## SHOP SKETCHING



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## A COURSE OF PROBLEMS FOR MECHANICAL DRAWING STUDENTS

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## PREFACE

THE ability to rapidly make freehand sketches, either in perspective or orthographic, is one of the essential accomplishments of all good draftsmen. By this means they may interpret to persons not informed how to read working drawings. With this ability draftsmen are able to rapidly sketeh some detail of a machine or a broken part too large to carry to the drafting room, where a working drawing can be made from the sketeh. A study of sketehing is one of the quickest means of learning how to read working drawings, as it does not involve the ability to use the drafting instruments skillfully. These are only a few of the many advantages that are well known and appreciated by teachers-advantages that have given shop sketching an important place in every mechanical drawing course.

This text presents a carefully arranged and thoroughly tested course of problems in shop sketching which will leave with the average student completing it the ability to make sketehes from objects; perspective sketches from working drawings: and the ability to accurately read working drawings. It
should be given in the last half of the first year's work, or in the second year. Since so many students drop out of school after the first year, the latter part of that year is recommended for this work, as nothing can be given that has the practical advantages of shop sketehing.

As much theory as possible has been omitted from this course. Technicalities concerning perspective have been carefully explained, simplified, or left to a more advanced course. The one aim has been to impart to the student the knowledge and practice necessary to rapidly make clear and accurate freehand shop sketches.

The work as arranged cau be covered in one half year of five months when the students work fortyfive minutes each day of the sehool week. This should take the average through plate twenty. Other plates have been added to supplement this work, lengthen the course, or to provide work for the more apt students. These more advanced plates will be of help where the course is used in normal and teehnical schools.

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## General Statement

Shop Sketching. The practical value of freehand sketching can not be overestimated. It is not too much to say that nothing that can be given in an elementary mechanical drawing course is of more importance to the man who expects to advance in the profession, and the student just beginning his drafting course will do well to bear this fact in mind.

Tracers and detailers-mere routine men-may be proficient without the ability to make good, clear, and accurate freehand sketches, but the engineer and the designer must have this ability. The inventor whose time is too valuable to spend in mechanical exceution at the drafting board must be able to materialize his thoughts by the means of frcchand sketches, which will later be passed on to the draftsmen to execute.

Definitions. Shop sketches may be of various kinds-as many kinds as there are modes of technical expression, though they are usually in one of two methods-orthographic or working sketches, and
perspective sketches. Any one of the axonometric projections can be utilized-especially isometric-or cabinet projection may be used. As a general rule, sketches from objects which are to be later drawn up to scale in the regular manner will be made in orthographic. Inventive sketches in either orthographic


Figure 1
or perspective, and sketches that are used to explain working drawings to the uninitiated, in perspective.

The camera, when properly focused, shows an object in true perspective. Figure 1 illustrates a library table from a photograph, Figure 2 is a perspective of the same table, and Figure 3 is its orthographic projection. The close resemblance between the photograph and the perspective is very apparent, while the orthographic gives the exact appearance of the top, front, and side views as if each were viewed alone and the others could not be seen. Hence each view in the orthographic shows but two dimensions, while the perspective and photograph show three. This will make it apparent that at least two views are necessary in orthographic projection to properly show all three dimensions of length, breadth, and thickness. To the student who has made a study of orthographic projection these statements will come as a review.

As stated before, all of the problems in this course will be made as freehand orthographic or perspective sketches.


Figure 2
Drawing Materials Required. A 2 II pencil, a 4 H pencil, a pencil eraser, paper, drawing beard, and thumb tacks are all the materials needed for the drawing work. The paper should have a rather hard surface as the rough surface of the ordinary drawing paper soils too rapidly. The plates are to be made on sheets measuring $11^{\prime \prime} \times 15^{\prime \prime}$, which can be cut without waste from the standard size of $22^{\prime \prime} \times 30^{\prime \prime}$.

The pencils should be sharpened to long, conical points.



