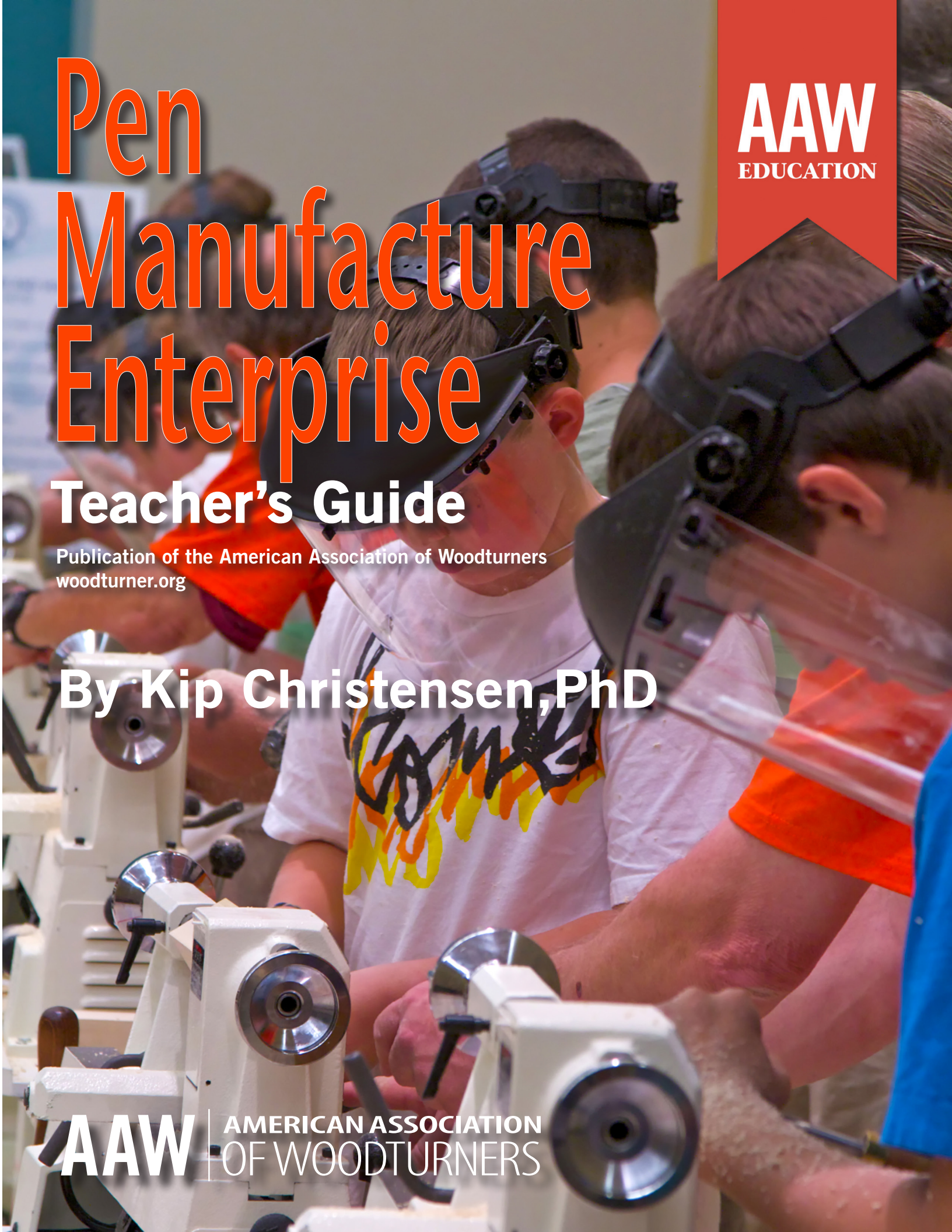




AAW
EDUCATION

Pen Manufacture Enterprise

Teacher's Guide

Publication of the American Association of Woodturners
woodturner.org

By Kip Christensen, PhD

AAW | AMERICAN ASSOCIATION
OF WOODTURNERS

Teaching Resources

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Manufacturing Model for Pen Turning Business: Issue Features



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Teaching Resources

a publication by the American Association of Woodturners
222 Landmark Ctr
75 5th St W
St. Paul, MN 55102
phone 651-484-9094
website woodturner.org
Exec. Director: Phil McDonald
phil@woodturner.org

Board of Directors

Dale Larson, President
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Philip Hauser, Treas.
Binh Pho
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A Note About Safety: An accident at the lathe can happen with blinding suddenness. Respiratory and other problems can build over years. Take precautions when you turn. Safety guidelines are published online at <http://www.woodturner.org/?page=Safety>. Following them will help you continue to enjoy woodturning.

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Turning to the Future

INTRODUCTION

Pen Manufacture Enterprise - Teachers Guide

Many technology education teachers in the United States give junior high and high school students a hands-on introduction to manufacturing. This is driven by national educational standards that have been broadly adopted by secondary education teachers throughout the US. The most current standards were set forth by the International Technology Education Association (ITEA) in the publication *Standards for Technological Literacy: Content for the Study of Technology* (STL). When most people hear the word “technology” they think primarily of computer-related technologies. However, technology educators view technology in much broader terms. Technology can be defined as the study of the man-made world. “Broadly speaking, technology is how people modify the natural world to suit their own purposes. From the Greek word *teche* or craft, technology literally means the act of making or crafting ...” (STL, pg 2).

