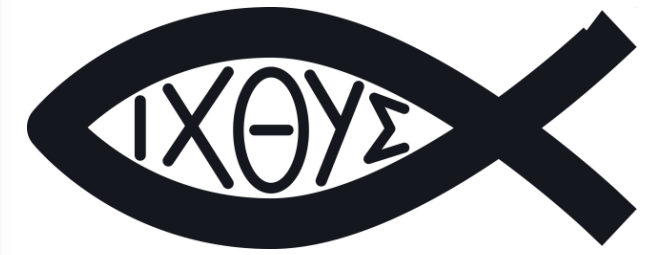


VOLUME I : SHOP BASICS, DRAWING, AND CAD

GUIDE TO SHOP AND ENGINEERING

FOR SECONDARY SCHOOL STUDENTS

By Kent Misegades
with
Michael Patrick Leahy and Anthony Gockowski



*With a Biblical
Worldview*

available at
LULU.com

Lecture Notes for CHAPTER 11



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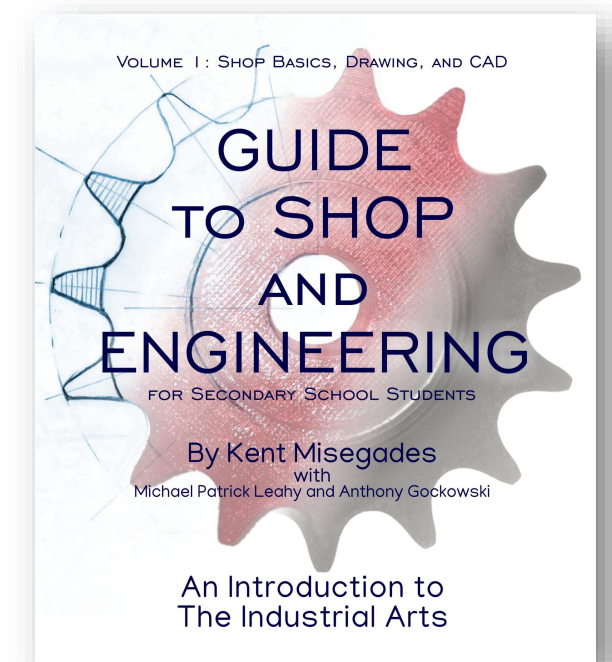
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Key Conversion Factors Between Metric and US Customary Units

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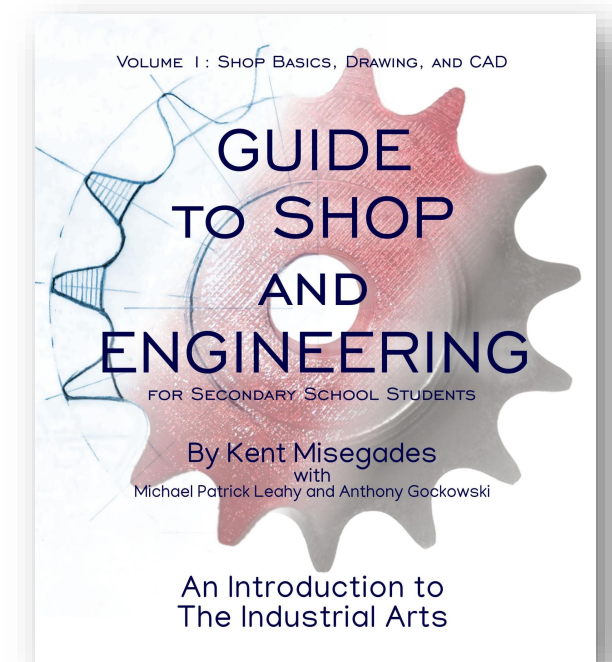
23 Shop Projects

Additional Reading

About the Author

Throughout the Guidebook: American Inventors

Throughout the Guidebook: Leading Schools



How to Use these Lecture Notes

1. **Read** the printed volume, **Shop & Engineering**, for this chapter.
2. **Gather materials** needed for this chapter's lessons, exercises and for recommended projects.
3. Use these Lecture Notes to **teach and discuss** the material. They contain more than the print version!
4. Work through all the **exercises** and check results. Correct errors and repeat until **100% correct**.
5. Take time to discuss the “**Questions to Ponder**” and “**What the Bible Says About**” sections at the end.
6. **Reinforce classroom learning** by doing one or more related **projects** in your workshop.



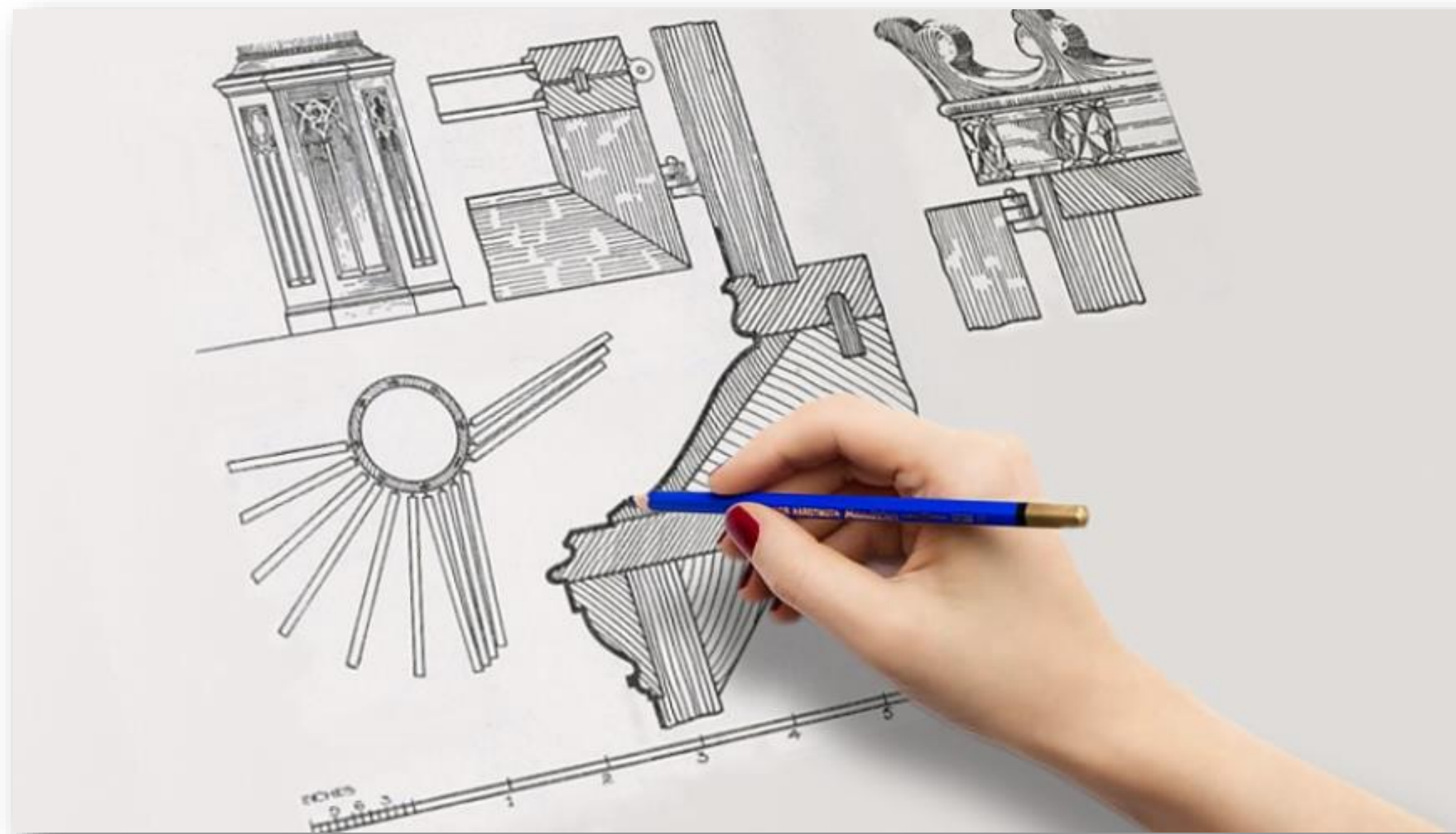
Engineering with a Biblical Worldview

- Everything in our lives is directed by **God**. At **home** and at **work**. His **wisdom and direction** for our lives is found in the **Bible**, so *of course* engineers should always have **scripture** first and foremost in their minds!
- Our **worldview** is developed as we establish beliefs about four critical topics: (from *Biblical Worldview*, Dr. J. Mulvihill)
 1. **Creation:** How did I get here? What is my purpose?
 2. **Rebellion:** What went wrong? Why is there evil and suffering?
 3. **Salvation:** What is the solution? Where do I find hope?
 4. **Restoration:** What happens in the future? How do we transform lives and change the world for the better?
- Engineers continually **face challenges** in their quest to develop products and solutions that ultimately “**transform lives and change the world for the better**”. The Bible provides many **answers**, the reason it should be found among every engineer’s **most-used reference books**.



Volume I : Chapter 11

Multi-View Drawings



What this chapter covers:

- **Definitions**
- **The Glass Box**
- **Orthographic** projections
- **Three Standard Views**
- **Minimum number** of views needed
- **Hidden lines & Centerlines**
- **Additional Drawing Elements**
- **American Inventor – Glenn Curtiss**
- **What the Bible Says**



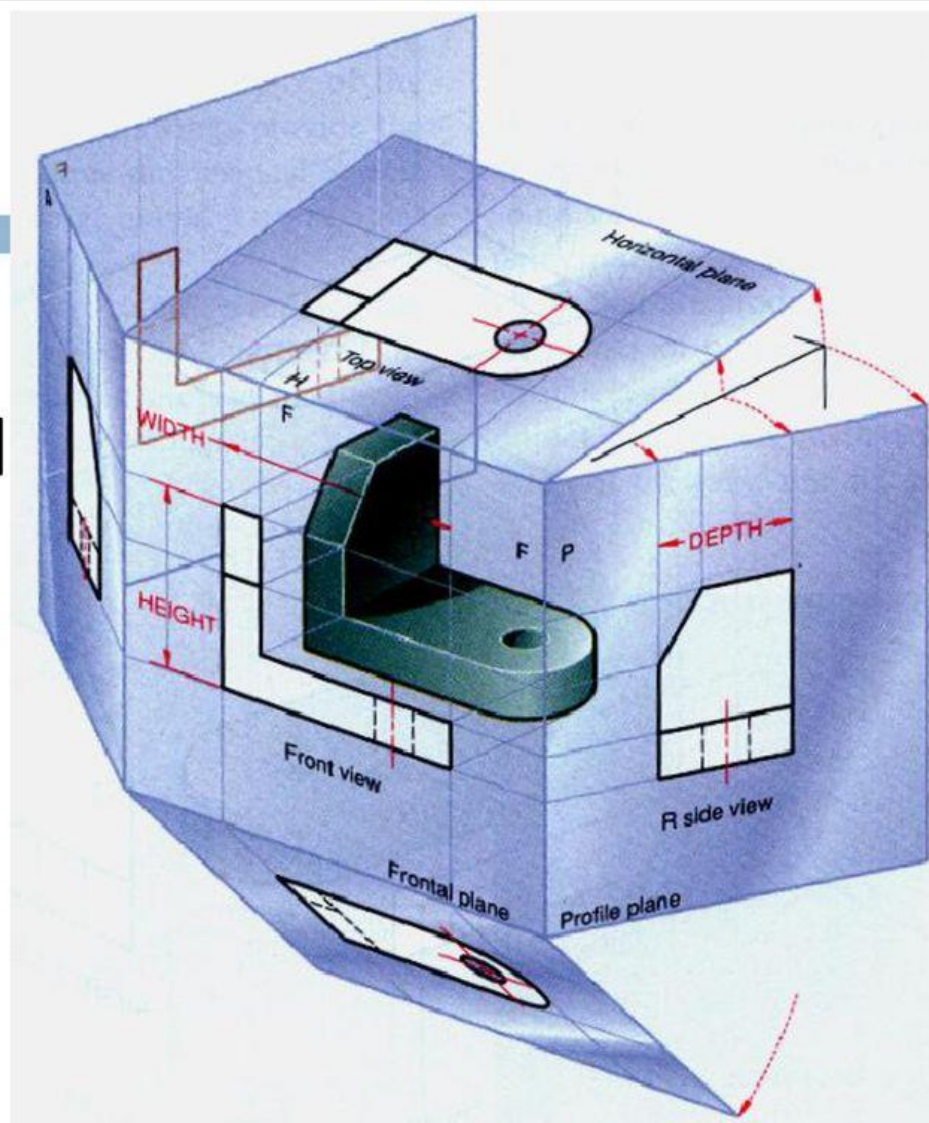
Definitions:

- **Boss** - a protruding feature on a work piece. For instance, a circle extended in a direction orthogonal to its plane becomes a cylinder. Same as an “extrusion”.
- **Centerlines** - lines used to indicate axes of symmetry and the location of the origins of holes and other features.
- **Extrusion** - a protruding feature on a work piece. For instance, a circle extended in a direction orthogonal to its plane becomes a cylinder. Same as a “boss”.
- **Glass Box** – an imaginary, six-sided box surrounding an object. Each one of the six sides of the box shows a 2D drawing representing the object’s projection onto it.
- **Hidden Lines** - a line that cannot be seen because view of it is obstructed by part of the object or of another object.
- **Mitre Line** – a 45 degree line, lightly drawing in the upper right-hand quadrant of a multi-view drawing. Used to aid in the transfer of dimensions between the top and right-hand side views.
- **Multi-View Drawings** - a technique of illustration by which a standardized series of orthographic two-dimensional pictures is constructed to represent the form of a three-dimensional object.
- **Orthographic Views** - a two-dimensional drawings of an object arranged at right angles to one another. Six such views describes the “walls” of the Glass Box.
- **Pictorial Drawings** - view of an object as it would be seen by an observer who looks at the object either in a chosen direction or from a selected point of view. The most common pictorial sketches are isometric, oblique and perspective views. Pictorial sketches aim to provide more realism to drawn objects.
- **Standard Views** – the minimum number of projected views of an object needed to provide all details to create the object. Depending on country and engineering discipline, what are considered the standard views varies.



