

Подстрочный перевод для книги:

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Joe Martin
Craig Libuse

Tabletop Machining

a basic approach to making small parts on miniature machine tools

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<https://github.com/ponyatov/tabletop>

Настольные станки

основные приемы изготовления мелких деталей на миниатюрных станках

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Joe Martin

фотографии и иллюстрации Craig Libuse

- модели
- приемы и техники
- прототипы
- измерения
- наладка станков

... Это то, что каждый инженер должен знать о станках, механической обработке и производстве

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Глава 1

A special note to engineers reading this book...

1.1 Machining for engineers and engineering for machinists

At first glance the subtitle on the cover of this book could be a bit deceiving. What does tabletop machining have do with engineering you may ask? Compare it to a book that has been written about the ocean. The seas could be described from the perspective of a young man who has just sailed around the world in a twenty-five foot sailboat or by a merchant seaman who has spent his career aboard a giant ocean liner. Each would have an entirely different view of what the ocean was all about. In a storm, the chap in the small boat would write about surviving broken masts and mountainous seas while the merchant seaman might write about seasick passengers. I believe you would learn more about the ocean from the young man in the small boat, because in a sense he was more involved in his subject. He was not just on it, he was *in* it.

1.2 Navigating the seas of machining

The ocean in this case is the world of machining. The craftsman using tabletop machine tools is like the sailor in a small boat, while the professional machinist with his big CNC shop tools is like the world-traveling seaman. The process of producing complex, accurate parts cannot be described by looking in the window of a quarter million dollar CNC machine. It would be like a merchant seaman working in the engine room trying to describe a storm in the Atlantic Ocean by telling you how much extra fuel the ship used. The professional's view of the subject may be so cluttered with details that it is difficult to sort the things you really need to know to sail in rough seas or make good parts. It is the craftsman working with small tools, turning the cranks by hand, who will have the most to tell you about the real world of working with metal.

1.3 Looking at engineering from the craftsman's perspective

With the aid of computers, parts can easily be drawn that can't be built. CAD programs allow a designer to put a perfect .0001" radius on the inside corner of a pocket cut in tool steel. Hopefully after reading this book you will not ask a toolmaker to do it, but if you do, you'll at least know it is going to cost a great deal of money to try. Working with metal is far more difficult than one would imagine. A false impression is gained by looking at the beautiful yet inexpensive machined parts that we deal with daily. They have been produced in very large quantities, and that five-dollar part you may consider a "rip-off" could easily cost five hundred dollars if you had to manufacture just one. New engineers will often think a toolmaker is a failure when the seemingly simple part they design ends up costing a thousand dollars to make. Most engineers will eventually have to deal with the craftsman who turn their ideas into reality, and in reading this book I would hope you come away with a new perspective of what is really involved in producing a machined part or a product. An alternate subtitle for the book might have been "Things they should have taught you in engineering school but didn't". This book might be considered your textbook for a course called "Reality 101".

1.4 Seeing production from the point of view of both the engineer and machinist

My perspective on machining could be considered unique because, in order to survive, I have had to deal with every aspect of product design from engineering to prototyping to tooling to manufacturing to sales. In this book I have tried to pass along the logic I used to solve the associated problems. Understanding how a craftsman thinks and works is an essential part of getting projects done. Unless you are willing to build your designs yourself, you are going to have to learn how to deal with the craftsman who will actually build them. The more you know about their methods, personalities and unique problems, the better your chances are for success. Smooth sailing.

— Joe Martin

Глава 2

About the Author

Joe Martin worked in the construction trades after graduating from high school, but his real love was always building and flying radio controlled model airplanes. When he decided to turn his hobby into a business and start his own company making components for the radio control industry, he had to learn about machining and toolmaking on his own. He simply couldn't afford to hire anyone else to set up the tools and make the molds. He has designed and taken to market numerous products and owned several companies over the years. He began his association with Sherline Products as an importer of Australian-built lathes in the early 1970's. Since then, Joe's company has grown to become the sole manufacturer and worldwide distributor of Sherline machine tools.