In the *Standards for Technological Literacy*, 20 specific standards are listed and discussed. Two of these standards can be addressed specifically through teaching a unit on manufacturing. Standard 19 states “Students will develop an understanding of and be able to select and use manufacturing technologies” (STL pages 182-190), and Standard 11 states “Students will develop the abilities to apply the design process” (STL pages 115-125).

One way educators often partially meet these standards is through teaching a unit in which students manufacture pens using a wood lathe and other machines. Students enjoy making pens because they are fun to turn and are a useful product. They take great pride in the pens they have made. Teachers like teaching pen-making because it is an inexpensive activity that gives students several meaningful educational experiences in a short period of time. As part of a unit on manufacturing, pen-making allows the students to use several different machines (band saw, sander, drill press, lathe, power hand drill), and processes (cutting, sanding, drilling, turning, finishing). In addition, students can use a variety of materials (typically various woods, plastics, or polymer/wood composites), and do simple assembly. If the teacher wants to add a strong design and problem-solving element, the unit can be expanded to include creating unique pen designs, and/or designing jigs and fixtures for mass production. If desired, the students can also get a real-world experience in free enterprise by developing marketing surveys, designing packaging, and selling their pens for profit. (Typically any profit would be donated to a charity or returned to the classroom to support the program.)

Possible Adaptation for Using This Material:

The materials in this book were generously provided by Kip W. Christensen, PhD, Technology and Engineering Education at Brigham Young University. This guide was adapted by Kip from a manufacturing unit he teaches as part of a technology education course in manufacturing materials and processes. In his course, he groups his students into manufacturing companies consisting of approximately seven students. Each student (company member) has a specific title and related responsibilities within the company. These include President, Product Engineer, Marketing Manager, Materials Manager, Production

Manager, Assistant Production Manager, and Finance Manager. The responsibilities of each person are detailed within this curriculum guide under “Company Organization and Responsibilities.” The material provided here can be adapted to include a brief experience in manufacturing pens or an extensive experience in developing and running a pen-making business. This unit can be structured to take only a few days of class time or be extended to involve a significant portion of a term. It can include elements of free enterprise or be limited to a manufacturing activity without the inclusion of a profit incentive. Market research can be optional, and the supporting papers required can vary from none to those listed. The documents in this publication were designed as part of school curriculum. If your intent is to have an ongoing business, please research and follow all state and federal business guidelines. (An adaptation of these materials that includes a classroom manufacturing competition is provided at the end of this material.)

Sections of the Publication: Included is a Student Experience Questionnaire that can be used to make initial evaluations of students’ abilities and experiences and assist the teacher in dividing the students into groups. Guides for steps in product design, production, marketing and distribution, and liquidation, as well as company organization are provided. Please use these to guide the students in setting goals and to develop a timeline for the course. Adaptations can be made for your students’ ages and experience levels.

Jigs and Fixtures: There are three options to choose from regarding the jigs and fixtures used in making pens: 1) the jigs and fixtures can be provided by the instructor, 2) materials and drawings can be available to the students to make their own jigs and fixtures from pre-existing designs, or 3) the students can design and create their own jigs and fixtures. Your selection will depend on age, student skill level, and available class time.

Evaluation and Final Presentations: Kip requires each company member to develop the paperwork needed to perform their responsibilities and to document their work. (These documents are listed in the section “Company Organization and Responsibilities.”) These documents are then compiled into a company report and presented as a PowerPoint summary of the activities of the company. The use of these requirements should be adjusted to match educational objectives, student abilities, and class time available.

Safety: Documents are available at woodturner.org regarding safety. Please read and follow all safety guidelines.

Our thanks and appreciation to Kip for providing these materials.

Stay Sharp and Keep Turning,
~ Linda Ferber
AAW Program Director

INTRODUCTION

Note from Phil McDonald, Executive Director

The AAW staff and board are pleased to present you with this complimentary special edition of our Turning to the Future Teaching Resources: Pen Manufacture Enterprise by Kip W. Christensen, PhD.

The AAW's Turning to the Future program offers reference materials and project resources designed specifically to aid teachers, schools, instructors, and other educators in developing programs to teach woodturning skills to students ages 10 to 25. In addition to supporting instructors who teach hands-on woodturning classes, the program endeavors to raise awareness about woodturning for students, inspire students to turn and create wood art and craft for the rest of their lives, raise awareness of American Association of Woodturners (AAW) and its educational mission. For more about the Turning to the Future program, visit the AAW website at <http://www.woodturner.org/?page=YoungTurners>.



I would like to extend my sincere appreciation to Kip Christensen for sharing these valuable teaching materials.