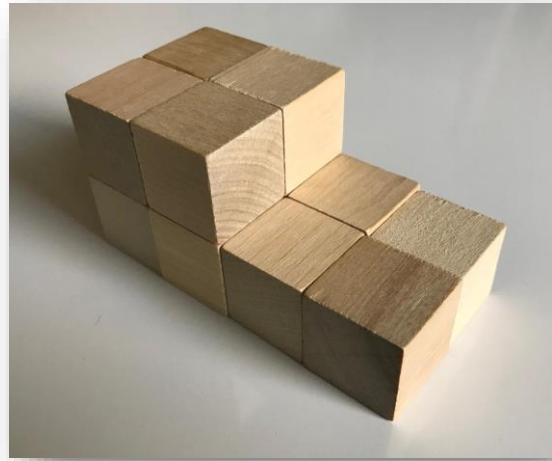
The Glass Box

Six principal views on glass box

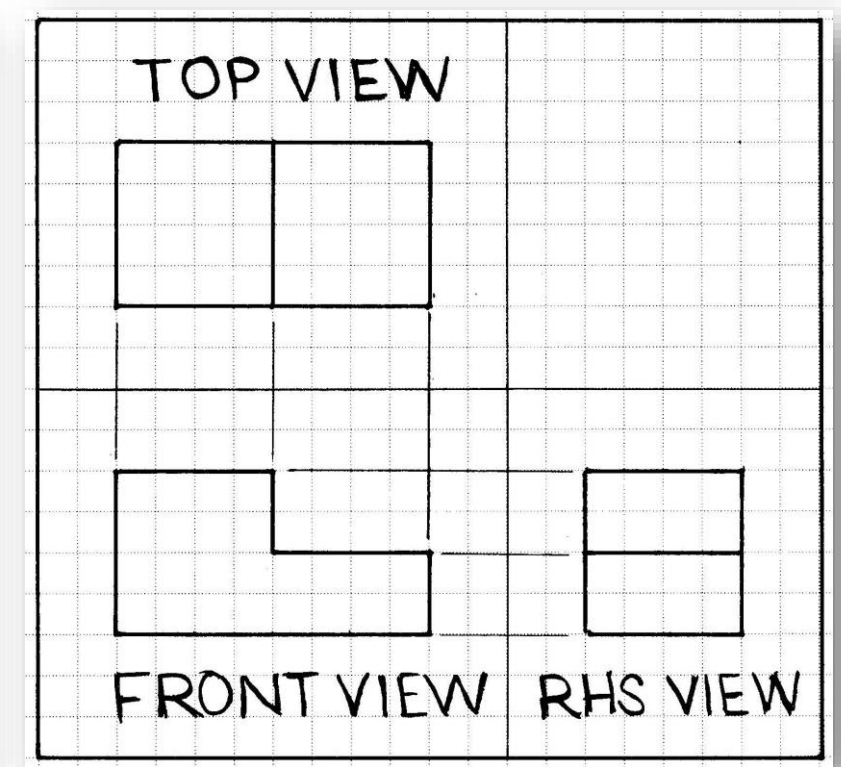
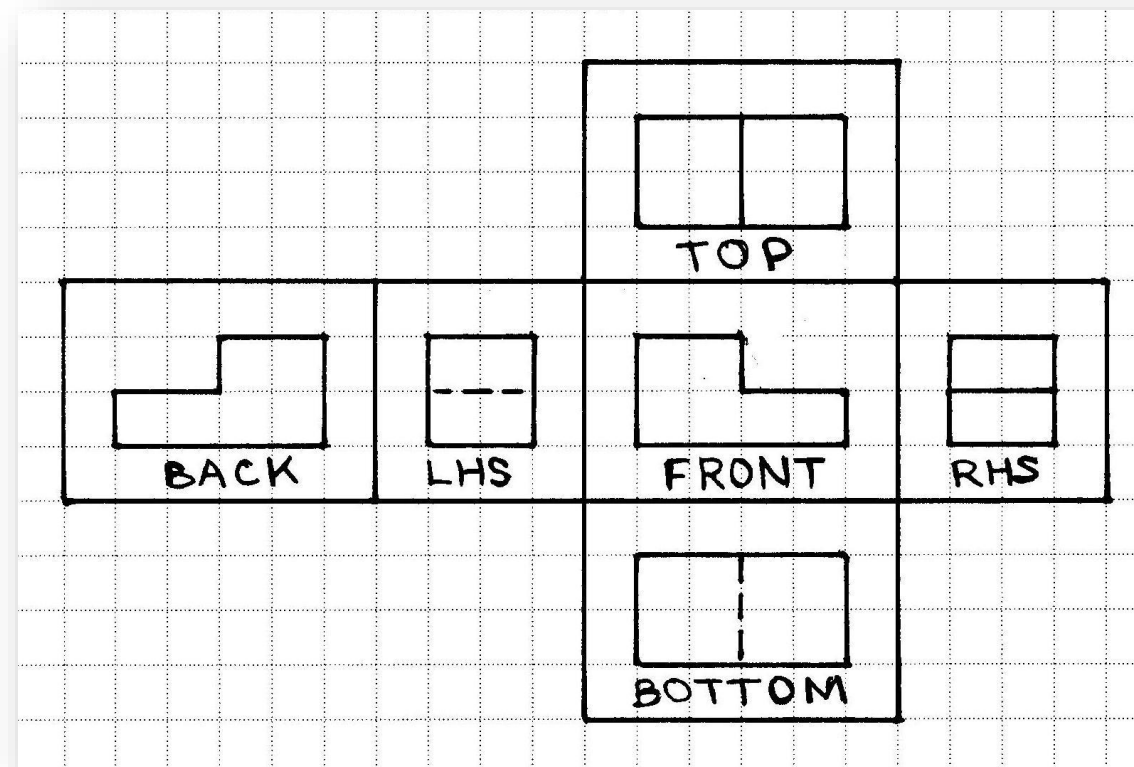
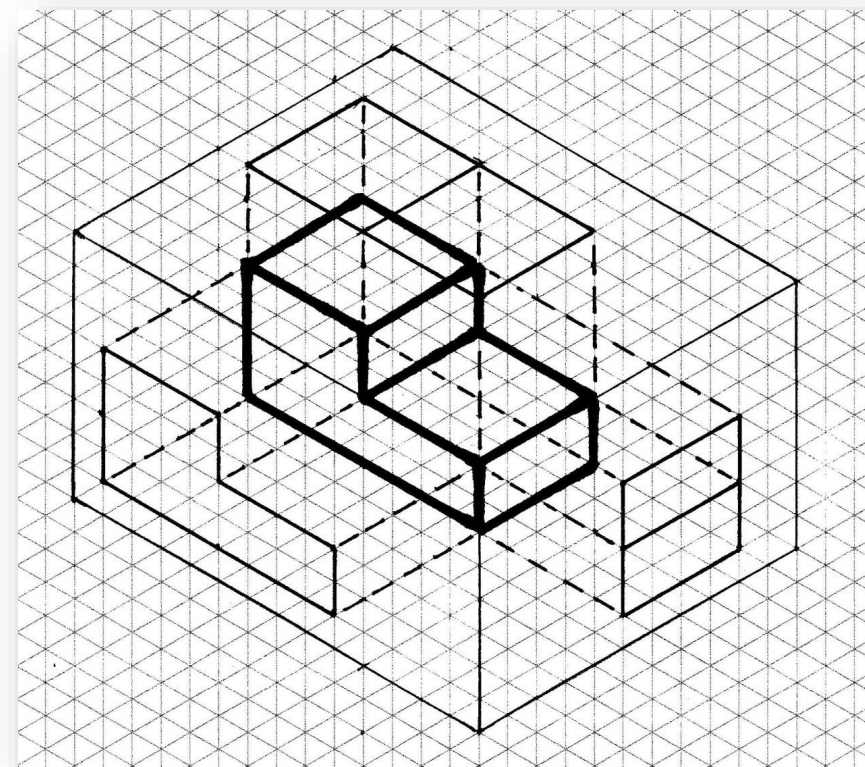


- To describe an object completely we need to create a series of views of it, each one from a different point of view from the observer. Then we will add dimensions, which is covered in Chapter 13. The result is a **Multi-View Drawing**.
- The most common series of multiple views are the six shown in the figure above, 'projected' onto the sides of an imaginary '**glass box**' that encloses the object.
- The views are called "**orthographic**" as they are oriented 90 degrees from each other.