FRONT VIEW


SIDE WIEW


Figure 4

Measuring Tools. A two-foot rule and a pair of calipers will be all the measuring tools actually needed for this course, but some additional tools will be of great help, especially when taking measurements of large or complicated machines and parts. These tools are all illustrated in Figure 4 and consist of, in addition to the two-foot rule and calipers, a $12^{\prime \prime}$ steel rule or straight edge, plum bob, combination square, and surface gauge.

How to Sketch. All work on the drawing board should be done freehand. The T-square and triangles may be used in laying out the trimming edge of the plates, but for no other purpose.

The vertical lines should be sketched as illustrated in Figure 5. The fingers grasping the pencil as in writing, control the movement entirely. The side of the hand rests upon the board, also the forearm. The lines are sketched downward, each one about one inch long, where longer lines are desired, and connected so as not to overlap. Vertical sketching is a finger movement.


Figure 5


Horizontal lines are sketched as Figure 6 illustrates. In this case the third and fourth fingers rest upon the board, as does the forearm. The lines are sketched from left to right, hinging at the wrist. This permits of drawing lines of about one inch and connecting them without laps for longer lines. Remember, horizontal lines are drawn with a wrisi movement, while vertical lines are drawn with a finger movement. Study the illustrations carefully and impress these methods strongly in mind.

## References:

Crawshaw and Phillips-"Mechanical Drawing for Secoudary Schools." Phillips and Orth-"Mechanical Drawing." French-"Engineering Drawing."

Figure 6

## Problems in Sketching

## Plate Layout

Plate Layout. Tack the paper on the drawing board near the upper left hand corner. Lay out the trimming edges of the plate, $10^{\prime \prime} \times 141 / 2^{\prime \prime}$, exact, using the T -square and triangles to pencil in these lines. Now put these tools away as all the rest of the work will be freehand.

Sketch the border lines in with the 4 H pencil, estimating $1^{\prime \prime}$ in from the left hand trimming line, and $1 / 2^{\prime \prime}$ in from the others. Sketch these lines as nearly vertical and horizontal as possible. This much will be done on every plate of the course, and is termed the plate layout.

## Plate 1

To draw the first plate, proceed as follows:

1. Draw the horizon line $21 / 2^{\prime \prime}$ down from the upper border line, using the 4 H pencil for all of this construction work, and estimating all dimensions.
2. Mark points in on this line for the right and left vanishing points $1 / 4^{\prime \prime}$ from the vertical border lines.
3. Draw a vertical line through the center, and establish point $A 134^{\prime \prime}$ down from the horizon on this line.

Note carefully that the two vanishing points are on the horizon and the vertical line through the
horizon intersects it at the level of the eye of the person who is viewing the perspective drawn.
4. Estimate $1^{\prime \prime}$ down from $A$ to $B$ and sketch the horizontal line through this latter point.
5. Connect $A$ and $B$ with the vanishing points, being very sure that the angle of inclination on both sides of $A B$ is the same.
6. This much of the work has been almost mechanical; now the student must estimate the distance between the vanishing lines that will give him the appearance of faces of a cube, and draw these vertical lines. Although the front edge $A B$ of a $1^{\prime \prime}$ cube is


PLATE LAYOUT
$1^{\prime \prime}$, none of the remaining edges will measure true, since the faces are "foreshortened" as they approach the vanishing points.
7. When these lines have been drawn, conneet their upper ends with the vanishing points, as illustrated, which will enclose the remaining faces of the eube.
8. If the cube appears as a true perspective, go over its outlines with the 2 H pencil, causing them to stand out from the construction lines. Repeat with the border lines.
9. Complete the plate by putting in the lettering as indicated on the copy, omitting the "instructions" and the dimensions in the circles.

You have now drawn your measuring cube, the basis for all future dimensions in perspeetive. Remember the following points:
a. Only the front edge is in its true length.
b. The other lines do not aetually measure $1^{\prime \prime}$, but they give that appearance.


e. This is due to the "foreshortening" of lines as they approaeh the vanishing points.
d. The level of the cye as you are observing the cube is above the object, hence you see the upper surface. If the level of the eye is below the object,
you see the lower surface. If the level of the eye is neither above nor below, you see neither the upper nor the lower surfaces as Figure 7 illustrates.
e. In this particular kind of perspective which is known as 45 degree perspective, the angles of inelination of similar lines are the same.