Respectfully,
~ Phil McDonald
Executive Director



Where to turn for Woodturning

- ✓ **AAW** is the organization with global membership that professionals and hobbyists turn to for inspiration, education and information about woodturning tools, techniques, projects, safety and more.
- ✓ **We're your source for expert, shop-tested materials.** As publisher of the *American Woodturner* journal, we offer practical and reliable educational resources for woodturners written by woodturners. Our books are available individually in soft cover or digital download, and as soft cover sets.
- ✓ **Join the AAW member community** and get six issues of *American Woodturner* annually, free digital downloads of special publications, and access to the largest collection of woodturning information anywhere in the world. What's more, you'll be able to tap into the expertise of more than 15,000 members globally who share your passion for woodturning.

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Our newest resource book



ABOUT THE AUTHOR

Kip W. Christensen, PhD



Kip W. Christensen, PhD, is a Professor in the School of Technology at Brigham Young University in Provo, Utah. His primary teaching areas include wood prototyping, furniture design, manufacturing, and supervising student teachers in Technology and Engineering Education.

Kip is also a well-known woodturner. He has co-authored three books and co-produced eight instructional DVDs about woodturning, including the book *Turning Pens and Pencils*, and the instructional DVDs *Turning Pens with Kip and Rex: The Basics and Beyond* and *Turning Pens with Kip and Rex: More Pens Plus Tips and Tricks*.

Kip has a particular interest in woodturning education and is often involved in instructing teachers how to help others learn to turn wood on a lathe. He has also authored several articles regarding woodworking and technology education. These have been published in: *American Woodturner*, *American Woodworker*, *Fine Woodworking*, *Journal of Industrial Teacher Education*, *Journal of Technology Studies*, *Tech Directions*, *The Technology Teacher*, *Wood*, *Woodcraft Magazine*, *Woodworker West*, *World of Wood*, *The Router* (UK), *Woodturning* (UK), and *Drechseln* (Ger.).

Kip has been invited to give over 300 national and international presentations at workshops, conferences, and symposia. His work has been published in over two dozen books and his turnings have been pictured in a variety of magazines and journals. Kip's work is housed in numerous collections, both public and private, and has been displayed in many galleries and international juried exhibitions.

While Kip is best known for his turned lidded containers, he is also comfortable working with bowls, vessels, spindles, and production turning. He has pioneered the use of elk antler as a medium for artistic turning. His work is characterized by clean lines and fine detail. Gallery curator and author Kevin Wallace wrote "The work of Kip Christensen is always aesthetically pure and technically precise."

From 1998 to 2007 he served as Director of the Utah Woodturning Symposium, and currently serves on the board of directors. Kip and his wife Kim live in Springville, Utah, and are the parents of five children.

MANUFACTURING

Company Organization & Responsibilities

Assignment:

Participate in a manufacturing and free enterprise activity in which you are grouped into a manufacturing company with several other class members. Organize your group into a company, name the company, establish individual and group responsibilities, design, mass produce, and sell a product. Listed below are titles and job descriptions of the company members, along with a list of documents they are required to generate. Keep the records as specified and produce a comprehensive written company report. Include with the report the distribution of the profits. (Typically the profits are donated to charity.) Each document in the company report should include the name of the company, the title of the document, and the name of those responsible for the preparation of the document.

Company Organization:

President. Responsible for overall operation of the company and for organizing the company report.

- Written Company Report. In a 3-ring binder with a table of contents and section dividers. Turn in one hard copy for grading.
- Organize the summary presentation to the class using PowerPoint. This should include photos and/or videos documenting the activities of the company. All company members need to participate in the presentation.
- Organization Chart with breakdown of responsibilities, who reports to whom*, and who is responsible for what documents.
- Record of attendance (sign in and out times) at classes, labs, and other company meetings*
- Historical summary for company report
- Lead discussion to name the company

Product Engineer. Responsible for engineering drawings and specifications, prototype, and quality control.

- Each Product Idea Summary Sheet submitted by company members*
- Orthographic projection of product*
- Detailed drawing of each part to be manufactured*
- Drawings of jigs and fixtures (optional)

Marketing Manager. Responsible for company branding, marketing plan, packaging, and distribution of products.

- Market Research Survey Form*
- Summary of Market Survey responses, including conclusions drawn from survey results*

Materials Manager. Responsible for obtaining, inventorying, and liquidating materials.

- Product Bill of Materials* (materials needed to make one product)
- Master Bill of Materials (materials needed to make all products)
- Materials needed for jigs, fixtures, tooling, etc. (these do not become part of the product)

Production Manager. Responsible for product production, including tooling, jigs/fixtures, quality control, safety. (All class members participate in the pilot run and the production run.)

- Work Station Layout Diagrams* (one for each work station)
- Lab Layout and Material Flow Diagram*
- Inspection gauges (if applicable)

Assistant Production Manager. Shares responsibilities of the Production Manager

Finance Manager. Responsible for handling and accounting for finances.

- General Ledger*
- Sales Record Sheet
- Receipts
- Liquidation Summary

Note: Even though each company member will have individual responsibilities, all members are expected to participate in--

- product selection
- market survey
- pilot run and production run
- sales
- final summary presentation

*Drafts of these items are due prior to conducting the pilot run.