Joe was one of the founders of the sport of Formula One model aircraft competition as well as one of its early champions. His competitive nature seems to find its way into whatever form of fun he pursues. He has been a winner in sports from model airplane competition to ocean sailboat racing and, most recently, automobile racing.

Never one to be a spectator in life, he has tried and mastered many skills. In this book, he passes on to you some of his hard-won knowledge about machining. His down-to-earth style is not highly polished. In fact, if you could say that life has put a finish on him, it would probably be described as ground or honed...very accurate

but not slick. I think his heartfelt love of good tools and miniature machining will be apparent to all who read this book. Working with him these past 25 years is certainly an experience I would not have wanted to miss.

— Craig Libuse

Joe at speed in a 1974 vintage IndyCar at Phoenix International Raceway.

Глава 3

Dedication

Carl Hammons — 1936–1997

Carl Hammons, my friend and business partner for thirty years, died September 11, 1997 as I was writing this book. We shared thousands of lunches and coffee breaks over the years we worked together, and much of the knowledge I have passed on in this book came from Carl. Carl and I shared the rare distinction of having been partners not just once, but twice. We both played different roles in putting together the product line, and without him it just isn't going to be as much fun.

When we joined forces for the second time, we had an agreement that eliminated any need to financially justify the purchase of a new piece of equipment. We would buy machines that interested us and find a job for them later. The laser engraver was a perfect example of this, but now we couldn't get along without it. It may seem contrary to smart business practice, but that's the way we did it. I have no regrets, for we were always the happiest when we were confronted with a new set of technical problems. Therefore, I dedicate this book to Carl Hammons; my business partner, my friend.

I should also credit the English teachers in the Cranston, Rhode Island school system for forcing a not-so-

willing student enrolled in the "boys general class" to learn enough about our language to dare to take on the task of expressing difficult concepts in simple words. I graduated in 1953. You, the reader, will be the ultimate judge of their (and my) success in this undertaking.

— Joe Martin

The photo composition above is a joint effort. The photo of Cart was taken by his wife Barbara. The photo of Swan Lake, Montana, a favorite spot of Carl's, was taken by friend Wayne Armstrong. The two images were composed in PhotoShop by artist Elaine Collins

Глава 4

Modeling Miniature Machine Tools

You will probably not be surprised to find that people who are interested in miniature machine tools often find it fun to make miniature models of full-size tools. This page shows beautiful examples of a lathe and a mill from two expert craftsmen.

Barry Jordan built a 2" diameter rotary table and then needed a machine to use it on. The result was this 1/5 scale Bridgeport® mill. The project was started in 1997 and completed just in time for Bridgeport's 60th anniversary in 1998. What started as a model turned into a real machine in miniature, capable of actually cutting small parts in mild steel.

The parts are all machined from aluminum and billet cast iron. No castings were used. The polished pulley cover is made from Dural. More of Barry Jordan's miniature tools can be seen on page 246.

This small but fully functional 1/6 scale Hardinge lathe was modeled by Wilhelm Huxhold of Ontario, Canada. A lifelong machinist, he shows his love for machine tools by modeling them in miniature. Unlike Barry Jordan's

Bridgeport, this project took many years to complete. More of Mr. Huxhold's work can be seen on pages 22 and 217. A profile of his career is presented on page 330.

TABLETOP MACHINING

... A basic approach to making small parts on miniature machine tools

Joe Martin

DESIGN, TYPESETTING, ILLUSTRATION AND PHOTOGRAPHY BY CRAIG LIBUSE

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The author takes no responsibility for the use or application of any of the materials or methods described in this book. All miniature projects shown were either made or could he made using tabletop machine tools similar to or identical to those described in this book.