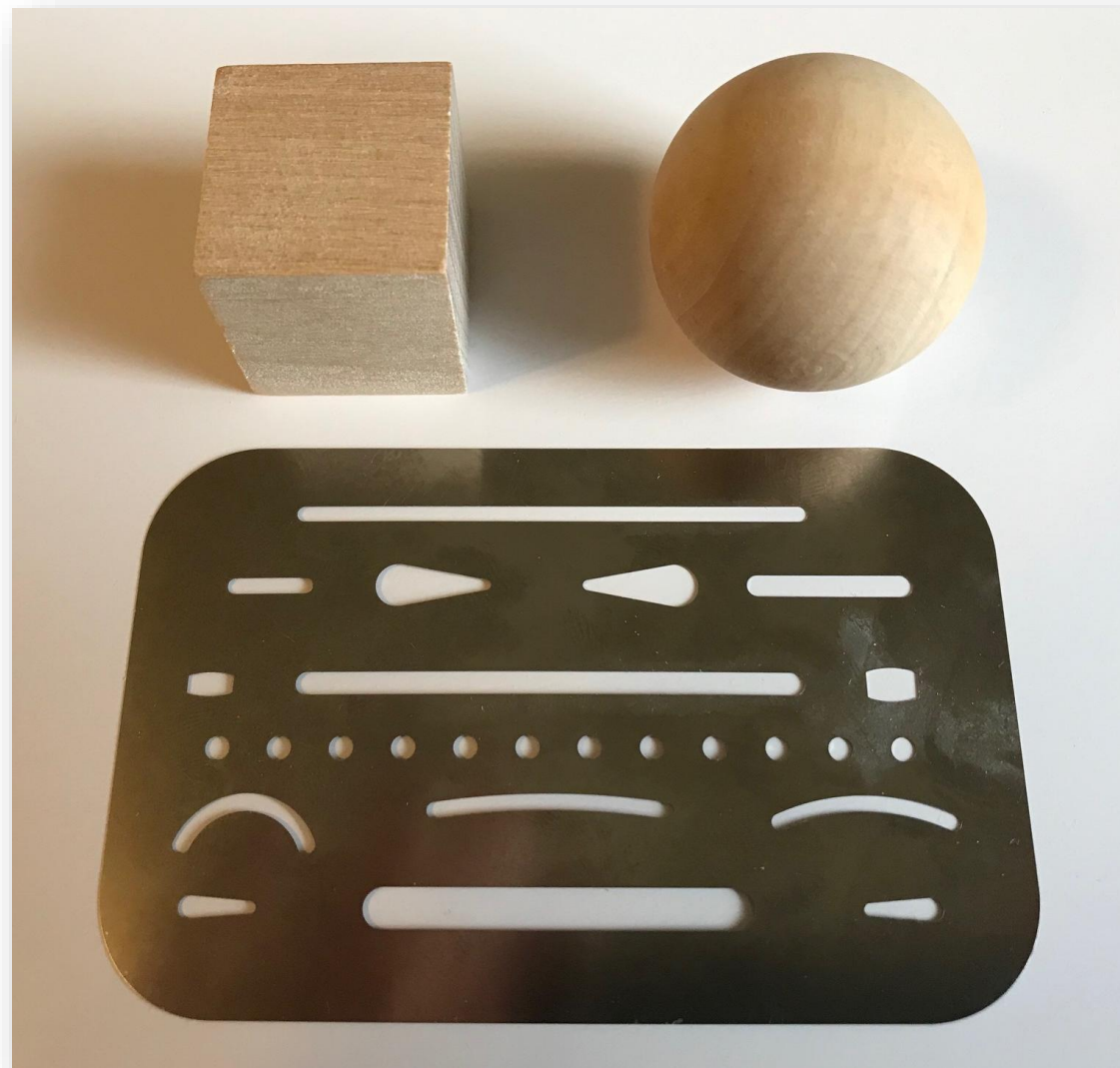
The Three Standard Views



- When the sides of the glass box shown above, left are unfolded, the **six orthographic views** shown above, middle result.
- Only three of these views are, in most cases, necessary to describe all details. In the USA, the **Standard Views** are **FRONT, TOP and RHS** (Right-Hand Side). These are shown above, right.
- Often, one additional “**pictorial**” view is included to add realism. This is covered in Chapter 12.



Minimum Number of Views



- In many instances, **fewer than three** views are required to show all details.
- Thin objects such as the eraser shield above need **only one top view** along with the material's thickness. A sphere also requires only one view.
- **Cylindrical** objects require **two views**, a front view showing height and shape, and a top view.
- When drawing objects, the **goal** should always be to use the **minimal number** of views to describe all details.



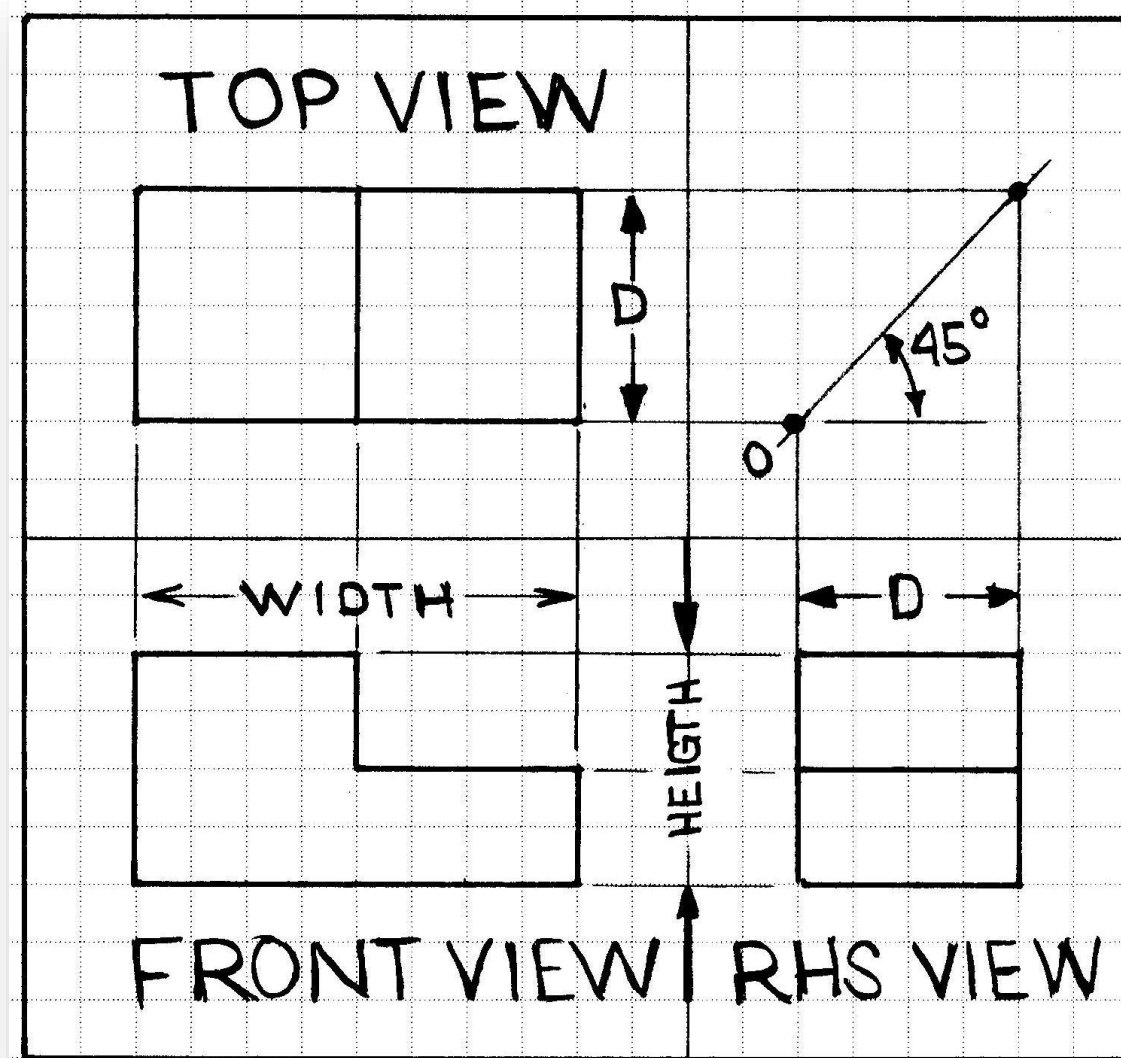
Which View Should be the Front?

Follow these **universal guidelines** for the best results:

1. The **most natural** view of an object; how it appears in reality.
2. The side with **the widest features**.
3. The side that will result in the **least number of hidden lines** in your drawing.
4. The side showing the **greatest number of features**, such as holes, fillets, and chamfers, rounds, etc.



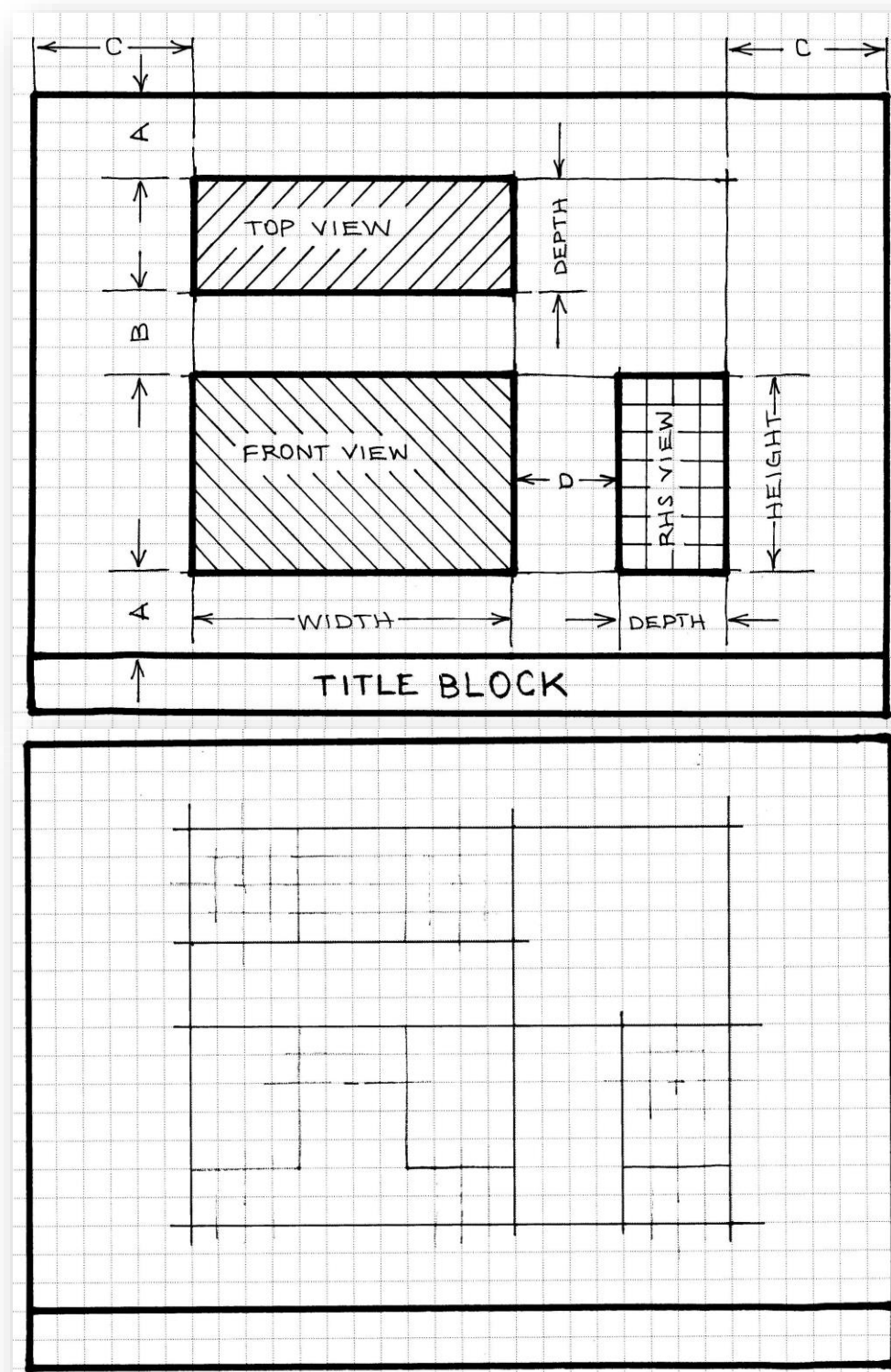
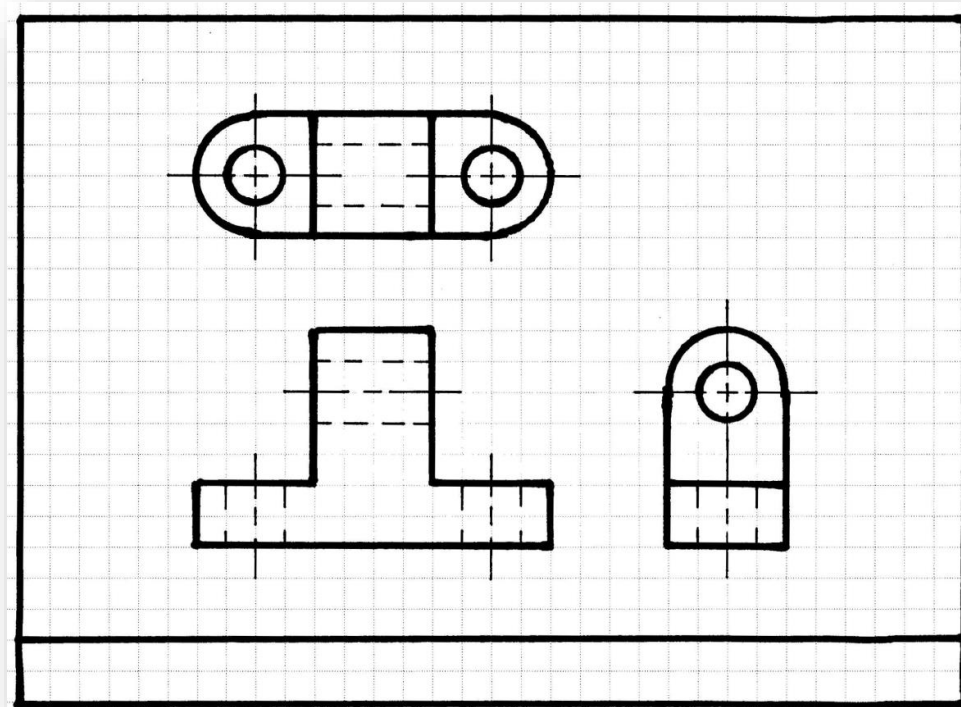
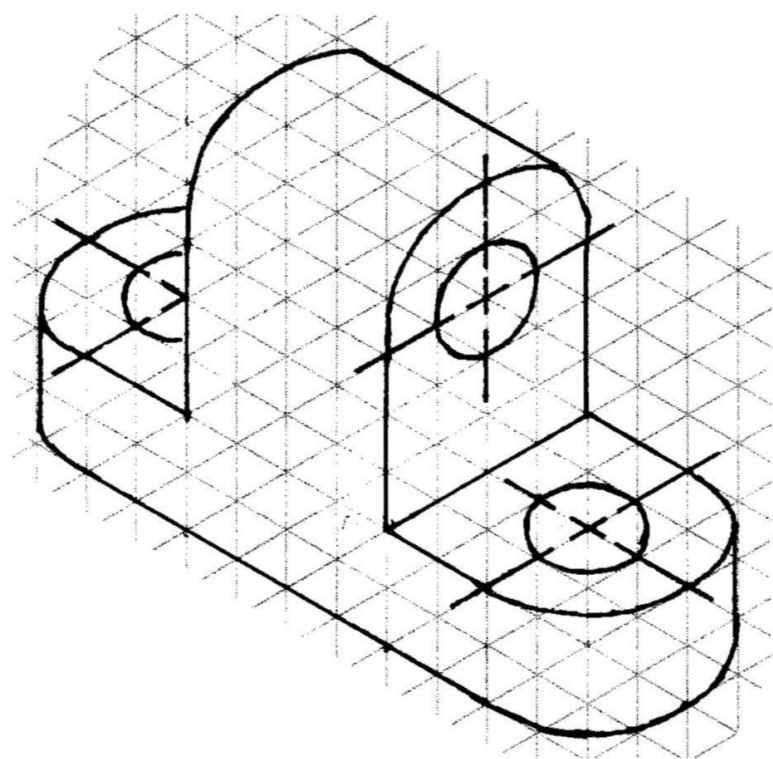
Multi-View Drawing Layout