MANUFACTURING

Product Design

The Design / Problem-Solving Cycle:

The basic process used for problem solving and designing consists of six steps. This process can be applied to help solve problems of most any kind. The basic process is listed below:

1. Identify, define, and **state the problem.**
2. **Research information** related to the problem.
3. **Explore possible solutions** (brainstorm, make sketches and/or models).
4. Select the best solution / design and **build a prototype.**
5. **Test** the prototype / solution.
6. **Evaluate** the solution.
7. (Repeat steps 1 - 6 to refine the solution.)

The design cycle will be used several times in selecting a product and developing a manufacturing system. The steps to follow are listed below.

Steps in Product Design, Production, Marketing/Distribution, Liquidation:

1. Product ideas selected, market survey conducted, final product selected
2. Prototype developed
3. Prototype tested and evaluated, revised if necessary
4. Production layout developed
5. Pilot run
6. Production layout modified if necessary
7. Production run (plan on two hours of production time, not including set-up and clean-up)
8. Products (and inventory) distributed, payment collected, and income dispersed
9. Final company report is compiled

MANUFACTURING

Jigs & Fixtures

Definitions:

A fixture is a device used in the manufacture of components to locate and hold a work piece.

A jig is a device used in manufacturing to guide a work tool. Jigs may also double as a fixture (they may also hold a work piece).

Purposes:

Jigs and fixtures have four primary purposes in manufacturing.

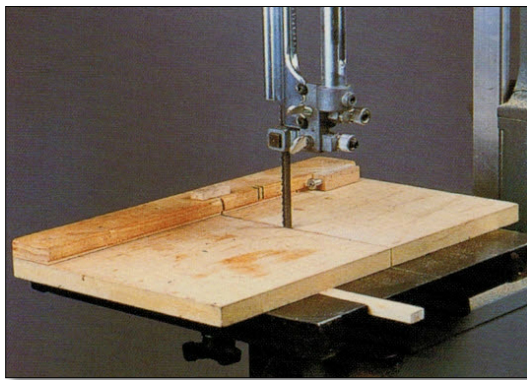
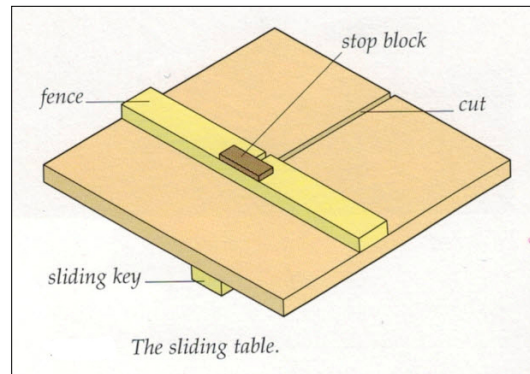
1. Increase safety—control the work piece, get the operator farther away from dangerous and hazardous tasks.
2. Increase accuracy (consistency)—reduce operator error.
3. Increase efficiency—allow repetitive tasks to be performed quicker.
4. Transfer skill from the operator to the tooling. (Whenever there is an individual directly involved in doing the actual work, that individual has the potential to influence the production and quality more than any other aspect (including machines, production layout, materials, etc.))

Making Jigs & Fixtures (elements to design and build into your jigs and fixtures):

1. Accuracy
 - a) Use materials with flat surfaces and square corners.
 - b) Measure carefully with accurate instruments (check for square).
 - c) Design for easy replacement of quickly worn parts (for ex.--replaceable insert of drilling base)
2. Efficiency
 - a) Design for quick insertion and removal of the work piece.
 - b) Design for automatic chip and sawdust removal (gaps, gravity, air hose, vacuum, water, oil, etc.).
3. Safety
 - a) Keep hands as far away as possible
 - b) Shield from flying pieces.
 - c) Hold the work piece securely.
4. Quality (influences accuracy, efficiency, and safety of the jig or fixture)
 - a. Countersink all screws, set all nails or staples below the surface.
 - b. Reinforce with glue when fastened with brads, nails, or staples.
 - c. Use stable material such as Baltic birch plywood, MDF, Corian (solid wood may be too unstable to use for some jigs and fixtures).

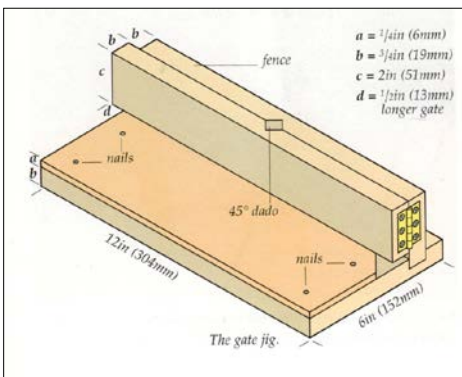
Jig design:

Sliding table for crosscutting pen blanks.



Jig design:

Gate jig for drilling pen blanks.



Images from "Turning Pens and Pencil," by Kip Christensen and Rex Burningham.
Photos used with permission from GMC Publications.