To order additional copies of this book call:

Toll Free in the USA – (800) 541-0735 ♦ International – 1-760-727-5857

or write to: Joe Martin. 3235 Executive Ridge, Vista. California 92081

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4.1 Machining is not a "paint-by-numbers" process

If you are looking for a book that will give you complete, step-by-step instructions on how to build your particular machining project, this is not it. In fact, that book probably does not exist. What this book will give you is all the basic knowledge you need to start machining metal. Your imagination plus the information in this book will allow you to make just about anything. The many photos showing what others have done are here to spark your imagination. None of the projects shown in the photos in this book came with detailed instructions. Most came with none at all. They are, for the most part, not beginner projects. I'd suggest you start with a relatively simple project and apply what you learn from this book. As your skill and experience increase, you'll be ready to tackle anything you see here. Read the parts about tools and materials. Read the parts about speeds and feed rates. Study the photos of setups carefully. Everything you need is right there, but you have to use some brainpower to apply it to your projects. The level of satisfaction you achieve will be directly related to the amount of effort you are willing to put forth.

The book is now in its fourth printing, and some have commented that it doesn't contain enough project plans. I have avoided adding a lot of "how to" plans in order to concentrate on the general skills, craftsmanship and techniques needed to create a good part. These will never be found in a set of plans. For those looking to take what they've learned here and apply it to a specific project, there are many sources of kits and plans on Sherline's web site at www.sherline.com. Several magazines like *The Home Shop Machinist* and *Machinist's Workshop* offer new plans in every issue.

4.2 Thanks to those who helped

Joe Martin and Craig Libuse would like to thank all of those who took the time to read this book word for word and sent in suggestions for corrections in the previous printings. Our thanks go to Marc Cimolino, Jim Clark, Glenn Ferguson Jr., Mort Goldberg, Alan Koski and especially Huntly Millar for their extremely diligent, voluntary efforts. Among other things, this book addresses the issue of quality and the quest for perfection,

so we have made every attempt to eliminate any typographical errors. We welcome your input in a continuing effort to improve the quality of this book. Though rarely achieved, perfection is a goal always worth pursuing.

Часть I

Safety rules for power tools

A patternmaker's interview for employment

One of the best patternmakers I ever knew apprenticed in the trade for many years with his father. When he went to work for U.S. Steel in their pattern shop, the foreman who was interviewing him for the job asked him to hold out his hands. When the foreman could see that the applicant still had all ten fingers, he was hired. The foreman could see from his work that the patternmaker was a good craftsman, but he figured that if he had been working in the trade that long and still had all his fingers he must be a good, safe worker too, and that was just as important.

Spinning tools that are powerful enough and sharp enough to remove metal can also remove just about anything else that gets in their way. Though less dangerous than their larger full size shop counterparts, small power tools can still cause serious injury to those who don't show them the proper respect. Even hand tools used improperly can cause injury. Talking about safety is not nearly as fun as talking about the beautiful miniature machining projects in this book, but working safely is part of the skill of a good craftsman.

Working safely is simply a series of habits that you develop. Once they become habits, it takes no longer and is no less enjoyable to work that way than to work with unsafe habits. Injuries definitely take the fun out of working with tools, and fun is what miniature machining is all about. Please read these rules and apply them until they become habits so that you can enjoy your hobby to the fullest.

1. **KNOW YOUR POWER TOOL** — Read the owner's manual carefully. Learn the tool's application and limitations as well as the specific potential hazards peculiar to this tool.
2. **GROUND ALL TOOLS** — If a tool is equipped with a three-prong plug, 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 KNOWN GROUND. Never remove the third prong. (See drawing on next page.)
3. **KEEP GUARDS IN PLACE** — and in working order.
4. **REMOVE ADJUSTING KEYS AND WRENCHES** — Form a habit of checking to see that keys and adjusting wrenches are removed from the tool before turning on your machine.