- Your paper will be divided into four sections, or “**quadrants**”. The FRONT, TOP and RHS views should **always** be drawn in the quadrants shown above. The upper right-hand quadrant is left open for a possible **pictorial view** later.
- Note how key features in one view line up with the same feature shown in an adjacent view. A 45 degree “**Mitre Line**” in the upper RH quadrant can be used to transfer dimensions from the TOP view to the RHS view. Draw it lightly for later removal.
- **WIDTH** and **HEIGHT** dimensions normally appear in the **FRONT** view. **DEPTH** dimensions appear in the **TOP** or **RHS** views. Leave room for dimensions and text.



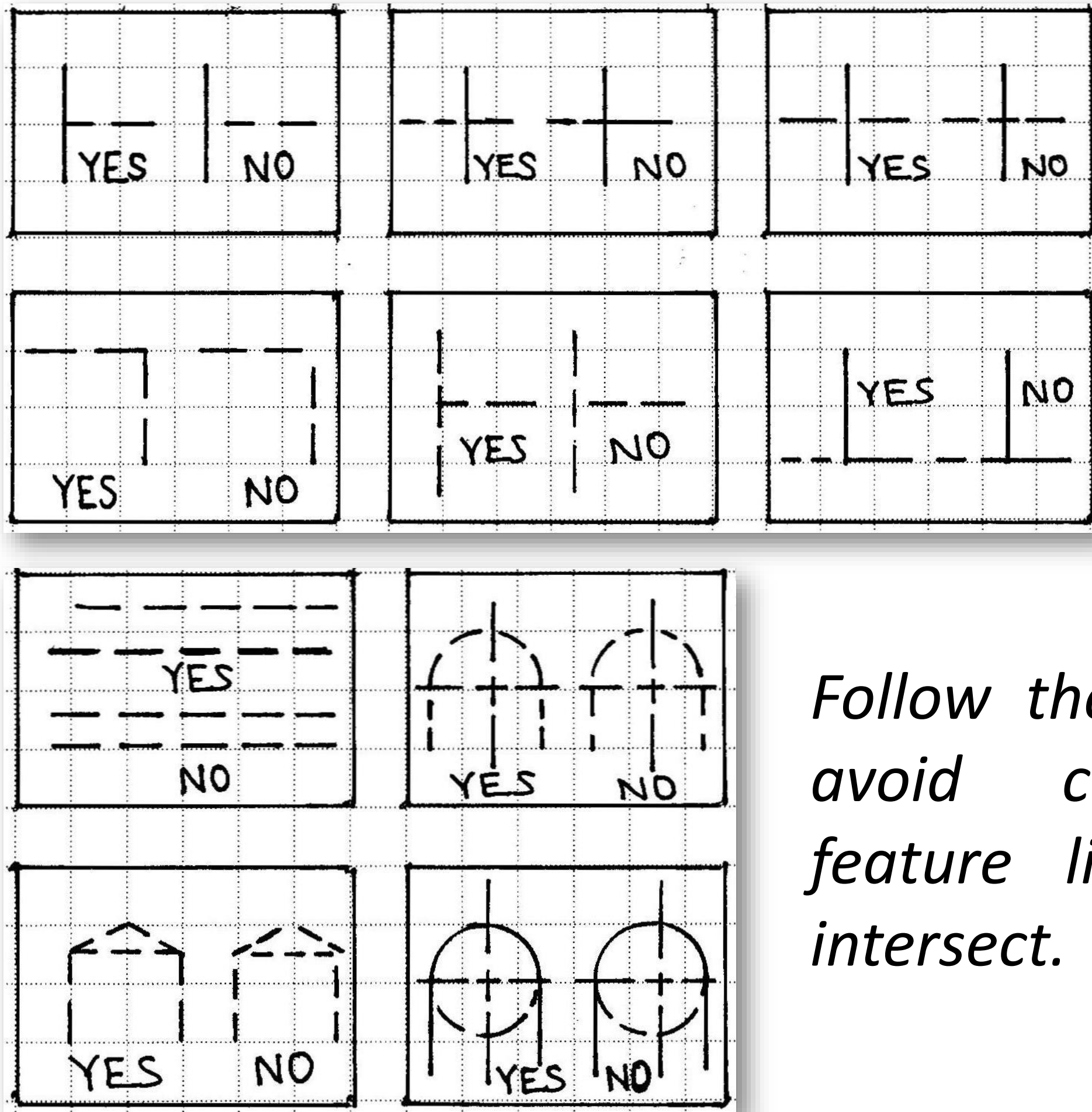
Multi-View Drawing Layout



How to lay out a multi-view drawing, clockwise from top left: isometric pictorial view of the object to be drawn, longest side chosen as front view; block out regions based on maximum dimensions in each of the three standard views; lightly draw in features; darken object lines and erase construction lines to complete the drawing.



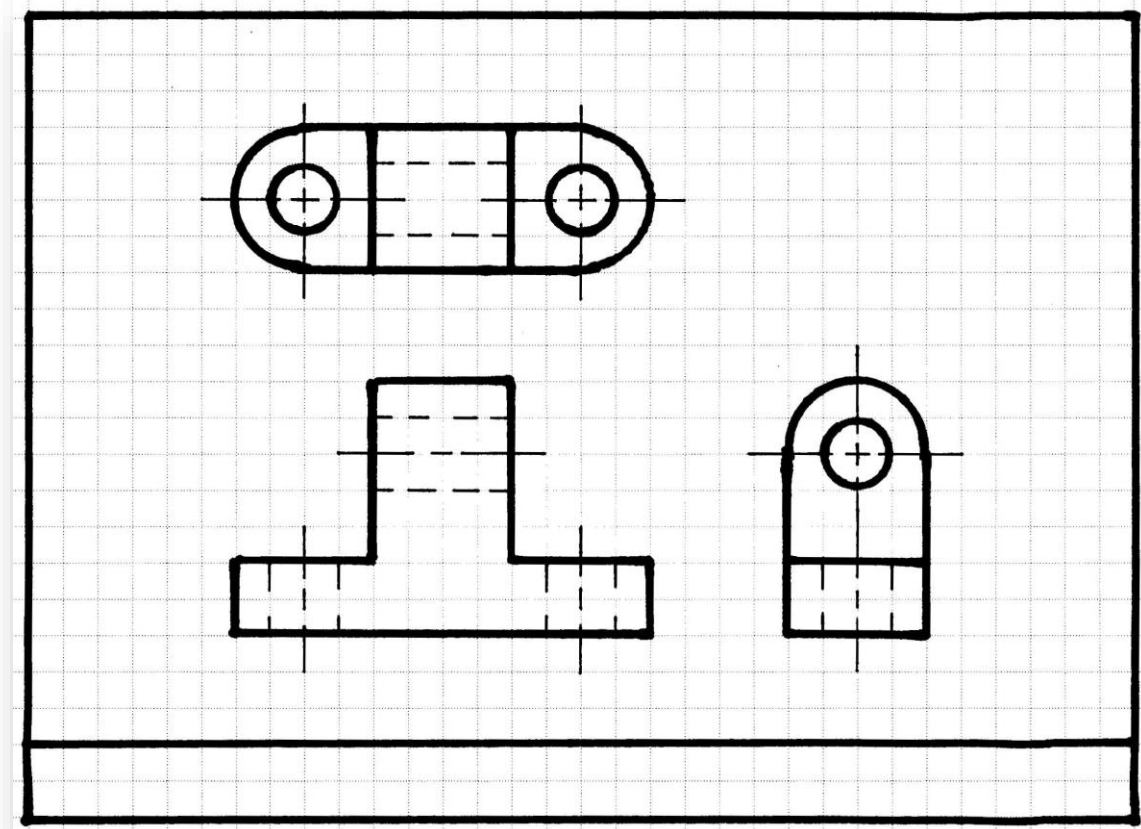
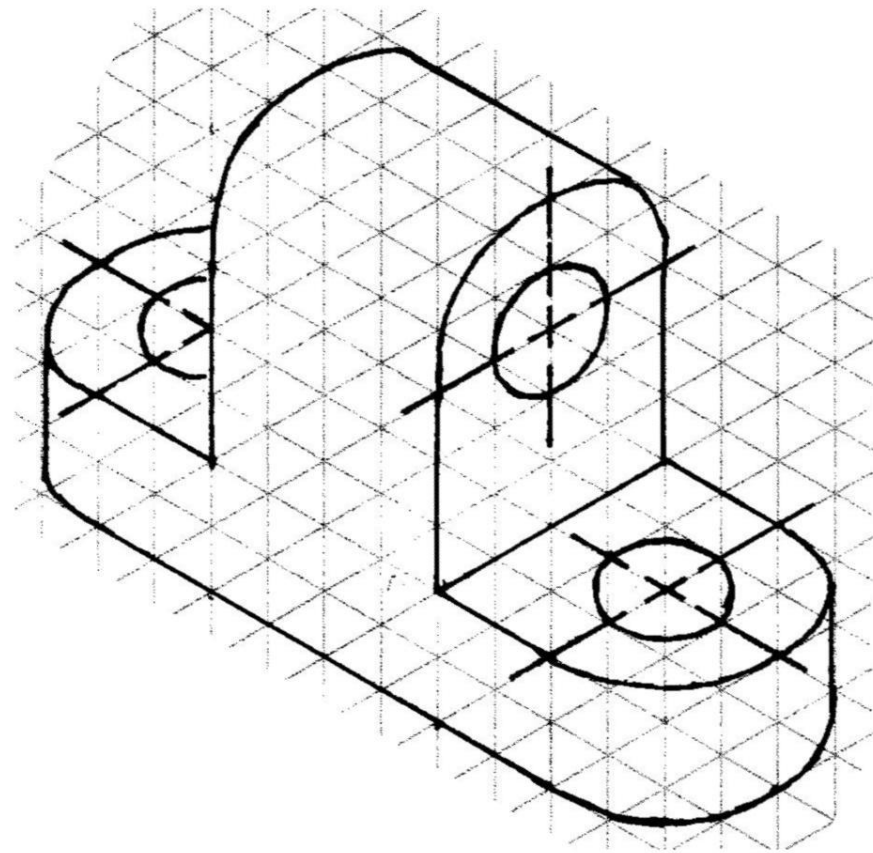
Hidden Lines



Follow these guidelines to avoid confusion when feature lines coincide or intersect.