MANUFACTURING

Student Experience Questionnaire

NAME:				
AREA OF EXPERIENCE	NONE	SOME	LOTS	List classes taken and describe other experience where applicable.
Woodworking				
Woodturning				
Working with other materials				
Manufacturing/Production				
Drafting/Drawing				
Graphic Arts/Art/Design				
Business Management/Marketing				
Accounting				
Other Experience Related to Manufacturing or Business				

MANUFACTURING

Product Idea Summary

Presented by:

Name of product idea:

Suggested retail price:

Product description:

Market audience:

Strong features of the product:

Possible weak features of the product:

Suggestions for sales:

Production considerations:

Profit potential scenario/s:

MANUFACTURING

Marketing Survey Process

Determine the market audience:

Develop a Market Survey form for each proposed product:

Survey several dozen people using the Market Survey form:

Summarize the survey responses:

Determine the strengths of the product based on the survey results:

Determine the weaknesses of the product based on the survey results:

Make changes to marketing plan and/or production plan based on the survey results.

Present all the above in the company report:

MANUFACTURING

Manufacturing Lab: Making a Turned Pen

One of the most common manufacturing activities taught in the junior high school is making a turned pen. For students, pens are inexpensive, useful, and quick and fun to make. As part of a unit on manufacturing, pen-making allows the students to use several different machines (bandsaw, sander, drill press, lathe, electric hand drill), processes (cutting, sanding, drilling, turning, finishing), use a variety of materials (typically wood, plastic, or a polymer/wood composite), and do simple assembly. If the teacher wants to expand the assignment to include designing and making jigs, marketing, and packaging, that can be easily done. (If students are not required to make jigs and fixtures, the teacher will probably need to make some that the students can use.)

STEP	SUMMARY	DESCRIPTION	TOOLS & SUPPLIES
1	Prepare blank to be drilled.	If you are not using a piece of wood specifically prepared for a pen blank, first cut the blank on a bandsaw to match the dimensions needed to make the style of pen you plan to make. A good general size is 3/4" x 3/4" x 5". Next, use a bold felt pen to mark the blank for grain match. Then cut the pen blank into lengths about 1/16" longer than the length of each brass tube from the pen kit.	pen blank, brass tubes from pen kit, felt tip marker, bandsaw
2	Drill for the brass tube/s.	Secure the pen blank (with the grain match end up) in a drill press vice or other fixture. Select a drill bit to match the outside diameter of the tube and secure it in the drill press chuck. Center the drill on the pen blank and drill a hole through the length of each pen blank. Back the drill bit out of the hole occasionally to clear out the shavings and prevent heat build-up. Slow the feed speed as you drill through the bottom end of the blank.	drill press vise (or other fixture), drill press, drill bit to match the brass tube

STEP	SUMMARY	DESCRIPTION	TOOLS & SUPPLIES
3	Glue the brass tubes into the pen blanks.	Use a chopstick to line the inside of the hole in the pen blank with a thin layer of thick CA glue or urethane glue. Then put a thin layer of adhesive on the outside of the tube. Press the tube into the hole from the grain-match end of the blank. (If using urethane glue, spray the inside of the hole with water before applying any glue. If using CA glue, apply a small amount of CA accelerator after the tube is inserted into the hole.	brass tube, drilled pen blank, chopstick (or other small stick for spreading glue), thick CA glue and CA accelerator-- or urethane glue and water in a spray bottle
4	Prepare the pen blank to be mounted on the mandrel.	After the adhesive is fully cured, clamp the pen blank in a vise and use a drill bit in a power hand drill to ream any excess glue out of the inside of the brass tube. Then use a barrel trimmer (pen mill) to trim the end of the pen blank square and flush with each end of the tube. (If you are making a slimline pen with straight barrels, mark the inside of each tube on the grain-match end.)	bench vise, pen blank with brass tube glued in, power hand drill, drill bit (to ream out excess glue), barrel trimmer, felt tip marker
5	Mount the pen blank on the pen mandrel.	Secure a pen mandrel in the headstock of the lathe and slide the pen blank and appropriate bushings onto the mandrel. Align the grain-match marks and secure the brass nut on the end of the mandrel (firm-finger-tight only). Next, bring the tailstock into position and apply light pressure on the end of the mandrel.	lathe, pen mandrel, bushings, pen blank, ball-bearing tail center with a cone point
6	Turn the pen blank to shape.	Turn the pen blank to the desired shape. Remove the corners with a shallow spindle gouge and do the final shaping with the gouge or an Easy Wood (carbide-tipped) Pen Tool.	shallow spindle gouge, Easy Wood Pen Tool

STEP	SUMMARY	DESCRIPTION	TOOLS & SUPPLIES
7	Sand the pen.	Begin sanding with 120- or 150-grit abrasive and progress to 220, 320, and 400 grit. Then turn the lathe off and sand along the length of the pen with 400 grit. (If you want to apply any details such as wire burning or finger grip grooves, do them now.) Finally, turn the lathe back on and polish the pen with 0000 steel wool, then polish with steel wool with the lathe stopped.	assorted abrasives, 0000 steel wool, wire burner (optional), finger grip tool or skew (optional)
8	Apply finish.	Put some finish (Mylands Friction Polish) on a rag and (with the lathe stopped) apply a coating of finish and quickly turn on the lathe and build up/buff the finish with the rag. If there is streaking on the surface, cut the finish back with 0000 steel wool and reapply the finish until you have a consistent gloss.	rag, Mylands Friction Polish, 0000 steel wool
9	Assemble the pen.	To prepare the pen for assembly, lightly sand the sharp corners on the ends of each turned blank. Then apply a small amount of wax to the sanded corners. To assemble the pen, use a bench vise with Corian jaws and carefully press the pen parts together. Use a stop block (if needed) to avoid compressing the parts too far. Align the pen parts so the grain is matched when the pen is in the closed position.	pen kit, turned pen parts, bench vise, stop block (if needed)

