** for the windows software: PCs only, Windows 7, Microsoft Windows XP, Windows 98. We have a demo version on our website. Try it out. If it runs on your computer, then the full program versions will also work.

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LatheCity Book series

**Volume 3 – Poor Man's CNC Lathe**

by Uwe Burghaus

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US Registered Copyright Number: pending  
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ISBN-10: 0985136049  
EAN: 661799788038



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