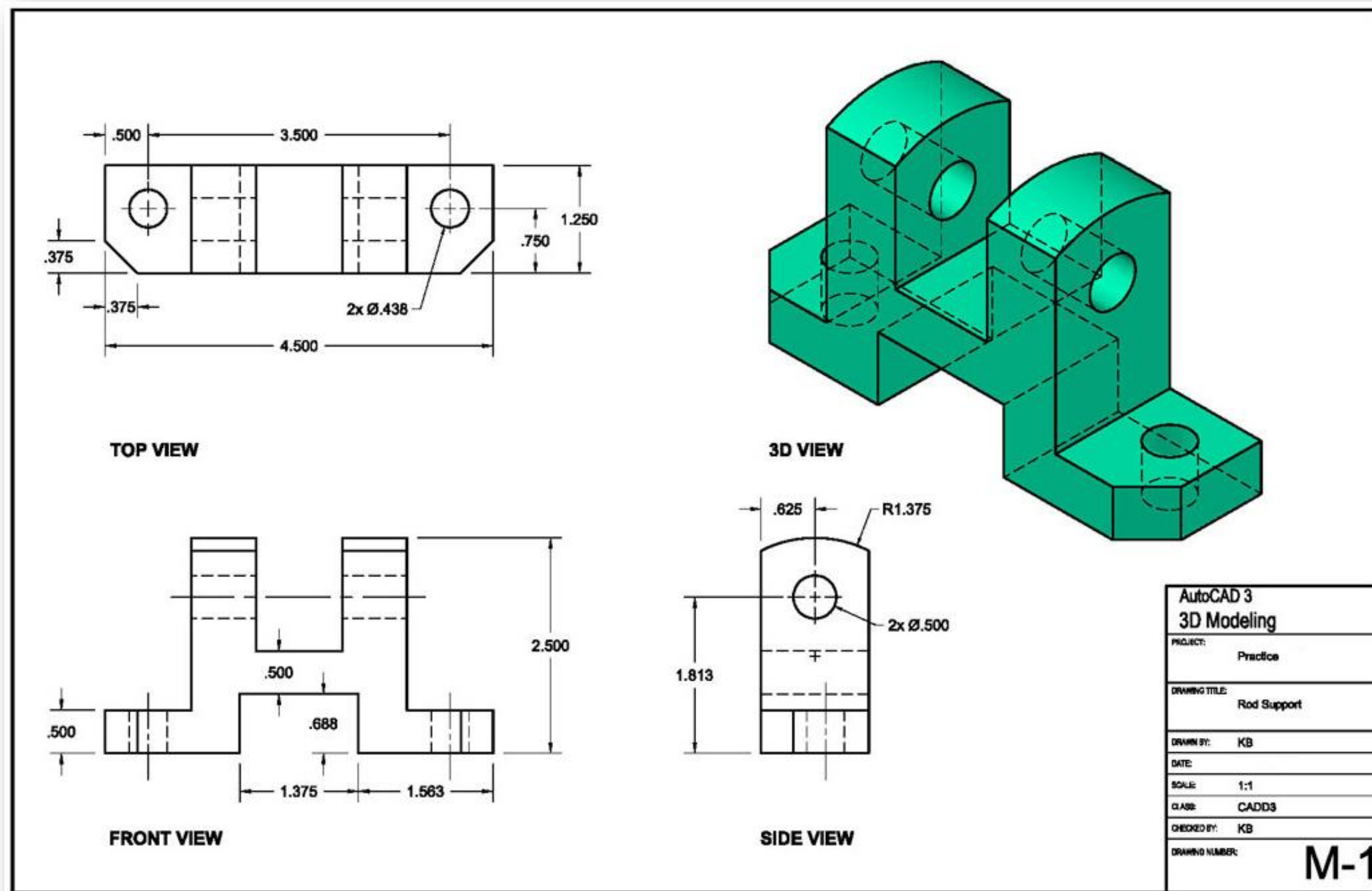
Centerlines



- Centerlines show an **axis of symmetry** or the location of the **origin** of holes, arcs, fillets, or rounds.
- Depending on whether a hole is viewed from the top or the side, the centerline is **drawn as shown above**.
- Follow the rules of **order of precedence** for which line is visible:
 - When a visible line coincides with (lies in front of or behind) either a hidden line or a centerline, the visible line is shown.
 - When a hidden line coincides with a centerline, the hidden line is shown.



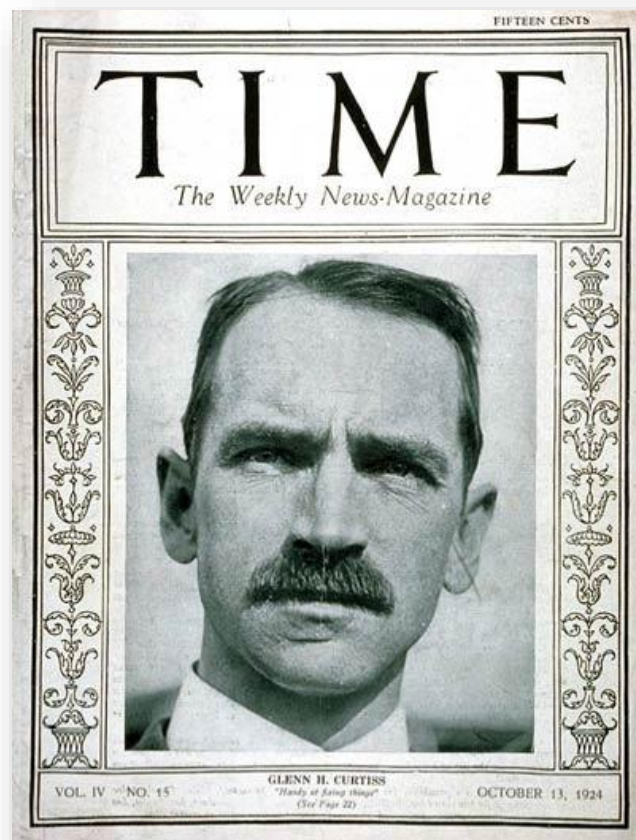
Additional Drawing Elements



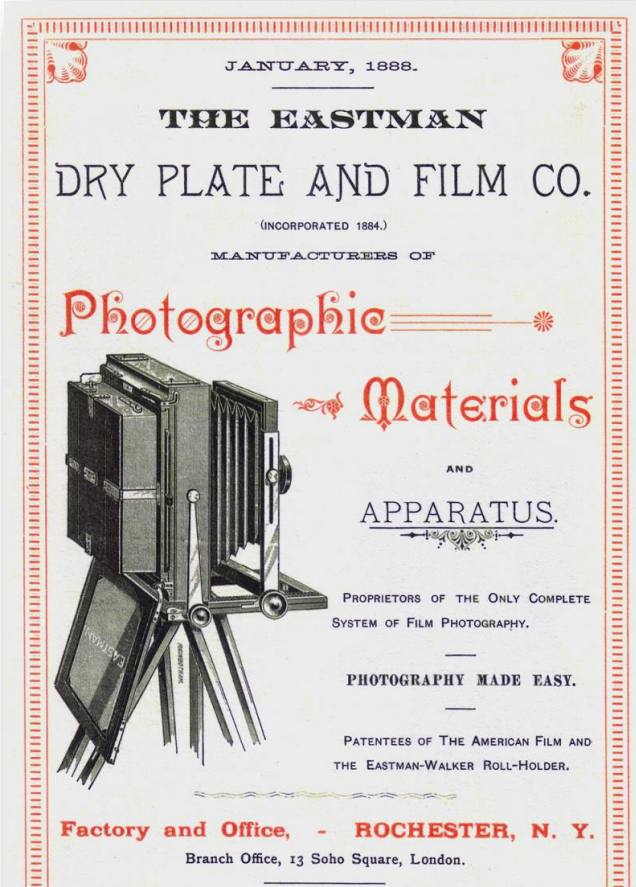
To complete a multi-view drawing one needs to add dimensions, a border, a title block, annotation and perhaps a pictorial view. Most objects will have to be scaled up or down to fit on standard paper.



American Inventor – Glenn Hammond Curtiss



- **Born in 1878** Hammondsport, NY. His father, Frank Richmond Curtiss was a harness maker. His paternal grandfather was Claudius G. Curtiss, a Methodist Episcopal clergyman.
- His parents named him after the lovely **glens** (narrow valleys) of the region and the town of **Hammondsport** at the southern end of Keuka Lake in the Finger Lakes region of upstate NY.
- Curtiss' **father died** of a stroke in 1882 when Glenn was **four**. When his younger sister, Rutha, **lost her hearing** as a result of childhood meningitis, his mother moved with Rutha to Rochester, NY so she could attend a school for the deaf. Glenn remained in Hammondsport with his grandmother until he ended his formal education with the **8th grade at age 14**.
- In 1903 Curtiss moved to Rochester, where his mother, a teacher, had opened a storefront school and Glenn found a **job** as a stencil maker and film stock assembler at **Eastman Dry Plate and Film Co.**, now known as Eastman Kodak.
- Although he loved working with cameras and became a **talented photographer**, he was frustrated by the **dullness and slowness of the assembly line**.



American Inventor – Glenn Hammond Curtiss



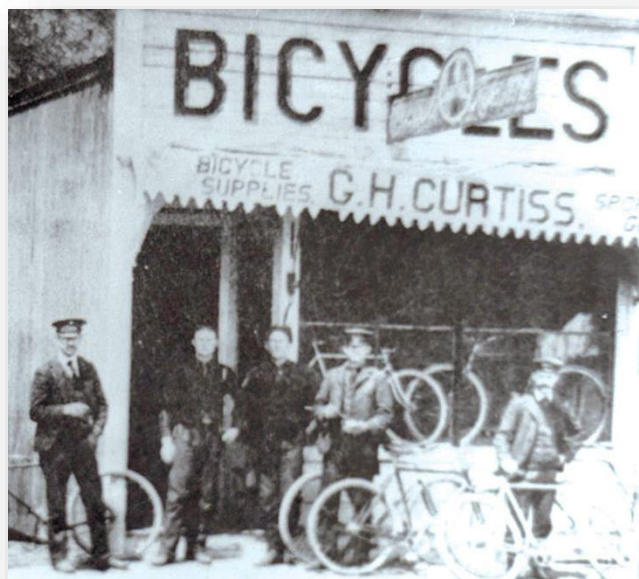
- While at Eastman, Curtiss asked to be **paid by the piece** rather than by the hour. Unbeknownst to them, Curtiss had **developed a device** that cut the work time in half and **quadrupled the output**.
- When Glenn Curtiss had saved up enough money, he left his factory position and bought a bicycle, becoming a **bike messenger** for the Rochester branch of the **Western Union Company**. He would speed through the streets delivering **telegrams** faster than anyone else. On the weekends, he raced his bicycle at events throughout the region, usually taking home cash prizes, becoming known as the **champion rider** for western New York State.
- In **1895** his mother remarried J. Charles Adams, whose family owned large vineyards on the shore of Lake Seneca, near Hammondsport. They moved to Rock Stream, NY in that year, where Glenn went to **work** in his stepfather's vineyard while continuing his cycling sport with the support of the **Hammondsport Wheelman's Club**.