5. **KEEP WORK AREA CLEAN** — Cluttered areas and benches invite accidents.
6. **AVOID DANGEROUS ENVIRONMENT** — Do not use power tools in damp or wet locations. Keep your work area well illuminated.
7. **KEEP CHILDREN AWAY** — All visitors should be kept a safe distance from the work area.
8. **MAKE WORKSHOP KID PROOF** — with padlocks, master switches or by removing starter keys.
9. **DO NOT FORCE TOOL** — Do not force a tool or attachment to do a job for which it was not designed. Use the proper tool for the job.
10. **WEAR PROPER APPAREL** — Avoid loose clothing, neckties, gloves or jewelry that could become caught in moving parts. Wear protective head gear to keep long hair styles away from moving parts.
11. **USE SAFETYGLASSES** — Also use a face or dust mask if cutting operation is dusty.
12. **SECURE WORK** — Use clamps or a vise to hold work when practicable. It is safer than using your hand and frees both hands to operate the tool.
13. **DO NOT OVERREACH** — Keep your proper footing and balance at all times.
14. **MAINTAIN TOOLS IN TOP CONDITION** — Keep tools sharp and clean for best and safest performance. Follow instructions for lubrication and changing accessories.
15. **DISCONNECT TOOLS** — Unplug the tool before servicing and when changing accessories such as blades, bits or cutters.
16. **AVOID ACCIDENTAL STARTING** — Make sure the switch is "OFF" before plugging in power cord.

17. **USE RECOMMENDED ACCESSORIES** – Consult the owner's manual. Use of improper accessories may be hazardous.
18. **TURN SPINDLE BY HAND BEFORE SWITCHING ON MOTOR** — This ensures that the workpiece or chuck jaws will not hit the lathe bed, saddle or crossslide. and also ensures that they clear the cutting tool.
19. **CHECK THAT ALL HOLDING, LOCKING AND DRIVING DEVICES ARE TIGHTENED** — At the same time, be careful not to overtighten these adjustments. They should be just tight enough to do the job. Overtightening may damage threads or warp parts, thereby reducing accuracy and effectiveness.
20. **WHEN WORKING THROUGH THE SPINDLE, DO NOT LET LONG, THIN STOCK PROTRUDE FROM THE BACK END OF THE SPINDLE SHAFT** — The end of unsupported stock turned at high RPM can suddenly bend and whip around.
21. **It is not recommended that the lathe be used for grinding.** The fine dust that results from the grinding operation is extremely 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.
22. **WEAR YOUR SAFETY GLASSES** — Foresight is better than NO SIGHT! The operation of any power tool can result in foreign objects being thrown into the eyes, which can result in severe eye damage. Always wear safety glasses or eye shields before commencing power tool operation. We recommend a Wide Vision Safety Mask for use over spectacles or standard safety glasses.

4.3 ELECTRICAL CONNECTIONS

The power cord used is equipped with a 3-prong grounding plug which should be connected only to a properly grounded receptacle for your safety. Should an electrical failure occur in the motor, the grounded plug and receptacle will protect the user from electrical shock. If a properly grounded receptacle is not available, use a grounding adapter to adapt the 3-prong plug to a properly grounded receptacle by attaching the grounding lead from the adapter to the receptacle cover screw.

NOTE: Electrical circuits designed into the speed control of the Sherline lathe or mill read incoming current and automatically adapt to supply the correct 90 volts DC to the motor. As long as you have a properly wired, grounded connector cord for your source, the machine will operate on any current from 100 to 240 volts AC and 50 or 60 Hz. without a transformer ¹. This should include just about any country in the world. Prior to 1994, an AC/DC motor was used. Use the AC/DC motor ONLY with the power source for which it was intended. It will not automatically adapt to any other current and using it with an improper power source will bum out the motor or speed control.

GROUNDING TYPE 3-PRONG PLUG

PROPERLY GROUNDED TYPE OUTLET

USE PROPERLY GROUNDED RECEPTACLE AS SHOWN

PLUG ADAPTER

GROUND WIRE

Proper grounding of electrical connections.