MANUFACTURING

Evaluation Sheet 1 – Turned Pen

NAME:				
Turn in: One pen and this grading sheet with the self-evaluation completed.				
OPERATION	GRADING CRITERIA	POINTS POSSIBLE	SELF-EVALUATION	TEACHER EVALUATION
TURNING	• Good transitions between parts--diameters of turned parts match diameters of purchased parts. (The diameter of the wood can be equal to or <u>slightly</u> larger--but not smaller--than the metal parts.) • Surfaces have clean lines--straight and/or curved. • Design of the turned parts complements the design of the pen kit.	10		
SANDING	• Surfaces are free of torn grain, crushed grain, tool marks, dents, sanding lines, chips, and other defects. • Corners are softened by hand sanding prior to assembly.	8		
FINISHING	• Consistent build-up, consistent level of gloss, no streaks.	7		
ASSEMBLY	• Pen is assembled properly and functions properly. • Writing cartridge extends the correct distance beyond the pen tip. • No parts (turned or purchased) were damaged during assembly. (Such as splits in the wood and marred plating on the metal.)	5		
TOTAL POSSIBLE		30		

MANUFACTURING

Evaluation Sheet 2 – Company Pilot Run

COMPANY NAME:		
CORPORATE REPORT ITEMS DUE PRIOR TO PILOT RUN: These should be in anticipated final form (not drafts), although revisions may need to be made later based on the pilot run experience.		
	3	Organization Chart
	7	Orthographic projection of product
	10	Detail drawings of each part to be manufactured
	3	Product Bill of Materials
	6	Workstation Layout Diagrams (May be included on Lab Layout and Material Flow Diagram)
	6	Lab Layout & Material Flow Diagram (May include Workstation Layout Diagrams)
	5	General Ledger
PILOT RUN		
	20	Preparation (jigs/fixtures/processes previously tested and revised if necessary)
	25	Organization of labor (each company member productively busy throughout, minimal wasted motion, all company members present)
	15	Overall planning and success of pilot run as an accurate test of potential production run
	100	TOTAL POSSIBLE (<i>Safety: Up to 25 points penalty for use of unsafe practices</i>)
		TOTAL

MANUFACTURING

Evaluation Sheet 3 – Company Production Run

COMPANY NAME:		
	5	Jigs and fixtures accurate, efficient, safe, fully tested prior to production
	10	Processes, layout, and material flow fully tested prior to production run
	10	Materials needed are on hand and in order.
	25	Each company member productively busy throughout. (All company members must be present for full credit).
	10	Minimal wasted motion based on efficiency of layout and material flow.
	10	Minimal wasted materials based on efficient use of standard stock purchased.
	10	Minimal number of rejected parts or products (# of rejected parts _____) (# of rejected products _____)
	10	Production goal of _____ completed within 100 to 120 minutes.
	10	Overall planning and success of production run.
	100	TOTAL POSSIBLE
		Safety: Up to 25 point penalty for use of unsafe practices
		TOTAL

MANUFACTURING

Evaluation Sheet 4 – Written Company Report

COMPANY NAME:		
On each document included in the Company Report, include the name of the person(s) who prepared the document.		
	5	Table of Contents with each document listed in order.
	6	Narrative Historical Summary Report summarizing the development, activities, and result of the enterprise.
	4	Organization Chart with breakdown of responsibilities for each member
	6	Detailed attendance records, including time in, time out, total time for each company member for all classes, labs, and company meetings.
	4	All “Product Idea Summary” sheets included
	9	Engineering drawings, including orthographic projections of product and detail drawings of each part manufactured
	9	Summary of Market Research activities, including the final version of the survey instrument, the market survey results, and how the results influenced product selection and decisions going forward.
	3	Product Bill of Materials, including specifications for all materials needed to produce one product.
	4	Master Bill of Materials, including all materials needed for products produced.
	7	Workstation Layout Diagrams (May be included on Lab Layout and Material Flow Diagram)
	7	Lab Layout and Material Flow Diagram (May include Workstation Layout Diagrams)

	6	Sales Record Sheet, including all sales made, who made the sales, dollar amount of sales, when funds were collected from sale.
	7	General Ledger, including all financial transactions – date, amount, purpose, person, etc. (This should include costs of materials for jigs, fixtures, and other items not used directly in the product.)
	5	Liquidation Summary, including who was paid, how much, when, and for what purpose.
	18	Overall quality of Written Company Report – three ring binder, section dividers, professional appearance, each document contains name of company and product and who prepared the document, consistent format throughout, includes digital copy of PPT presentation.
	100	TOTAL