## Plate 2

1. Lay out this plate as you did Plate 1.
2. Locate point $A 5^{\prime \prime}$ in from the right hand vertical border line and $21 / 2^{\prime \prime}$ down from the horizon. At this point sketeh your measuring cube. The lines to the $V P R$ are estimated the same as those to the $V P L$ which is located on the drawing.

Your problem is to sketch a pile of 108 one-inch cubes, 36 in a layer, three layers high.
3. Draw two cubes directly below your measuring cube, remembering that the front edges are in their true length.
4. Connect the edges with VPL.
5. Between the upper converging lines, estimate the faces of six cubes. These will get smaller as they approaeh the vanishing point.
6. If they appear as eubes, drop vertical lines through the other converging lines.
7. Estimate the angles of inclination toward the right, and repeat.
8. Complete the construction by drawing the lines toward the vanishing points that will give the upper faces of the cubes.


Plate 2
9. Go over the outlines of the cubes with the 2 H pencil. Omit the "instructions" and the dimensions in the circles.

In this problem you have learned how to secure the measurements in perspective for any object, examples of which will follow.

## Plate 3

This plate represents both an orthographic and a perspective sketch of a small block grooved through the center. It is to be copied freehand, observing the "instructions" on the copy.

1. Lay out the plate as before.
2. Sketch the orthographic, using the 4 H pencil for all of the preliminary work.
3. At point $A$, draw a measuring cube, and to the right and left of it draw two similar cubes, representing a surface $1^{\prime \prime} \times 3^{\prime \prime} \times 3^{\prime \prime}$.
4. As the block is $2^{\prime \prime}$ high, estimate another inch down from the measuring cube, thus forming your enclosing solid for a block $2^{\prime \prime} \times 3^{\prime \prime} \times 3^{\prime \prime}$.
5. Complete the construction of the perspective by drawing the groove through the center, as shown.
6. Go over the outlines of both the orthographic and the perspective with the 2 H pencil, leaving the dimensions on the orthographic light lines.
7. Draw a horizontal through the object for a table line. This will be done on all future perspective drawings.

In this example no vanishing points are to be locatcd, the lines appearing to meet at some distance off the drawing board. Remember that this is 45 degree perspective and the angles of inclination are the same on both sides of the vertical center.


Plate 3

## Plate 4

Tiris plate involves new work in the form of an incompleted orthographic which is to be completed by the student, and lines in perspective other than vertical or horizontal.

1. Lay out the plate.
2. Sketch the orthographie as indieated, completing it where lines are omitted.
3. Draw the "enelosing solid" as a 3 " cube.
4. Since the upper edge of the prism comes exactly in the center, estimate $11 / 2^{\prime \prime}$ over from $A$ and connect this point with the bottom edges by the means of slant lines.
5. Complete the plate as previously instructed.

Note that the distance toward the front edge is greater than the same distance toward the far side, since the lines are foreshortened as they approaeh the vanishing points.

This method may be used to locate any slant lines in perspective. Simply draw vertieals and horizontals around the slant lines, and estimate the distances on the vertieals and horizontals.

The half-inch dimension of the lower edge of the prism must' be estimated on the front vertieal edge of the enclosing solid and carried baek to the point where needed. All horizontal measurements are estimated on this edge since here they are in their true length.


Plate 4

## Plate 5

The new work on this plate involves invisible edges.

1. Lay out the plate.
2. Sketch the orthographic, completing it where lines have been omitted on the copy.
3. Draw the enclosing solid representing a block $21 / 2^{\prime \prime} \times 4^{\prime \prime} \times 4^{\prime \prime}$. Figure 8 illustrates the constructive lay-out.
4. Sketch the slant lines as you did on the last plate, and complete the left hand and upper surfaces.
5. Copy the invisible edges, noting that they follow the same principles as visible edges.
6. Complete the plate as before.

Invisible edges are seldom used in perspective, since the idea, as with the camera, is to show an


Figure 8
object as it would appear to a spectator. They have been included in this plate as a matter of practice.