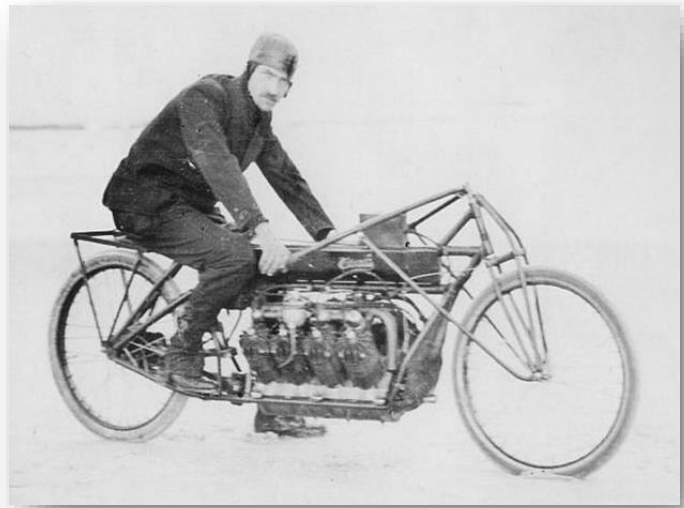
American Inventor – Glenn Hammond Curtiss



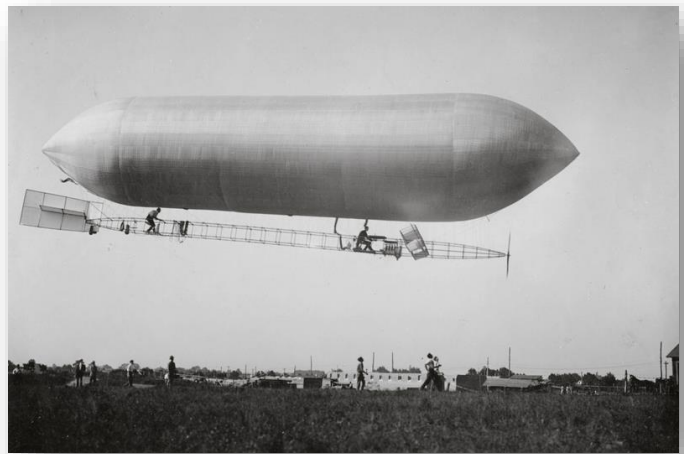
- In 1898, at **age 20**, Curtiss married Lena Pearl Neff, a sawmill superintendent's daughter. She was Glenn's closest confidant and friend for life.
- Being a **“man with family responsibilities,”** in 1900 Curtiss opened a bicycle rental and repair shop in Hammondsport that was the home of his own **Hercules-brand** bicycles, and later his **motorcycles** of the same name.
- Sadly, Curtiss and Lena's first child, their **son Carlton, died** before his first birthday. When Lena was expecting a second child, Glenn **stopped his lucrative exhibition flying** to be near his family. **Glenn Hammond Curtiss II** was born healthy in 1912.
- In 1901 he formed the **Hercules Bicycle Company** and soon thereafter the **G.H. Curtiss Manufacturing Company** to produce his own motorcycles. After initial experiments with engine kits from the E.R. Thomas company, Curtiss designed and build his **own engines**, which were known for their **high quality and low weight**, ideal for motorcycles, and later, aircraft. The first Hercules motorcycles were produced in 1902 and sold for \$180.



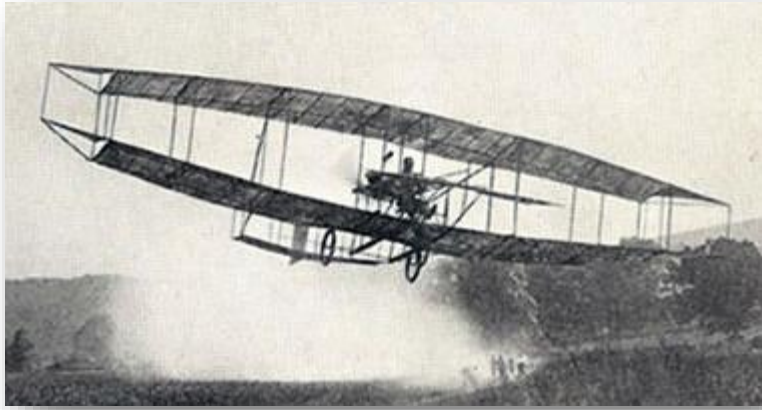
American Inventor – Glenn Hammond Curtiss



- As a serious competitor, Curtiss developed a series of **racing motorcycles** with which he won numerous races and set many records. On January 24th, 1907, piloting this V8-powered machine, Curtiss set a **world's speed record** of 136.36 miles per hour on Ormond Beach in Florida, winning him the title of “**The Fastest Man on Earth.**” This record stood until 1930.
- Curtiss' first experience with aviation was as supplier of engines for early airplane builders and to dirigible pioneer **Captain Thomas Scott Baldwin** of San Francisco, California. When he flew in the summer of 1905 as engine mechanic on Baldwin's successful demonstration flight of **US Army Dirigible Number One**, Curtiss' skepticism of aviation disappeared, and he became an important force in aircraft development.
- In the summer of 1907, at the invitation of the inventor of the telephone, **Alexander Graham Bell**, Curtiss joined the **Aerial Experiment Association (AEA)**, based at Bell's estate in Baddeck, Nova Scotia, Canada. As an expert on lightweight engines, Curtiss became the primary supplier for AEA's aircraft.



American Inventor – Glenn Hammond Curtiss



- During 1908 the AEA made several successful powered flights in three designs, the **Red Wing, White Wing and June Bug**, all powered by Curtiss B-8, V8 engines. While flying the June Bug, a craft of his own design, Curtiss won the first aeronautical prize, the Scientific American Cup, ever awarded in the United States. His use of **ailerons** to control flight direction set off years of bitter patent debates with the **Wright Brothers**, who had earlier turned down Curtiss' offer of an engine for the aircraft.
- Shifting his attention from motorcycles to aircraft, Glenn established the **Curtiss Aeroplane Company**, which became the world's largest aircraft manufacturer during World War I, earning him the title of "**Father of American Aircraft Manufacturers.**" The most widely produced model during the war was Curtiss's **JN-4, "Jenny,"** used to train US pilots.
- The Curtiss **NC-4 "Flying Boat"** crossed the Atlantic Ocean in 1919, making the **first transatlantic crossing** in the history of our country. Curtiss was named "**Father of Naval Aviation.**"



American Inventor – Glenn Hammond Curtiss



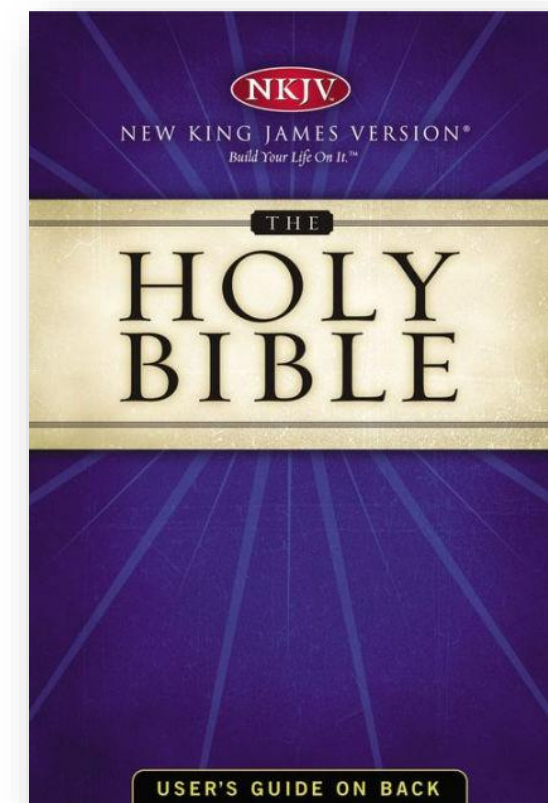
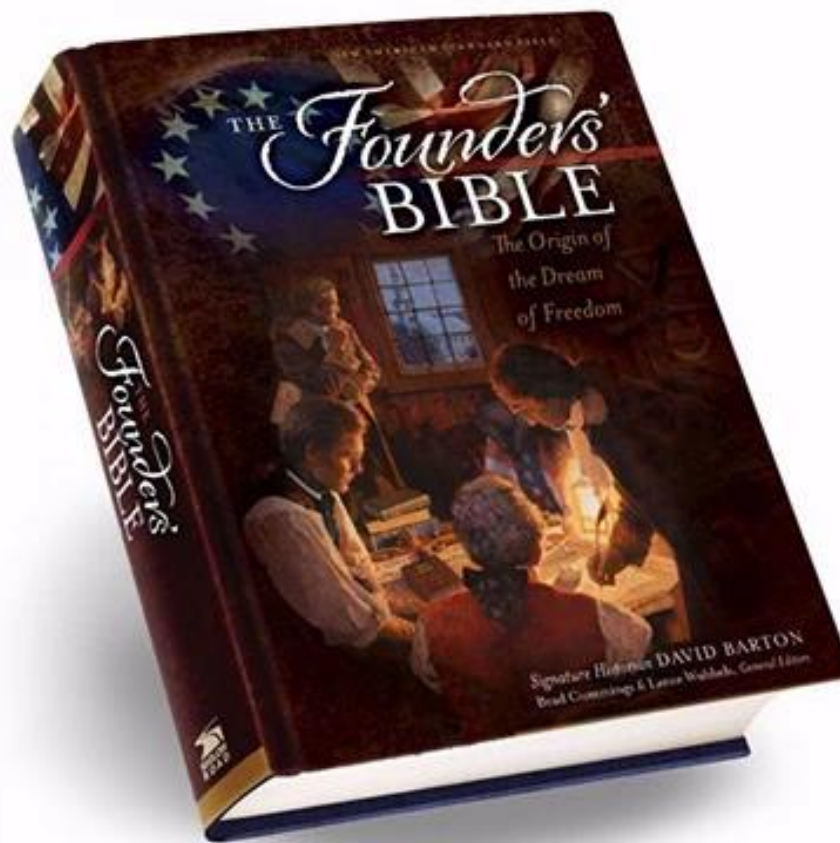
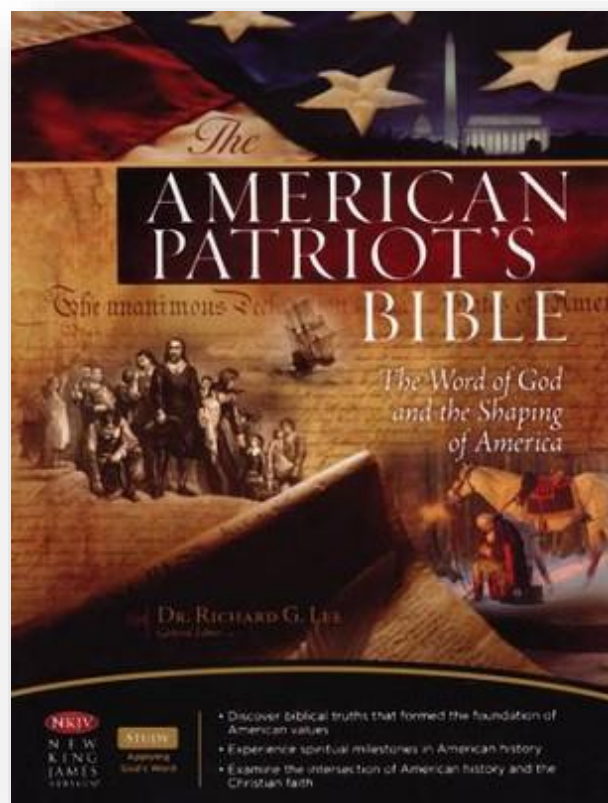
- The Aero Club of America under Federation Aeronautique Internationale (F.A.I.) issued **pilot's license # 1** to Curtiss in recognition of “the first person to publicly fly in the United States” (July 4, 1908 June Bug flight).
- **Blanche Stuart Scott**, student of Glenn Curtiss and later called the “Tomboy of the Air,” was the **first woman to fly in public** in the US on Sept. 2, 1910 when the plane's throttle block “accidentally” slipped out of place and she “soared” to 150 feet.
- Another of Glenn Curtiss's students was **Emory Conrad Malick**, who became **America's first licensed African-American aviator** on March 20, 1912 with F.A.I. License #105.
- In September 1920, the Curtiss Aeroplane and Motor Company underwent a financial reorganization. Glenn Curtiss cashed out his stock in the company for \$32 million and **retired to Florida**.
- Until his death in 1930, Curtiss remained active in business as the developer of Hialeah, Miami Springs and Opa-Locka, FL. Through the **Curtiss Aerocar Company** of 1928 he developed and produced a streamlined, luxury “5th wheel” travel trailer.



What does the Bible

Bible

say about this chapter?



Questions to Ponder

- As shown in the exercises for this chapter, engineers must learn to visualize the actual 3D appearance of an object described by three (or sometimes fewer) 2D drawings. Why are humans uniquely capable of doing this?
- In this era of global production and trade, it is common to receive instructions solely through pictograms. Could a Christian producer of goods sent abroad use such pictograms to spread the Gospel of Jesus Christ when preparing instructions on the assembly and use of his product? How?
- Glenn Curtiss experienced several family tragedies in his youth – the loss of his father, illness and deafness of his sister, and the death of his first child. Yet at the same time he was successful in cycling and business, provided for his extended family, and continued learning and creating his entire life, despite having only an 8th-grade education. How was he able to keep a balance in his life? Where did he find the time to accomplish all he did in his relatively short life of 52 years?