MANUFACTURING

Evaluation Sheet 5 – Company Presentation

COMPANY NAME:		
	10	President – introduction, overall summary
	10	Marketing Manager – summary of survey questions and results, including how the results influenced company decisions, summary of sales, commissions paid (if applicable)
	10	Product Engineer – engineering drawings (main views, detail views)
	10	Materials Manager – summary of materials purchased and suppliers used, efficiency of use of materials.
	15	Production Managers – production layout, pilot run, production run, efficiency of time and motion
	10	Finance Manager – summary of all expenditures, liquidation data, net profits, charitable donation
	10	Each member of the company participated in the company presentation.
	25	Overall Presentation – professional dress and manner, punctual, organized, well thought out and prepared, use of visual/teaching aids, interesting/engaging, informative
	100	TOTAL

MANUFACTURING

Adaptation for Teaching a Classroom Manufacturing Competition

Below is the framework for another possible manufacturing activity—a manufacturing competition that is a fun way to help students learn the concepts of mass production. The time required to do this activity in a class is greatly influenced by the simplicity of the product. Students should have a basic understanding of the principles of mass production. Only basic and minimal paperwork is necessary and can be adjusted as appropriate.

Procedure:

- The class chooses (or is assigned) a product and a set of engineering drawings is developed (or provided).
- Individuals are assigned into groups or companies.
- Each company plans the production system independent of the other companies and separately designs jigs (or uses jigs provided by the instructor) and determines production procedures.
- A timed production run is held where the groups compete.

Required (prior to the production run):

- Jigs and fixtures (provided by the instructor or developed by the students (if student-developed, these can be graded based on quality and function))
- Inspection gauges (if applicable) (provided by the instructor or developed by the students (if student-developed, these can be graded based on quality and function))
- Lab layout and material flow diagram
- Record of hours worked prior to production run (efficiency)

In addition to the above, grading is based on:

- Manufacturing system design (efficiency and accuracy)
- System output (quality of products produced)
- Productivity (products produced per hours worked, minus rejects)
- Paperwork (neat and complete)

MANUFACTURING

References

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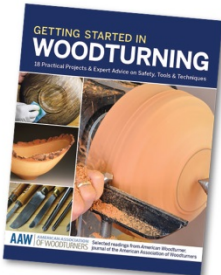
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GETTING STARTED IN WOODTURNING

Features shop-tested insights and detailed practical advice a beginner needs for a great start in woodturning, including:

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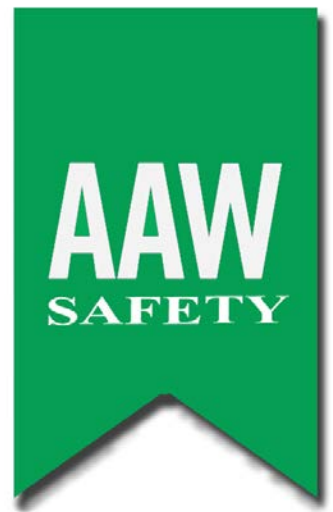
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SAFETY

Safety & Introduction to the Lathe

It is of utmost importance to teach through example proper respect for equipment and an attitude of safety. After discussing safety concerns with the group, be sure to reinforce safety principles as you provide individual instruction. It is good practice to start each lesson with a safety reminder.



1. Use a full faceshield
2. Tie back long hair, do not wear gloves, and avoid loose clothing objects that may catch on rotating parts or accessories.
3. Always check the speed of the lathe before turning it on. Use slower speeds for larger diameters or rough pieces, and higher speeds for smaller diameters and pieces that are balanced. Always start a piece at a slower speed until the work pieces is balanced. If the lathe is shaking or vibrating, lower the speed. If the workpiece vibrates, always top the machine to check the reason.
4. Check that all locking devices on the tailstock and tool rest assembly (rest and base) are tight before operating the lathe.
5. Position the tool rest close to work, almost touching the wood. Check tool rest position often and as wood is removed, turn off the lathe and re-position the rest.
6. Rotate your workpiece by hand to make sure it clears the toolrest and bed before turning the lathe "on." Be certain that the workpiece turns freely and is firmly mounted. A handwheel on the outboard side of the headstock simplifies this process of spinning the lathe by hand before turning on the switch.
7. Be aware of the turners call the "red zone" or "firing zone." This is the area directly behind and in front of the workpiece - the areas most likely for a piece to travel as it comes off the lathe. A good safety habit is to stop out of this zone when switching the lathe to the "on" position. When observing others turn stay out of the area.
8. Hold turning tools securely on the toolrest, holding the tool in a controlled and comfortable manner. Always contact the tool rest with the tool before contacting the wood.
9. It is safest to turn the lathe "off" before adjusting the toolrest or tool rest base (banjo).
10. Remove the tool rest before sanding or polishing operations.
11. Never leave the lathe running unattended. Turn the power off. Don't leave that lathe until it comes to a complete stop.