Plate 5

## Plate 6

Make a working drawing and a perspective from some small straight line, square object assigned by the tcacher.

This may be a model joint, a geometrical solid, a block of some kind made for the purpose, or a small piece of furniture such as a footstool or taboret.

Figure 9 gives suggestions as to type.
In drawing the orthographic, sketch the views without taking any measurements. Estimate the measurements and draw the object as near to scalc as possible. When the views are finislied, put in the dimension lines, then the dimensions, which will be


Figure 9 -measured on the object with the rule.

## The Perspective Protractor

Oor previous examples have all been in 45 degree perspective, that is, the angles of inclination of similar lines have been the same; hence the vanishing points have been the same distance each side of the
vertical touching the horizon at the level of the eye.
It is apparent that if the object is of irregular shape, much longer than it is wide or high, the 45 degree perspective will not balance up well on the
drawing. Hence we will construct a protractor that will be of help in solving problems involving irregular dimensions.


Figure 10

Figure 10 illustrates the "perspective protractor." It is constructed as follows, using the regular drawing instruments:

On a piece of heavy drawing paper or Bristol board, draw the vertical and horizontal center lines. With their intersection as center, draw two circles, one $1^{\prime \prime}$ in diameter, and the other $3^{\prime \prime}$ in diameter. Divide the larger circle into 24 equal parts, and, by the means of radials, divide the smaller likewise. From the divisions on the smaller circle draw horizontal lines to the right and left. From the same divisions on the larger circle draw verticals intersecting these horizontals. The intersection of these lines, as shown in the lower half of the construction, will locate points on the curve of the ellipse. The upper half is drawn in the same manner. Use the irregular curve to obtain an accurate figure.

Erase all construction lines within the ellipsc, and connect radials to the points located on its curve, as in the upper half of the construction.

Number these points in degrees-starting at the left hand end of the horizontal center line- $\mathbf{1 5}^{\circ}$,
$30^{\circ}, 45^{\circ}$, etc. With a sharp knife or scissors trim the ellipse carefully.

Figure 11 shows the protractor in use in the drawing of a measuring cube. In this case the left hand edge makes an angle of 30 degrees with the horizontal, hence the right hand must be at 120 degrees since the corner of the cube is a right angle. If the left hand edge had been at 15 degrees, the right hand would have been at 105 degrees, etc. When the object is square on the front corner, there must be 90 degrees between the two faces representing that corner in perspective.


Figure 11

## Plate 7

This plate involves the use of the perspective protractor.

It is largely a copy plate, but, as far as possible, each student should be assigned a different angle for the perspective.

Place the working drawing nearer the center as your plate will not contain the "instructions."

The sketching of the perspective is like the previous work with the exception of the different angles.


Plate 7

Note that when the angles of inclination are not the same, the vanishing points will be at different distanees from the front corner of the object.

## Plate 8

This plate requires no orthographic. The problem is to make a perspeetive from the working sketch given. The long axis is to slope toward the left at 30 degrees on the perspective protractor.

Figure 12 is from a photograph of this joint, which will be of some assistance in sketching the perspective.



Figure 13
The Circle in Perspective
None of the previous plates have contained circles or ares of circles. This feature of the work will now be considered.

All perspective cireles are in the form of the ellipse. Figure 13 shows how they are formed on the

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SKETCH OF SCARF NOINT
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INSTAUCTIONS THE STUDENT IS TO DAAW A PERSPECTIVE SHETCH FROM THS WORHING SHETGH-THE LONG AXIS TO THE LEFT AT $30^{\circ}$ ON THE PERSPECTVE EROTRACTOR.
DATE PLATE NO

Plate 8
surfaces of a cube. Note carefully that the circles are tangent to the sides of the square faces where the center lines of the squares touch the outlines. This is apparent when the orthographic circle is considered, since the circle is tangent to the square at the same points, Figure 14. Hence, in order to draw circles in perspective, enclose the circles in the orthographic with squares, draw the squares on the perspective with their center lines, and sketch in the perspective circles tangent at these four points. Arcs are treated in the same manner, though in this case it is only part of the circle desired. After a little practice in this longer method, the student will be able to sketch in perspective circles and arcs without the aid of the squares.