¹The first DC units built in early 1994 did not include the circuits to adapt to other currents. The capability to include that feature was not available to Sherline at that time. As soon as it was, it was included. If you think you may have an early DC model, remove the plastic speed control housing and look for a label on the aluminum speed control frame. If it has a small metallic label on top of the frame that lists input voltage as 120 VAC, DO NOT ATTEMPT TO CONVERT THIS UNIT TO OTHER CURRENTS. Models that can be used with any current have a paper label on the end of the speed control frame which lists the model number as KBLC-240DS.

Older AC/DC motors available from Grainger

Sherline's supply of older AC/DC motors is slowly being depleted. A very large run must be custom ordered to get more, and this is not economically feasible. However, the Grainger catalog stocks a 1/5 horsepower motor identical to the one used on early Sherline tools. The catalog number is 2M139. They have locations in every state and can be found in the Yellow Pages under "Electric Motors". Their web address is www.grainger.com. Your other option would be to upgrade your motor and speed control to the newer, more powerful DC version.

"Common sense is instinct, and enough of it is genius."

— Josh Billings

Часть II

FOREWORD

4.4 What is "tabletop machining"?

Tabletop machining is about operating miniature machine tools. These are machines that can be picked up and set on a small bench or, if need be, a kitchen table, and used to build precise metal parts. They are inexpensive compared to their full-size shop equivalents, but are just as versatile and accurate as long as the size of the part is appropriate for the machine. The "Unimat" was the first miniature lathe mass produced and well known. Thousands of Unimats were sold, and today many are still in use. It had a wide variety of accessories manufactured for it and a price that was affordable. A number of other miniature machine tools have been manufactured since the Unimat, and the company I own, Sherline Products Inc., has become today's leader for this class of machine. I believe the fact I am both a hobbyist and toolmaker gave me more insight into what our customers needed when it comes to both accessories and instructions.

The original Unimat lathe was the first miniature machine tool to achieve international popularity. It came in a professional looking wood box and offered a versatile design and many accessories at a reasonable price. Its two-rail bed design made it too flexible for jobs requiring a high degree of accuracy, but it introduced many people to the fun of machining in miniature.

4.5 Beating the system

For me there has always been something special about projects that have been built on these small machines. The machinist who works with miniature machine tools will have beaten the system by not spending thousands of dollars on tools. These craftsmen build beautiful projects for enjoyment, not wages. These are special people who may suddenly have an urge to accurately build that model they have dreamed of for years. The machinists who are successful will realize there is a learning curve involved in accomplishing this. This book is about shortening that learning curve and giving you a new sense of what craftsmanship is all about.

4.6 Not just the “how”, but also the “why”

The tables and charts can be found in *Machinery's Handbook*, and I don't plan to duplicate them in this book. Library shelves are full of books of this nature. The information in this book won't be found in charts and graphs. I'm going to attempt to give you the information to actually start making "parts". Instructions that tell you "how" to do a job too often skip the most basic information, and that is "why" you would want to do a job this way or that way. I believe the customers who purchase miniature machines are intelligent enough to find the specific information they need at a library. These customers just don't happen to know much about machining. However, I also believe this book contains enough general rules to get a job done. Get started on a project as soon as you have your tools set up and working. Read a little, machine a little. Never cut metal without a plan that includes dimensions. "Making chips" without a plan can develop terrible work habits. This trade has few choices when it comes to parts fitting together. To work in unison they must be accurate, and your first task should be to make parts "to size".

4.7 How to read this book

A book like this doesn't need to be read from front to back like a novel. You will probably skip around reading first the sections that interest you the most. Therefore, this book may seem at times to be redundant. I have attempted to make each chapter relatively complete in and of itself, and some rules apply to more than one machining operation. Some of the more important ones may be repeated wherever they apply. To keep you interested and make the book more fun, we have included many pictures of actual projects and the people who made them. The examples of what has actually been done using tabletop machine tools speak more eloquently about their capabilities than anything I could say.

