

LatheCity

Safely Working with Benchtop Lathes – Booklet III

Featuring the Sherline System

**Booklet 3 – Summary of Basic Metal
Lathe Operations**

2nd Edition

by Uwe Burghaus



LatheCity
Safely Working with Benchtop Lathes – Booklet III
Booklet 3 – Summary of Basic Metal Lathe Operations
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Disclaimer

Our lawyers let us write the following. 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 power tool can be dangerous and the proper use is the responsibility of the one who is using the tool. Neither the author nor publisher shall be liable for damage arising herefrom.** If you are not perfectly comfortable with working with power 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 half broken or damaged tools, perhaps purchased for cheap at a secondhand 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. He is a hobby machinist as you probably are. In fact, the author holds a PhD 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 miniature benchtop (tabletop) lathe for hobby type work.

This book features in particular the Sherline lathe and accessories. 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.

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Brief introductory note

The text and images of the booklets are nearly identical to the full length textbooks. However, we offer these subsets of texts at a lower price for customers who don't need the full text versions, would like to save a few dollars, and are interested in these special topics. Most customers, however, purchase one of our book packages, including the full length books.

This is the 2nd edition of booklet three. Although the text and images of the 1st and 2nd editions are identical, the booklet has been reformatted, making it more appealing, we hope. For example, pictograms were added, and larger page margins were used. In addition, a few images were added. Booklet three is also now available in full color print. This is appealing since many shop photos are included, which look much better in color. Again, the text was proofread, as detailed in the acknowledgements.

Please note that this booklet is a very brief primer about standard lathe operations for hobby machinists with a background in metalwork. If you have worked with a wood lathe previously, this booklet may be sufficient for getting started on a metal lathe. However, this booklet is mostly a collection of images accompanied by a few text lines. This is not a comprehensive introduction into metal lathe work. For this, see volume 1.

Featured, in particular, are the Sherline lathes. However, basic lathe operations are very similar on all lathe models. Differences among lathes are evident when it comes to thread cutting or taper turning, as briefly discussed in this booklet.

Pictograms used in the LatheCity books



Object of a given chapter / brief introduction.
Start of a project.



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 advanced 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 hospital. **All procedures are performed at your own risk.**



Engineering terms or topics are described here. 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.



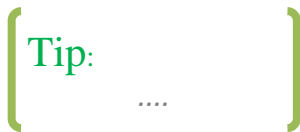
Projects: engineering / artwork projects.



Comparison of lathe and mill operations. Most of us started with lathe work, i.e., these comparisons can help gaining a deeper understanding (even of lathe work).



Summary of the chapters.



Tips and tricks.

The idea of using pictograms is allowing for fast browsing through the book as well as making it more appealing to read. Only text is hard to digest and boring after a while.

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Disclaimer

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The text of this booklet is identical with shortened text segments in LatheCity Vol. 2 and Vol. 1.



Booklet 3

⇒ 1. Required safety notes



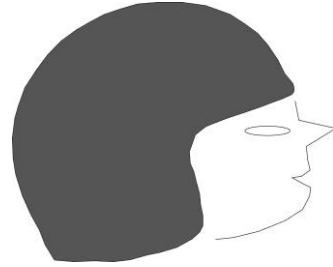
Fig. 1.1: Safety glasses. Use versions with ANSI Z87 label. ANSI is short for American National Standards Institute. Chemistry goggles, as also shown here, are not recommended for metal work, since they may block the vision too much.

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 power 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 power 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 toward the end of the book since I assume that you learn safe working practice along with the operation of your power 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 primer: “Safely 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** (see Fig. 1.1). Chemistry goggles, which are also shown here, 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

Do NOT work on large diameter and/or long stock pieces without using a center. In any case, this is not advisable on a small benchtop lathe.

safety guards. However, the little safety shields that sometimes come with a lathe provide only very limited protection. Use always goggles, in any case.

- 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/tabletop 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, self-ejecting mini-chuck keys are 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 home shop work, 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/cut 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>
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 milliseconds = 0.040 sec 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.



Fig. 1.2: Full face shield with plastic foil that needs 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 (Fig. 1.2) – just a note in case you didn't realize. (I have seen students running around ...)

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

- 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. A sharp knife is dangerous, indeed. However, a dull lathe cutting tool may be even more dangerous. (Why? It does not cut properly. It will over-heat, etc.)
- 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.
- 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.

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

- 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 will suddenly bend and loop around. This WILL indeed happen. You may be amazed that an aluminum or steel rod bends like nothing. (Supporting the end may be an option, but I would not recommend this.)
- 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. (These glasses should come together with any lathe package. Unfortunately, they don't.)
- 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.