Figure 14

## THE GIRCLE IN DERSDECTIVE



INSTRUCTIONS
SHETCH THREE E" CUBES WHICH WUL ENCLOSE CYLINDERS AS SHOWN COMOLETF THE RIGHT CVLINOER RNO DRAW THE LEFT WITH THE CIRCLE IN THE
RIOHT HAND EACE.
ERASE CONSTRUCTION CUBES ON COMPLETED OLATE.
DATE PLATE NO. N

## Plate 9

Tuis plate gives practice in the drawing of circles and arcs in perspective. It represents three cylinders, two in the horizontal position, and one in the vertical. The instructions are given on the plate.

In the horizontal position, the far side curve is not quite parallel with the front, but it is easily
sketched if the far side face of the cube is put in and the curve made as directed before. The slight difference is caused by the foreshortening.

Erase all construction cubes on the finished plate, leaving the three cylinders with the table line.

## Plate 10

This plate is an application of the principles previously learned, the object being a small machine part. The two view orthographic and the perspective are both required. Notice that in a working sketch,
holes are sometimes indicated with a note, which gives the size as well as the method of making them"drill," "bore," etc.

The student is to copy this plate.


Plate 10

## Plate 11

This plate is a further application of the principles stated. Here more curved surfaces are given. Note that on a perspective, curves that are not sharp, such as filleted corners on a casting, can only be in-
dicated with short, curved lines. The photograph, Figure 15, will be of help when drawing the perspeetive.


Figure 15


DATE ATE NO

Plate 11

## Plate 12

This plate requires the completion of the top view in the orthographic, and a perspective sketch. Figure 16 will be of help in the making of this perspective.

Run the long axis to the left at an angle of $30^{\circ}$ on the perspective protractor, since the eccentric is much longer than it is wide.


Figure 16


DATE PLATE NO
Plate 12

## Plate 13

Plate 13 is a dimensioned perspective of a buffet, from which a two view working sketeh is required. This sketch must be dimensioned completely, and inside construction must be indicated. The student's knowledge of furniture construction will be of help in this; also working drawings of similar types will make good references.

Dimensioned perspectives are not as practical as
working sketches, as they usually consume more time in the making, and it is more difficult to show inside construction with them. But, for small, simple picces such as washers, bolts, nuts, etc., from whieh working drawings will be made later, they are sometimes, used. And again, they are used occasionally when explaining what is meant by a working drawing to a craftsman who cannot read one.


## Plate 14

Turs problem requires the sketching of a perspective from the working sketch and the photograph, Figure 1\%. Make the sketch large enough to balance
the plate well, as it will occupy the plate alone-the orthographic not being required.

Put the dimensions on the perspective.


Figure 17


Plate 14

## Plate 15

This problem is similar to the last-a dimensioned perspective alone being required.

Note that in the side view, a full seetion is given on the plate. This is often done in working drawings since the inside construction can be more elearly shown.

A section is an imaginary drawing. In this example, we have imagined that we have eut the piston on a center line through the two wrist pin bearings. We have then removed the front portion and drawn the remainder of the object. Where we have imagined the saw to have ent the metal, we have drawn light 45 degree lines, known as "section lines."

On future sketehing plates from objeets show sections if it will make the interior construction any clearer.


Figure 18
 DISTON EROM THIS WORKING SKETCH DUT
QUTE ATE NO

Plate 15

## Plate 16

Make an orthographic and a perspective sketch of some small object selected by the teacher. Type suggestions are given in Figure 19. Place dimensions on the orthographic.

When sketching from objects, take no measurements until the views are sketched in. Estimate your proportions to scale as nearly as practical. That is, if you are sketching as nearly full size as possible, try to make your sketches show it in every view and every part. If the object is about $5^{\prime \prime}$ long, make it as near $5^{\prime \prime}$ as you can estimate, but have the length the same on both the top and front views. Have the width about the same on the top and side views. Have the height about the same on the front and side views.

If you are reducing the object in size on the sketch, show this reduction evenly all the way through.

When the sketches have been completed-no measurements having been taken-put in the dimension and extension lines. Put on the arrow heads, and then measure up the object. As each measurement is taken, put it down in its proper dimension line.