BEST PRACTICES



Before Turning on the Lathe

Checklist

A short checklist will assure that students are ready to turn on the lathe:

1. Face shield on
2. Blank properly mounted between centers: drive center point engaged in the end-grain
3. Tailstock base firmly locked
4. Tailstock ram not extended too far out, and live center pressed into the end-grain
5. Tailstock ram locked
6. Tool rest base locked firmly in position
7. Tool rest set at proper height and distance from the wood to avoid contact

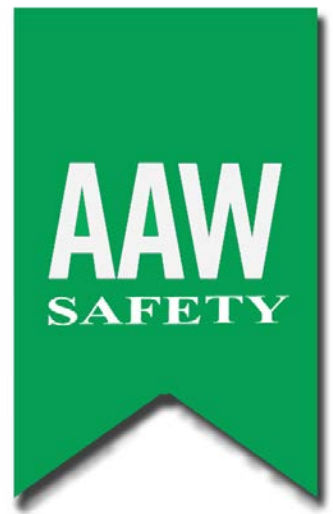
Free rotation

Instruct students to spin the outboard hand-wheel with their left hand before turning on the lathe, just to confirm that the wood won't strike the tool rest. If this is always done before they turn the lathe on, they will avoid problems after re-positioning the tool rest.

On and off

Direct the students to practice starting and stopping the lathe a few times before actually taking any cuts. They should be able to find the switch and quickly stop the lathe in a matter of seconds. Teach them to listen for inappropriate or unusual sounds.

SAFETY



How to Determine Safe Lathe Speeds

Appropriate lathe speed should allow the blanks to be turned with little or no vibration. Vibration is usually caused by the wood being unbalanced in weight, and is particularly common before the wood has been rough turned down to round. Low speeds are needed to reduce the vibration until the work becomes balanced, then speeds can be increased for more efficient turning.

Suggested lathe speeds for various diameters of spindle stock are given below. If there is a question regarding whether a lathe rpm is set too high, chances are it is. It is best to work on the side of caution. A slower lathe speed may require more time to remove the excess stock, but will allow for safety turning. Cutting principles remain constant regardless of lathe speed.

Suggested Lathe Speeds

Diameter of Stock	Lathe Speed
1" or less	3,000 rpm
1.5 "	2,500 rpm
2"	2,000 rpm
3"	1,500 rpm

BEST PRACTICES



First Cuts: ABC's

One recommendation is that you have every student remember the A B C's:

Anchor – **B**evel – **C**ut

Anchor:

Set the tool firmly on the tool rest. Explain that the forces of the cut must be taken by the tool rest in as direct a manner as possible.

Bevel:

Instruct the students to always begin with the handle low, so that the bevel is the first part of the tool steel that contacts the spinning wood.

Cut:

Slowly raise the handle until the edge engages that wood and begins to cut a shaving. Keep the handle as low as is possible while still producing a shaving.

Direction of Cut

When spindle turning, teach students to cut “downhill” from large diameter to small diameter.

Bevel Contact

Constantly bring their awareness to the importance of bevel contact. The bevel being in contact with the wood is what gives the turner control of the tool. When the bevel loses contact with the wood, a catch is likely to occur.

Stance

Proper stance and body mechanics are paramount in helping student progress.

SAFETY

Personal Protection Equipment (PPE)

Face Shield

Having at least minimal protection in place to reduce the chances that these projectiles will reach and damage the eyes should be a common sense no-brainer for ANYONE who intends to stand at the lathe,



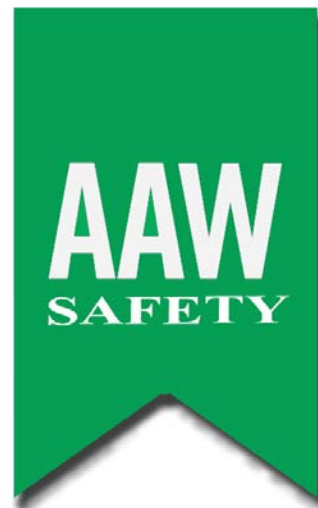
It is advisable to select a face shield that is not simply a piece of plastic hanging from a headband, but one which includes lower face and jaw protection as well.

Respiratory Protection

Another safety issue involving the use of personal protection equipment involves ensuring that the operator is adequately protected from fine wood dust carried in inhaled air. Since inhaled fine particulates can represent a significant health risk, particularly in repeated exposures over extended periods of time, it is particularly important that this aspect of woodturning safety be treated very seriously.

Installation of an efficient dust collection capability in the classroom workstation is recommended. Respiratory PPE involves specific devices that are used to eliminate or reduce the possibility of inhaling fine air-suspended particles deep into the lungs.

Face masks are recommended for protection from wood dust generated during sanding, this is the greatest respiratory health risk.



Hearing Protection

In general, woodturning at the lathe is a fairly quiet endeavor, especially when compared to running other woodshop machinery such as surface planers, jointers, miter saws, and table saws.

There are numerous kinds of hearing protection (Hearing Protection Devices, HPD) available in different designs. Some prefer an earmuff style hearing protector, with a spring-tension band that can be worn over the top of the head, behind the head, or even under the chin. Others prefer hearing protection that inserts into the outer ear canal as an ear plug which attenuates high noise levels before they reach the ear drum and inner ear anatomy.



...it is particularly important that this aspect of woodturning safety be treated very seriously.