- 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 probably often (but not always) “harmless”, but steel chips are sharp as razor blades. Never clean up chips with your bare fingers, never.
- This kind of list can never be complete. Read the disclaimer statement.

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

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.fricknet.com/lp/safety_posters.php?gclid=CPTW6ZfFhaYCFQTNKgodFQolpA

Safety products can also be purchased on-line, for example, perhaps look at e.g.:

http://www.envirosafetyproducts.com/product/magnifying_safety_glasses_magnifying_safety_glass

Internet

Booklet 3

2. Brief summary of standard metal lathe operations



Object: refreshing your memory if you forgot how to run standard cuts on a lathe before starting to work with more complex accessories. **This book is not for beginners! If you never worked with a lathe before start with LatheCity Vol. 1 which includes a full description of lathe operations together with detailed safety notes.**

The entire first volume of the LatheCity books series with nearly 200 pages details what I will summarize here in a few pages. **If you never worked before with a lathe, start with volume one!** Given below is just a brief summary of standard lathe operations. However, I added a few engineering type notes which were not included in the first volume.

2.1 Different lathe types are in use

Different types of lathes can be distinguished including engine lathes, turret lathes (which have automated tool change systems, the turret, a carousel with different tools mounted on it), single spindle and multi-spindle lathes, CNC (computer numeric controlled) lathes as well as combination systems which have a lathe and mill mounted on the same lathe bed (these became quite popular in the hobby sector). I am not sure if Sherline's benchtop lathe would be considered as a small engine lathe, since engine lathes typically have a gear box and allow for cutting threads directly. CNC (Computer Numeric Control) lathes simply have stepper motors mounted on the lead and cross-slide spindles which control the position of the cutting tool. All standard lathe operations were detailed in the first volume of the LatheCity book series. Therefore, in the following only a very brief summary of standard lathe operations is given, mostly in the form of images.

Booklet 3

3. Brief example: how to use a right hand cutting tool

→ **Object:** one of the simplest and most often used applications of a lathe is to turn down round stock, i.e., reducing the diameter of a metal rod.

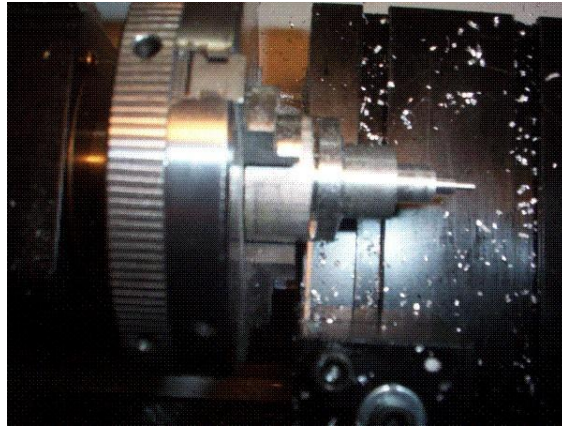


Fig. 3.1: Cutting the first LatheCity towerer



- ⇒ Safety first: Do not run the lathe without fixing the chuck on its own or a piece of work.
- ⇒ Longer and/or larger diameter stock needs either to be fixed at both ends using a live center or supported by a steady rest. Start with small diameter ($\frac{1}{2}$ " or 12.7 mm max) and short (2" or 50.8 mm max) Al round stock, only. (I did see somewhere that the maximum length of a work piece, without using a center, should not exceed three times the chuck diameter. That appears, however, somewhat large to me.)
- ⇒ Use safety glasses.
- ⇒ Make sure not to hit the chuck with the cutter; use the DRO (digital readout).
- ⇒ Make sure that the spindle turns freely before starting the lathe.
- ⇒ For now, use only aluminum (Al) rounds, no steel, no square bars!

P Procedure

a) *Prepare metal stock.* Cut an aluminum round no longer than 2" (50.8 mm) and no thicker than $\frac{1}{2}$ " (12.7 mm) using e.g. a hacksaw. Square the cut as well as possible which makes it simpler to mount the piece afterwards in the lathe!

Abbreviations

DRO	Digital readout
CNC	Computer Numeric Control
O.D.	Outer diameter
I.D.	Inner diameter
RH	Right-hand cutter
LH	Left-hand cutter
HSS	High-speed steel
Al	Aluminum
CAD	Computer-aided design
CAM	Computer-aided manufacturing
MSDS	Materials safety data sheet
SFM	Surface feed per minute
IPR	Inches per revolution
RPM	Revolutions per minute
BSPP	British Standard Pipe Parallel
BSPT	British Standard Pipe Taper
NC	National Coarse
NEF	National Extra Fine
NF	National Fine
NPS	National Pipe Straight
NPSF	National Pipe Straight Dryseal
NPT	National Pipe Taper
NPTF	National Pipe Taper Dryseal
NS	National Special
N/UN	Unified Inch Screw Thread



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 and 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 for scientific instruments.