When all have been completed, check it over to see if any dimensions have been omitted. Are the three dimensions given for every piece and every part? Are the sizes and centers of holes carefully located, etc.?

Remember that in actual practice if a working drawing is being made from a sketch, the draftsman must not take the time to go back to the object and measure it for missing dimensions. Every dimension and every detail must be shown in the sketch.


Figure 19

## Plate 17

Figure 20 illustrates the body of a hanger and it is required to make a working sketch from this figure. A few dimensions are given-just enough to secure correct proportions. The problem is to sketch
the front and side views, put on dimension lines, place the dimensions that are given, and estimate the others. This will give excellent practice in proportion and balance. Cheek your dimensions carefully.


Firure 20

## Plate 18

Make a perspective sketch from a piece of furni- perspectives carefully, using the 2 H pencil sharpened ture, but do not dimension it. The cabinet shop projects can be used as models, or the tables, benches, stools, cases, desks, chairs, etc., in the drawing room can be utilized. Each student should be assigned a different project as far as possible. Finish these
to a long point for the finished pencilling stage.

A small amount of shading and graining can be added to this drawing if desired, but do not spoil the effect with too much. Figure 21 is a good suggestion.


Plate 19

From a rather small, complicated object such as a valve, carburetor, ete., make a set of detailed orthographic sketches, and an assembly sketeh. This may require more than one sheet. If so, number
them Plates $19-\mathrm{A}, 19-\mathrm{B}, 19-\mathrm{C}$, etc.
This problem is no more difficult than a single object sketch, it simply requires more sketehes. Each part should be drawn up as a single object, but the


Figure 22
dimensions should be so carefully taken that the detailed parts will go together in the assembly without a conflict.

Figure 22 illustrates a few of the objects suggested for this work.

Plate 20
This final plate of the sketching course is to be drawn up from some machine-a lathe, Figure 23, for example-a gas engine, or any large machine.

The charaeter of the work on this plate will be determined by the amount of time left to devote to it.

Considering the lathe as an example, one student might detail the headstock, another the tailstock, another the tool rest, a fourth the bed, etc., thus completing a set of sketches of a large machinc. Or, if time permits, one student could do this alone, other students working on other machines.

If the instruetor desires any more perspeetive sketches, these machines might serve as models for this advanced perspective sketching.


## Sketching on Cross-Section Paper

## Sketching on Cross-Section Paper

Some draftsmen prefer to make their sketches on cross section paper. Figure 24 illustrates such a sketch. 'This practice has a number of advantages over the plain paper sketch, especially if the paper used is ruled off in inches and subdivided into eights. The vertical and horizontal lines can be eights of an inch. The vertical and horizontal lines can be used to guide the pencil in drawing straight lines, and the divisions make it easy to sketch to seale. The main difference between this method and the other is that it becomes necessary to take measure-
ments from the object as the views are drawn if the correct seale is to be maintained.

In this course it is recommended that a few of the orthographic sketches be made on cross section paper in order to familiarize the students with this procedure.

Another ruled paper that might be of help is the isometric paper now on the market. By its use isometrics can be sketched in place of perspectives, but this is not to be recommended if the ability to make rapid perspeetives is to be acquired.


Figure 24

## Supplementary Problems

The following plates have been added to supplement the course. They may be used in a number of ways. They may serve as additional plates for the more apt students to work upon while the slower are catching up; they may serve as regular plates in
longer courses sueh as might be given in trade or normal schools; or they may be used to make regular mechanical machine drawings for the machine drawing courses.

## Supplementary Plate 1

This plate represents a test plate to follow regular plate 6. It contains less instructive material than the plates preceding, hence the students must use more initiative to work it out. No instruction should
be given concerning it, and students should not be allowed to visit with each other nor look at each other's work while solving it.

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GROOVED BLOOK
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INSTRUCTIONS
COMPLETE THE TOP VIELV AND DQAW A PERSPECTVE $N$ THIS SPACE:


Supplementary Plate 1

## Supplementary Plate 2

This plate represents two small machine parts in dimensioned perspective. Its use may be restricted to the drawing of working sketches, or a working
sketch and a copy of the perspective can be requireci of each piece.