4.8 Why Sherline tools are used in the examples

I must say up front that Sherline tools will be used in the examples throughout this book. It is not my intention to use this book as a tool to sell Sherline tools, but rather to use these tools to demonstrate the techniques I am discussing. The reason should be obvious; that is, they are what I have available and what I know the most about. The principles involved in using these tools are pretty much typical of all machine tools, even larger full size shop tools, so what you learn through these examples should be able to be applied to whatever brand of tools you are using. Also, we have sold many thousands of these tools over the past twenty-five years, so the knowledge specific to Sherline tools will be of additional benefit to those of you who are using them as you work with this book. In addition, I hope the information I've included about how this tool line was developed and how our business is run might inspire some of you to follow your dreams and start a business of your own, whether it is in the area of machining or in any area that interests you.

Craig Libuse is seen at the drawing board with author Joe Martin. Craig has been doing all of Sherline's illustrations, instruction sheets, magazine advertisements and catalogs since shortly after Joe started the company in the mid-1970's. He ran his own graphic design studio for 22 years doing Sherline's work on contract before coming on board full time as Marketing Director in 1995.

According to builder Edward J. Young of Mobile, Alabama, this model Stuart 10H steam engine runs "smooth as silk" when powered by compressed air. The inset photo shows the plexiglass cover he made to replace the plate over the valve so its action can be viewed as the engine runs.

Глава 5

INTRODUCTION

5.1 The essence of “craftsmanship”

I wrote the introduction to this book last. That’s because when I started writing, I didn’t quite know where I was headed. I knew that over the years I had written many instructions for our products which contained enough knowledge and advice to be valuable. I also figured I could start writing answers to questions that had been asked of me over the years. I could fill the remainder of the book with pictures and charts and end up with a book that wouldn’t be any different or better than what was already out there. For me, therefore, the most important part was to try and instill in a potential machinist the value of good craftsmanship. Great craftsmen not only get the job done, they add a certain "look" to parts they build. It is almost a signature. I have seen the same part made by two different craftsmen using the same drawing. They were both highly skilled toolmakers. Both parts met the specifications perfectly, yet I could easily tell who built each part. Machining should be considered a form of art.

5.2 Some pretty good advice

Professional photographer, Tim Schroeder of Michigan built these five identical Stirling hot air engines to polish his skill as a new machinist. By making each part five times, he was able to get in more machining time with each setup and learn more in a shorter period... a pretty good way to learn.

On the wall of my Uncle's shop when I was a boy was a sign which I still remember. I'm not sure who said it, but I think it expresses what I'm trying to say pretty well. It said:

"A man who works with his hands is a laborer.

A man who works with his hands and his brain is a craftsman.

A man who works with his hands, his brain and his heart is an artist."

When I was building model aircraft, my friends and I had an interesting way of judging the quality of a model. We would set the model aircraft on the ground and start backing away from it until it looked good. A three-foot model would be considered superb and a fifty-foot model was one that was pretty crude. There were also models that wouldn't look good no matter what the distance was or the viewing angle. In those cases, the failure was in the design, and the best craftsman in the world can't make a bad design look good.

5.3 The best design is usually not your first design

The home machinist usually has more control over a design he is working with than a professional does. Don't use the first idea that comes into your head without proving to yourself that it's the *best* way. When a product has been designed properly, no one would even consider building it in a different way.

It is the way it is supposed to look because it's obvious. Unfortunately, these are the designs that are the hardest to come up with. They are also the designs you will get the least credit for even though they are your best. The assumption is that the obvious solution is also the easy solution, but this is usually not the case. The home craftsman also doesn't have to work within the constraints of commercial products where costs limit your choices. For us, time is not money, it's fun!