Acknowledgements – 1st edition

Proofreading of this booklet by A. Erickson (ND) is acknowledged.

I will continue to update and improve on the texts over time. These updates will be made available to our customers as a free newsletter – assuming that one of the textbooks was purchased from LatheCity. Go to the customer’s corner and use the password provided with your purchase. We will not bother you with e-mails, but the updates can be downloaded from our website.

Writing a book about metal working typically does not improve the reputation of a scientist (some prefer not to get dirty fingers...) and chemistry college teacher. Therefore, many thanks in advance to open-minded colleagues. However, in the UK, there is apparently a “tradition” to write your own book about “gardening” – the LatheCity books would be my version of this, I guess.

Acknowledgements—2nd edition

The proofreading of this booklet by William D. Gardner (CA) is acknowledged. I met William as a customer and got to know him somewhat via e-mail. He is a hobby machinist and runs a small part-time business. Although he is using a larger lathe, LatheCity books interested him, and he proofread some of our books. His suggestions are highly appreciated, and the number of typos was further reduced thanks to him.



Tailstock Accessories



Endmill Holder

All accessories come with a detailed manual and safety booklet.

<http://www.LatheCity.com/Tools/>

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Featuring The Sherline Metal Shop

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LatheCity Accessories

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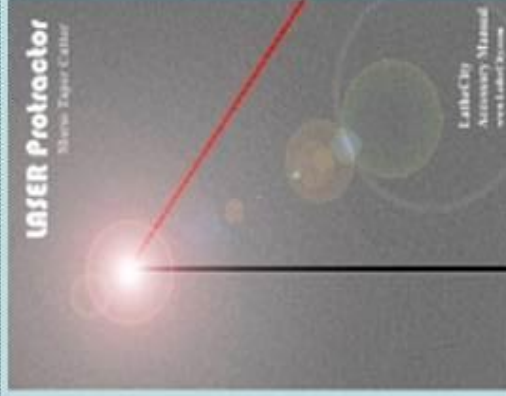
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2012

<http://www.LatheCity.com>

Disclaimer: Neither LatheCity nor its owner shall be liable for damage arising from misuse or unprofessional use of lathe and mill accessories. Training and experience is required to safely use power tools and accessories. 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/power tools, then don't do it! Find a different hobby. Don't use half broken or damaged tools. Thoughtful work will be at your responsibility. The manufacturer is not a professional machinist or engineer. Therefore, no information provided in manuals 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 the accessories. Read the safety notes and follow these and other relevant safety procedures.



LASER Protractor - Sherline Compatible
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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.

Lathe Tailstock Accessories

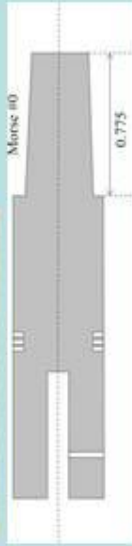
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LatheCity
Safely Working with Benchtop Lathes II
Featuring the Sherline System

Volume 2 - Working with Lathe Accessories

by Uwe Bergmann



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Compound Slide Stop

Accessories For The Sherline Metal Shop

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Available soon ...

- Affordable **endmill** holder (screw-on type).
- **LASER** protractor for benchtop lathe. [Allows for setting taper angles with a precision of about 0.2 deg. Zero-point-two degree. That makes it easy to cut your own Morse taper accessories.]
- Affordable **indexing tool** holder. [Would mount on the cross-slide of a Lathe / Mill and allows for precise drilling / milling operations at variable angle settings.]
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<http://www.lathecity.com/Machinists/MachinistPreview.html>

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LatheCity

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LatheCity offers a 30-day-money back guarantee.

Synopsis. Very briefly described are basic operations on a metal lathe. This booklet serves as a primer for advanced hobby machinists. If you never worked before with a lathe then consider vol. 1 of the LatheCity book series. This primer would not provide enough information.

The author is a hobby machinist as you probably are.

The text of this booklet is identical in part with sections in LathCity Vol. 1 and Vol. 2.

LatheCity
Safely Working with Benchtop Lathes – Booklet III
Booklet 3 – Summary of Basic Metal Lathe Operations
2nd edition
Uwe Burghaus

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