DEILL BLOCK


## Supplementary Plate 3

A working sketch of a special wrench is illustrated on this plate. One feature is a revolved sec-tion-a section at right angles to the center line at any chosen point to show the shape of the object at that point. A revolved section is often used to illustrate the shape of the spokes in fly-wheels and
pulleys, and is sometimes drawn on the object itself. rather than to the side as illustrated.

The problem in sketching is to make a perspective from this working sketch, or to make a similar sketch from a wrench furnished by the teacher.


## Supplementary Plate 4

Plate 4 illustrates two working sketches, one of a clamp handle such as is sometimes used to tighten the tail stock of a wood lathe, and the other an S wrench.

The elamp handle shows screw threads in section,
it being imagined that a part of the object has been broken away in order to show the threads. This is called a "partial section."

It is suggested that perspectives be required of these objects.


Supplementary Plate 4

## Supplementary Plate 5

Many good problems in sketching can be secured in the wood shop. The footstool and taboret are very familiar objects to most students. Working
sketches can be made from these perspectives, or similar sketches can be made from the working drawings which the cabinet shop will have in abundance.

FOOTSTOOL


## Supplementary Plate 6

The working sketch of a tumbling shaft bracket is a good example of a simple bearing. Notice that on the front view two full cireles are represented, the large one being the hole bored out in the body of the bracket, and the small one the inside bearing surface of the bushing which is driven or pressed in
place. An oil hole through both the bearing and the bushing allow lubrication for the shaft which moves baek and forth in the bearing.

A perspeetive from this working sketch is the required problem in this case.

## TUMELING SMAFT BRACHET



Supplementary Plate 6

## Supplementary Plate 7

This dimensioned perspective shows a valve yoke such as is used on most types of locomotives. A working sketeh, completely dimensioned, is required
of it. Notice the manner of showing the eurved edges in perspective.

## VAI.VE YOKE



## Supplementary Plate 8

This bearing shows two views in full section. When it is necessary, any number of sections can be used to illustrate, clearly, the internal construction of a piece. A large object with many holes inside,
such as the cylinder block of a gas engine, may requive at least a dozen sections, taken through varions parts of the body.

A perspective should be made of this project.

## CAP BOOY SIDE BEARING FOR UP REFR. CARS



Supplementary Plate 8

## Supplementary Plate 9

It will be very good practice for the student to trace out the meaning of the various dotted lines on this working sketch. As his problem, and to test his ability to read working drawings, the student should
copy the top view and draw full sections in place of the front and side views as they are here given.

A perspective from this working drawing will also prove of value to the student.


Supplementary Plate 9

## Supplementary Plate 10

If a perspective of this bracket is drawn, notice that there are two bearings, the one to the left being the same distance from the center linc that the one to the right is drawn. This is often done in working drawings when the object is long, and the parts
on each side of the center line are the same. There is always one dimension which covers the entire length of the finished piece. The dimension $321 / 2^{\prime \prime}$ represents it here, and there is no arrow head on its left hand end.


Supplementary Plate 10

## Supplementary Plate 11

The last three plates represent projects of interest to agricultural and architectural students.

In the first the perspeetive of a watering trough is given. The principal dimensions are attaehed.

The ability to make such sketches will be appreciated by the farmer who very often is called upon to explain some part of his farm equipment to another. person who is to build it for him.


Supplementary Plate 11

## Supplementary Plate 12

The perspective of an ordinary window frame is shown on this plate.

The student should draw sections through the
head, stile, and sill, dimensioning the parts in the regular manner.

WINDOW FRAME


Supplementary Plate 12

## Supplementary Plate 13

The problem presented on this plate is an interesting one to the student of agriculture. After solving it and putting on its principal dimensions, he should have acquired the ability to make working sketches of simple structures of this type. If a neighbor owns a hog pen which the student's father
wishes to duplicate on his farm, it will be a very useful procedure for the student to measure up and sketch the hog pen in such shape that the building can be built from his sketches without the need of further reference to the existing building.


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