This is what craftsmanship is all about. Too few citizens really appreciate what good craftsmen do, Because their work doesn't fail it is taken for granted. A good craftsman can tell at a glance when someone's work is better than his, and he can start improving his work to be Number One, It is almost a form of competition between craftsmen where time and quality are considered at the same lime. Do you think Michaelangelo would be considered a great artist if he had only carved one statue and painted one picture? He produced so much good work in his lifetime that he set a standard that is still sought after today. One good part doesn't make you a craftsman. You are judged on the body of your work.

Author Joe Martin is shown with some of the miniature machine tools produced by Sherline Products. The small size of miniature machine tools makes them easy to use and not too intimidating for new machinists.

I not only wanted my writings to be useful to the hobbyist/machinist who builds parts for pleasure. but also to those future craftsman who want to build parts that have that "look". Please realize the parts being referred to in this book are not production parts. Machinists who produce these kinds of parts have the training and skill to make automatic machines build good parts. The only thing an automatic machine will manufacture automatically is scrap. It stilt takes that craftsman's touch to make machines run perfectly. The parts being discussed in this book will be parts built one at a time... "one off. These parts are usually part of another assembly that would be considered the final product.

5.4 You don't become a machinist by buying a machine

You should strive from the beginning to make better and more accurate parts than you think you need. Work to closer tolerances than the job demands. Be on the lookout for ways to make a job easier or better. I hope you will enjoy the process of creating accurate parts from raw metal. Buying a machine won't make you a machinist, but using it along with the skill and knowledge you acquire along the way eventually will.

5.5 What new machinists like most and least

If you are new to machining, you may find it to be either one of the most rewarding skills one can learn or the most frustrating thing you have ever attempted. What makes machining fun for some is the complexity and challenge. The same thing will drive others up the wall. One person may be overjoyed because he can now make parts that were not available for purchase. Another may wonder why he just spent all day making a part that is similar to one he could have purchased for two dollars. (The difference, of course, is that it is not the same as the two dollar part — it is *exactly* the part needed.)

Jewel-like projects like this miniature marine winch are a showcase for the kind of craftsmanship machinists strive for. Being able to display your work on a desk or coffee table or even carry it with you in your pocket is an advantage of working on small projects.

5.6 There are no shortcuts

Machining is a slow process because parts are made one at a time. The interesting thing is, a skilled machinist may take almost as long to make the same part as a novice. Shortcuts usually end in failure. Unlike some other trades, mistakes cannot be covered up. There are no erasers, white-out or "putting-on tools" for machinists. You

simply start over. Do a lot of thinking before you start cutting. To expand a little on an old rule: "*Think three times, measure twice and cut once!*"

5.7 Anticipation of a tool's limitations is the crafts man's strength

The skill in machining isn't just "moving the dials". It is a combination of engineering and craftsmanship. A file is just as useful a tool to a machinist as a multi-thousand dollar machine tool. Tools "deflect" or bend under load, and anticipating this bend is what it is all about. Sharp tools deflect less than dull tools, but with each pass the tool dulls a little and the deflection becomes greater. If you try to machine a long shaft with a small diameter, the center will always have a slightly larger diameter than the ends because the part deflects away from the tool where it has less support. You can go crazy trying to machine it straight, or you can simply pick up a good, flat mill file and file it straight in a few moments. Machine tools will never replace the "craftsman's touch and machining is a combination of both good tools and good technique.

5.8 The great parts about running a business like this

I'm a hobbyist who has been lucky enough to make a living at a hobby I enjoy. I own and manage Sherline Products Inc. and enjoy coming up with new products. After working at it for over twenty-five years, this has become more of a hobby to me than a business. I still work the same number of hours, but it's more fun now that I don't have to worry about making payroll. I have a good staff to take care of the day-to-day business, and I get to spend most of the day thinking about better ways of doing things and deciding which new products to make. I appreciate it all the more because it wasn't always that way. At first I had to do it all; buying and maintaining machines, making parts, assembling, packaging and shipping them, doing the bookkeeping and paying the taxes. I realized I had reached a real benchmark in business when I found that a product had gone from raw material to delivery and I didn't know one thing about it.

Here's a miniature machine tool you won't often see. The ManSon lathe is a fully functional miniature machine tool made in the 1940's by a Los Angeles company. It had a number of accessories available, but its extremely small size limited the projects you could actually make on it. It is one of a number of miniature machine tools collected for display by the author. (Sherline chuck and toolpost are for size comparison.)

5.9 The satisfaction of watching others progress

Another thing I enjoy is determining how a particular part will be run through the shop. Designing new products has become easier for me now because of the wide assortment of tools we own — about a million dollars worth. In 1985, I could set up and operate every machine I owned, but that time has passed. I don't operate my own machines now because they are too complex to casually start pushing buttons. I have to rely on my employees, and I get a lot of enjoyment out of watching employees progress as they become accomplished craftsmen in their chosen trade. However, I still don't believe anyone in the shop knows more about making good parts than I do. I may not know what button to push any more but I'm still the best at solving problems in the shop. I've learned a lot about machining over the last 30 years and I'm going to try to pass on some of that knowledge. Because of my experience I can compare methods used by a hobbyist and a professional machinist. I've have also added information that I hope you will find interesting about machining. It will give me a lot of satisfaction if I inspire readers to strike out on their own and start a new business with a product that has been "prototyped" on Sherline machines.

5.10 The Inspection Department only finds mistakes after it's too late

Most of this knowledge I've gathered has been learned the hard way because money was too tight to hire experts. At Sherline we make all of our own parts and only contract out the plating, heat treating, and powder

coating. In the past, we have also done a lot of contract machining and I've learned the problems one can get into by finding errors in the inspection department. It's just too late. Parts must be inspected as they are built, not after. Errors found after the parts are made mean you start over. Design errors found after the parts are made will always result in scrap. The only difference is who pays for the scrap.

5.11 Work extra hard to eliminate errors when “the chips are down”

I've never met a good craftsman who wants to do a job over, even when he is getting paid for it. It goes against his nature. I have also never met a good craftsman who has never had to do a job over because of his own mistakes. This is a good time to stay away from him, because he is mad at himself. The fact is, you can't work with this many types of tools, dimensions, and materials without making an occasional error. The trick is not to make errors when it counts. Good toolmakers will work with an entirely different attitude when they are making an inexpensive fixture than they will when working on a part that has thousands of dollars worth of material and labor in it.

5.12 Inattention can lead to more than just scrapped parts

You can't have a couple of beers and machine good parts. The job is too demanding. Machining is a serious business. Inattention can result in scrap or, worse yet, injury. You can always make another part but you can't grow a new hand. Even a machine as small as a Sherline lathe or mill can give you a nasty cut. Machinists may have to work for days at a time with their hands in close proximity to moving cutters and parts, yet there are few injuries. They pay attention to what they are doing.

5.13 The credit for a good part goes to the craftsman

Good craftsmen know when they have made an exceptional part and get much satisfaction from it. They also have the ability to produce good work on machines that should be in a junkyard. It just takes them longer. I have a great respect for good craftsmen, because they have to work without excuses or erasers. I try to keep reminding you of this fact in this book, because it is the craftsman, not the machine, who builds the beautiful things we see daily in this world. Modern machines have given this talented group of people a way to produce more and better work, but it will always be their "touch" that makes those parts beautiful. In my eyes they just don't seem to get enough respect.

5.14 An open invitation

If you ever travel to San Diego, California, the Sherline factory is less than an hour away to the North. It's also about two hours South of Los Angeles. I always offer an open invitation for anyone to stop by to see how modern production machines produce parts used in Sherline tools.

“You’ve achieved success in your field when you don’t know whether what you’re doing is work or play.”

— Warren Beatty

Sherline’s facility has a showroom where you can see the entire line of tools and accessories as well as some sample projects built on the tools. Factory tours are available for anyone who would like to see how miniature machine tools are manufactured.