Questions to Ponder

- Glenn Curtiss was a follower of Christian Science. Its founder, Mary Baker Eddy, argued in her 1875 book, *Science and Health*, that sickness can be healed by prayer and is most effective when not combined with medicine. Curtiss died suddenly following an emergency appendectomy performed in a hospital. Unbeknownst to his family and friends, he had been extremely ill with appendicitis. Is prayer sufficient to solve our problems? Are doctors and medicine answers to our prayers? After all, Luke the Evangelist, author of the *Gospel of Luke* and *Acts of the Apostles* was a Greek doctor.
- Contrast Glenn Curtiss' long, happy marriage with his wife Lena, whom he considered his closest friend, to the Wright Brothers, who never married. Which made a greater impact on aviation?
- Glenn Curtiss married at age 20 and was a father a few years later. How did his life as the head of his household influence his professional career? Contrast this to the lives of young men today having only an 8th grade education.

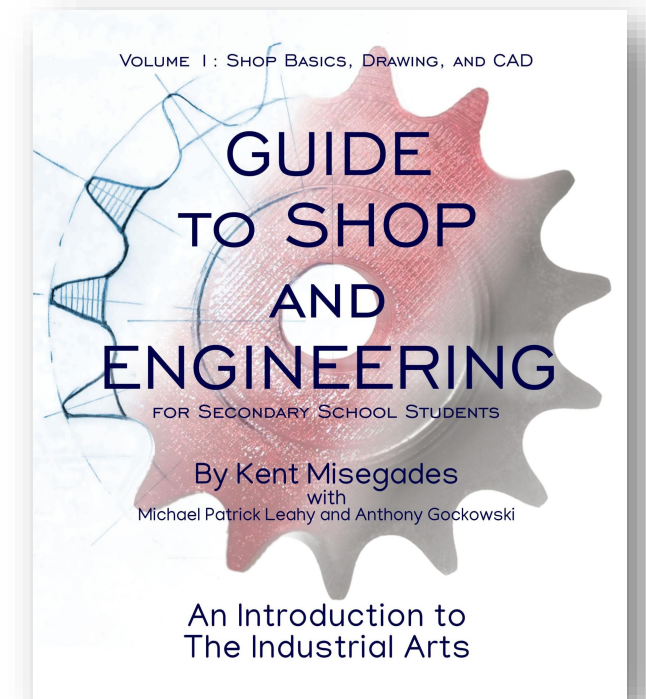


What the Bible says about

- **Importance of Work:** 1 Thessalonians 4:11 “And to aspire to live quietly, and to mind your own affairs, and to work with your hands, as we instructed you,” 1 Timothy 5:8 “But if someone does not provide for his own, especially his own family, he has denied the faith and is worse than an unbeliever.”
- **Husband and Wife:** 1 Peter 3:1 “Likewise, wives, be subject to your own husbands, so that even if some do not obey the word, they may be won without a word by the conduct of their wives,” 1 Peter 3:7 “Likewise, husbands, live with your wives in an understanding way, showing honor to the woman as the weaker vessel, since they are heirs with you of the grace of life, so that your prayers may not be hindered.”
- **The Virtuous Wife:** Proverbs 31:10-31 “Who can find a virtuous wife? For her worth is far above rubies. 11 The heart of her husband safely trusts her; So he will have no lack of gain. 12 She does him good and not evil All the days of her life....”
- **Prayer, Physicians and Medicine:** Proverbs 17:22 “A joyful heart is good medicine, but a crushed spirit dries up the bones.” Matthew 9:12 “But when Jesus heard it, he said, “Those who are well have no need of a physician, but those who are sick.” James 5:15 “And the prayer of faith will save the one who is sick, and the Lord will raise him up. And if he has committed sins, he will be forgiven.” Psalm 103:2-3 “Bless the Lord, my soul, and never forget any of his benefits: He continues to forgive all your sins, he continues to heal all your diseases.”



Volume I : Chapter 11



EXERCISES

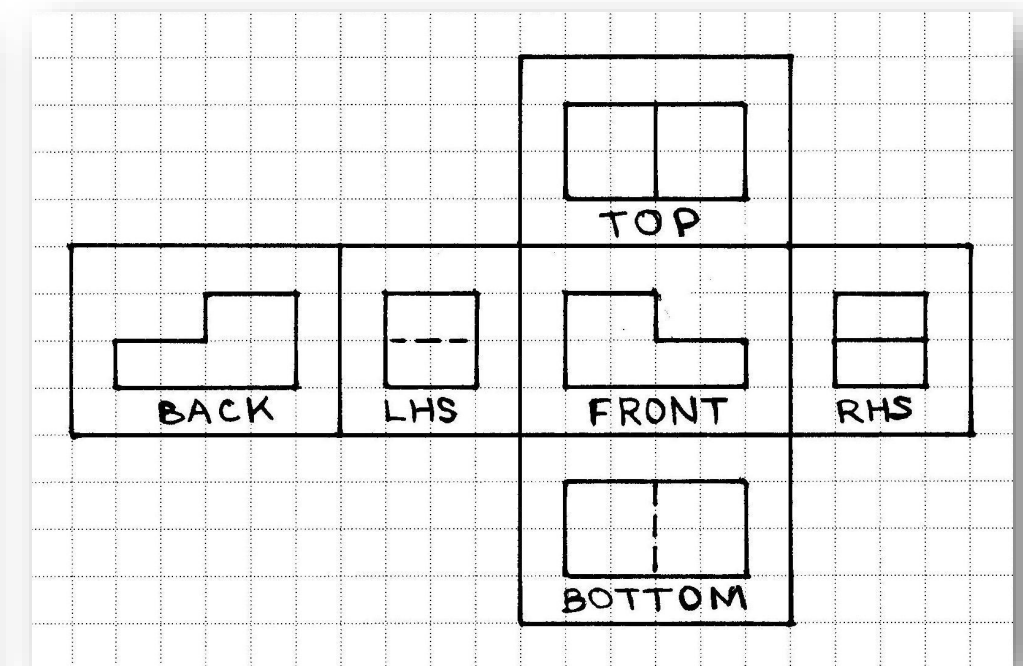
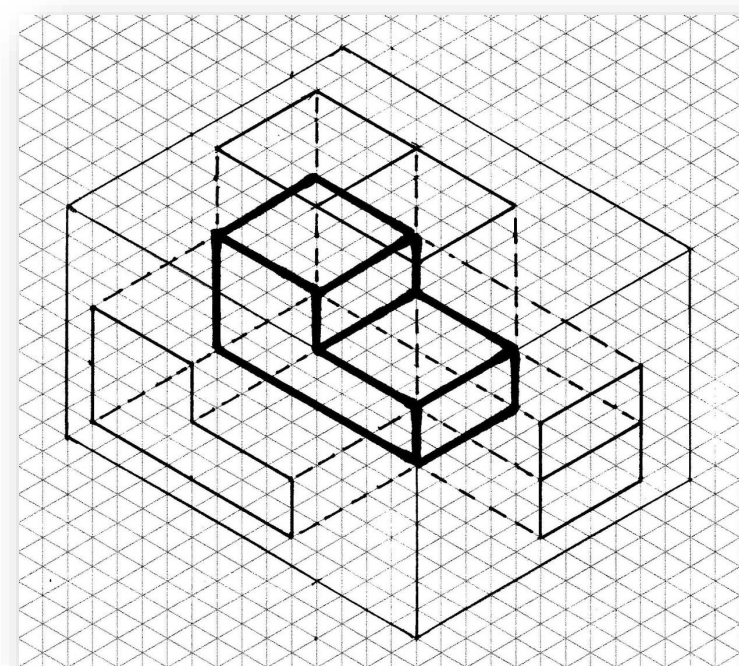


Exercises – Chapter Eleven

Exercise 1 : Glass House (see figures on following page)

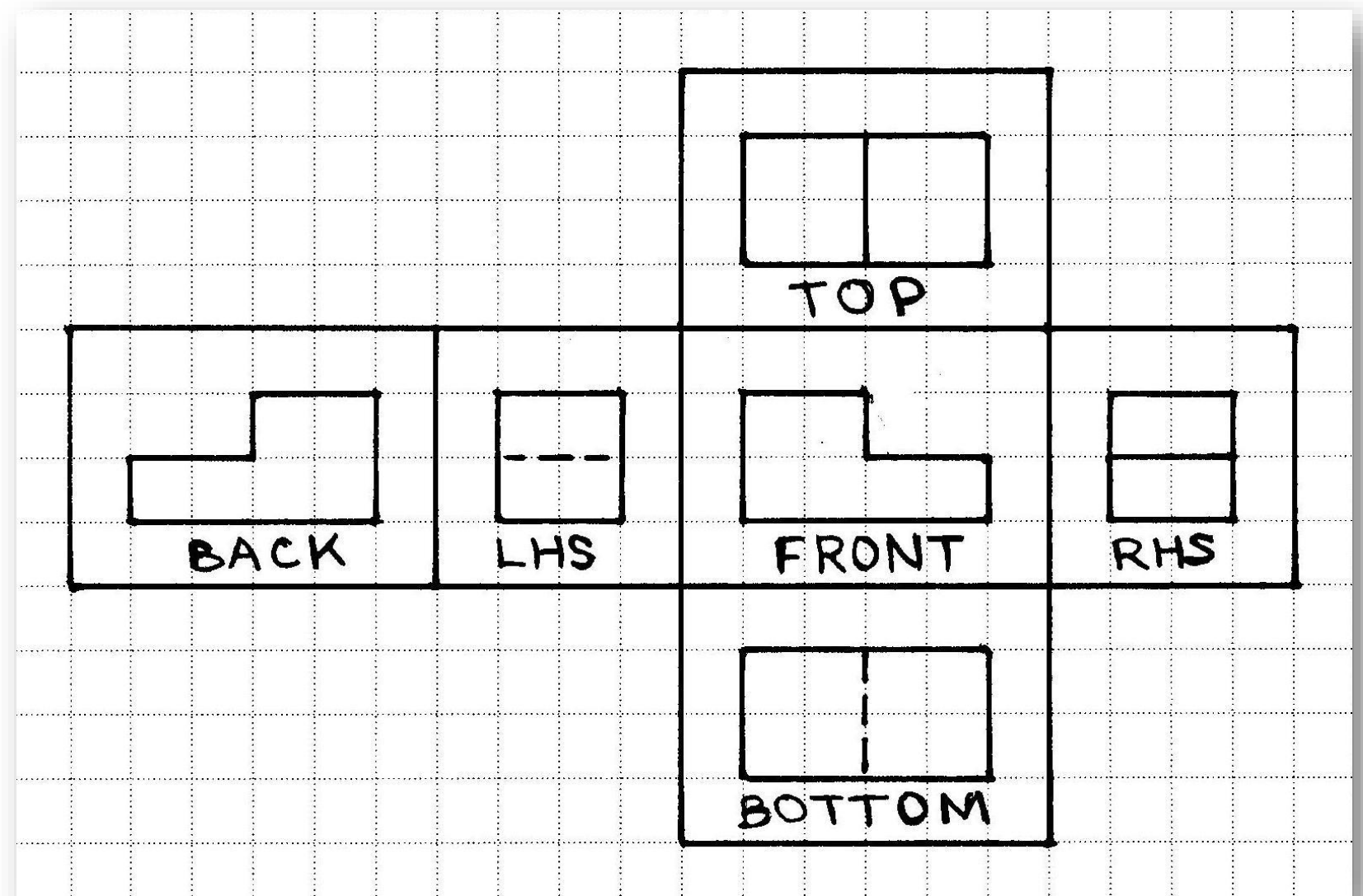
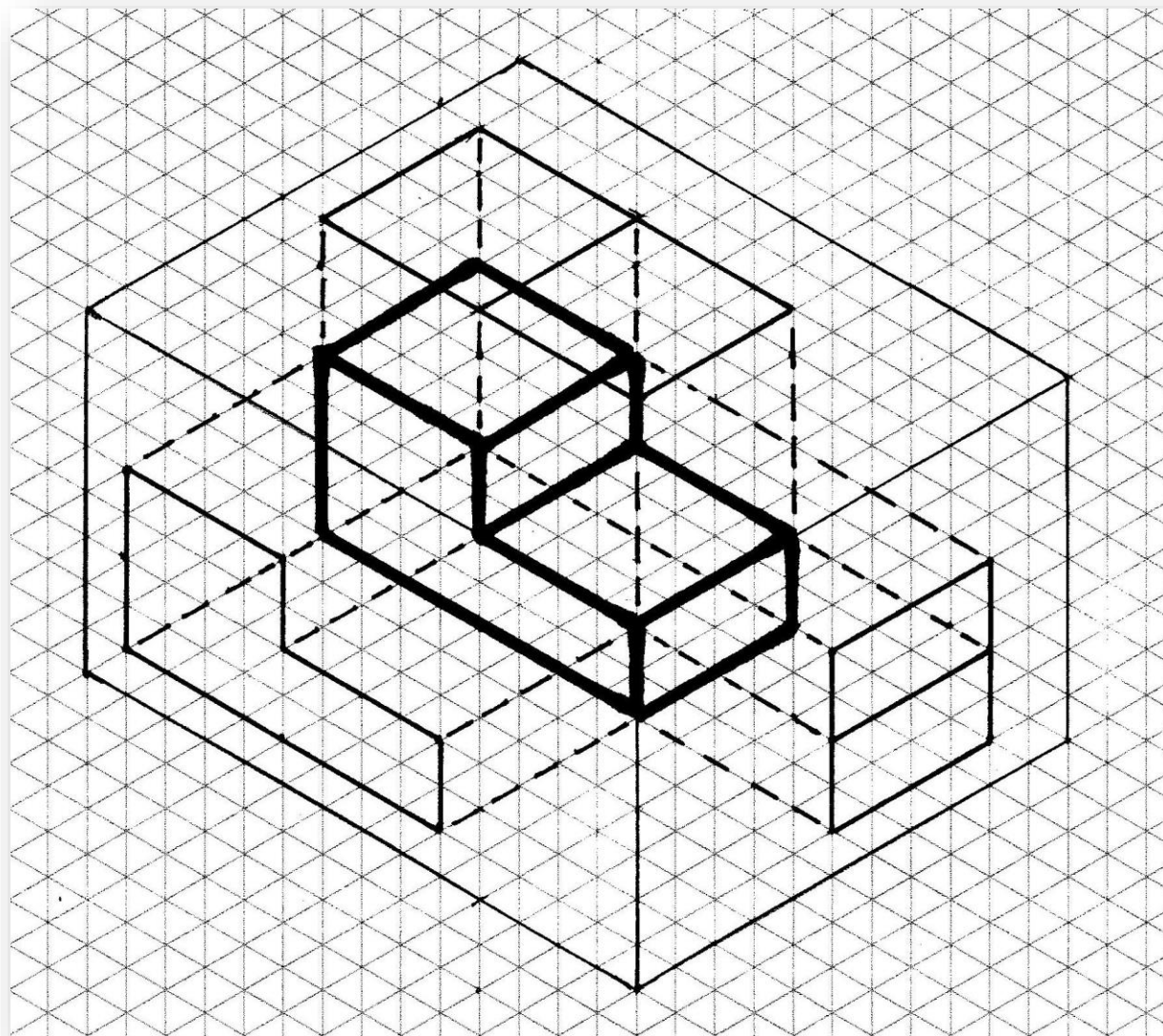
The figure below, left shows the 'glass house', the six walls of an imaginary transparent box surrounding an object. The figure below, right shows the six views on the walls of this glass house, referred to as the "lay flat" form of the house. For this exercise you will create such a glass house:

1. Draw the six walls of the glass house with the corresponding view of the object on each wall. Your drawing should be similar to the figure on the lower right
2. Label each view below the projected drawing of the object.
3. Cut out the lay-flat drawing, trimming away all blank parts of your drawing.
4. Fold each view on the solid line separating it from the adjacent view.
5. Now glue or tape together the free edges of the paper, resulting in a glass house that should look like the figure below left.



Exercises – Chapter Eleven

Exercise 1 : Glass House



Exercises – Chapter Eleven

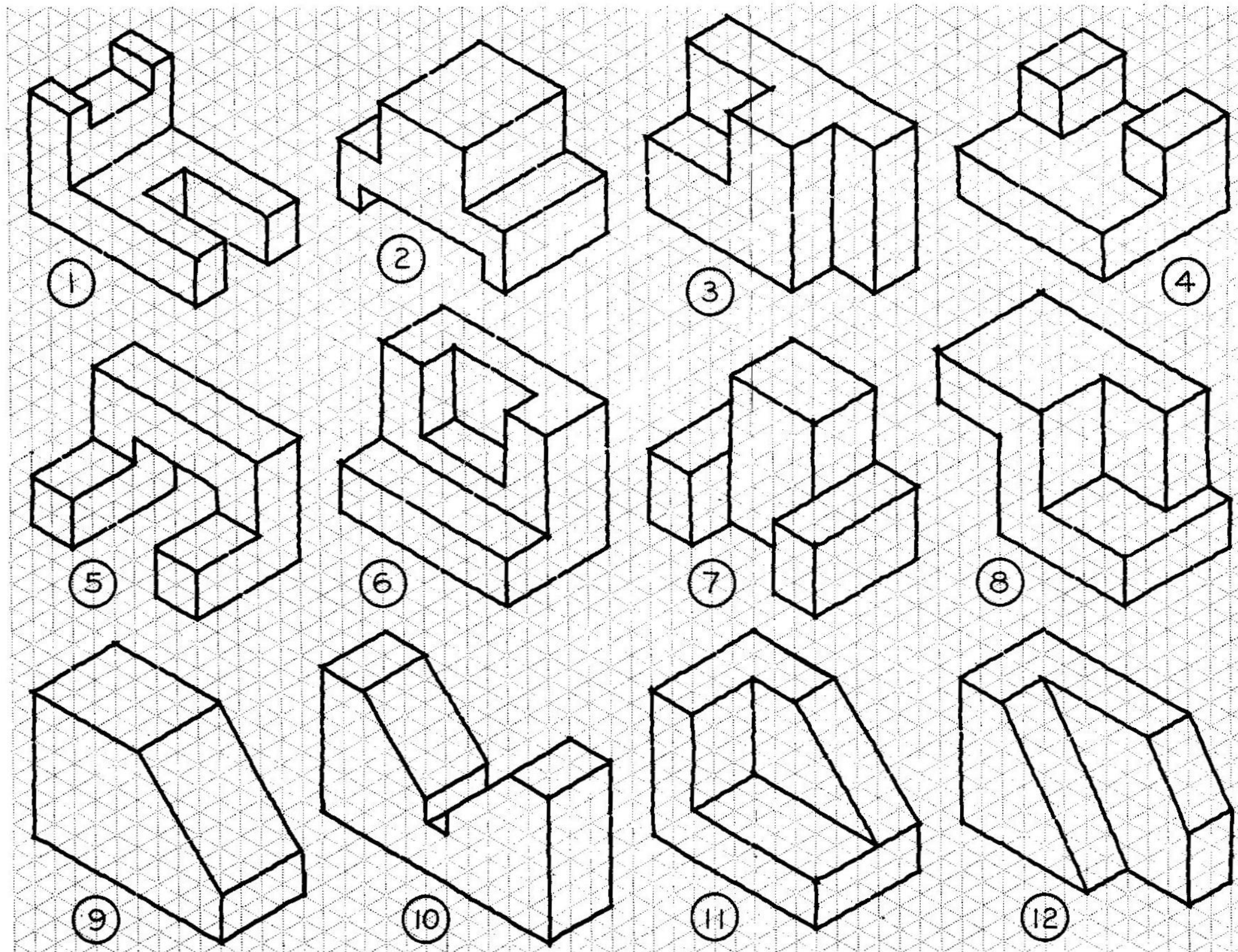
Exercise 11-2: Simple Multi-View Drawings

1. The figure on the following page gives 12 basic shapes, shown as isometric pictorial views.
2. Choose one from each row for a total of three objects. (The more you do, the better you will become at this.)
3. Assume that each division on this isometric paper equal $\frac{1}{4}$ ".
4. Using grid paper, draw the equivalent orthographic, multi-view drawing. Assume that the front face is that projecting to the lower left in the drawing below.



Exercises – Chapter Eleven

Exercise 11-2: Simple Multi-View Drawings



Exercises – Chapter Eleven

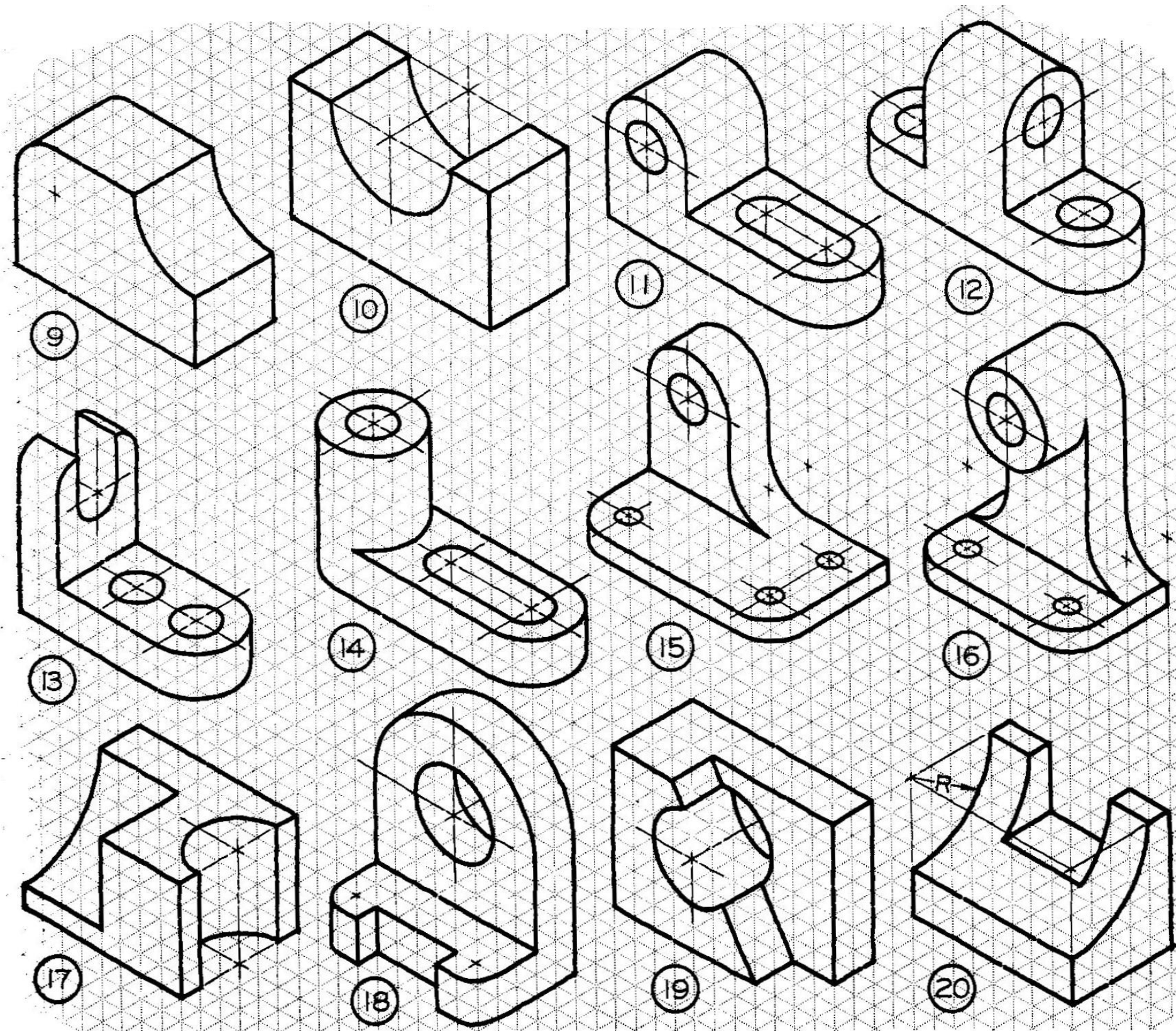
Exercise 11-3: Advanced Multi-View Drawings

1. The figure on the following page gives 12 basic shapes, shown as isometric pictorial views.
2. Choose one from each row for a total of three objects. (The more you do, the better you will become at this.)
3. Assume that each division on this isometric paper equal $\frac{1}{4}$ ".
4. Using grid paper, draw the equivalent orthographic, multi-view drawing. Assume that the front face is that projecting to the lower left in the drawing below.



Exercises – Chapter Eleven

Exercise 11-3: Advanced Multi-View Drawings



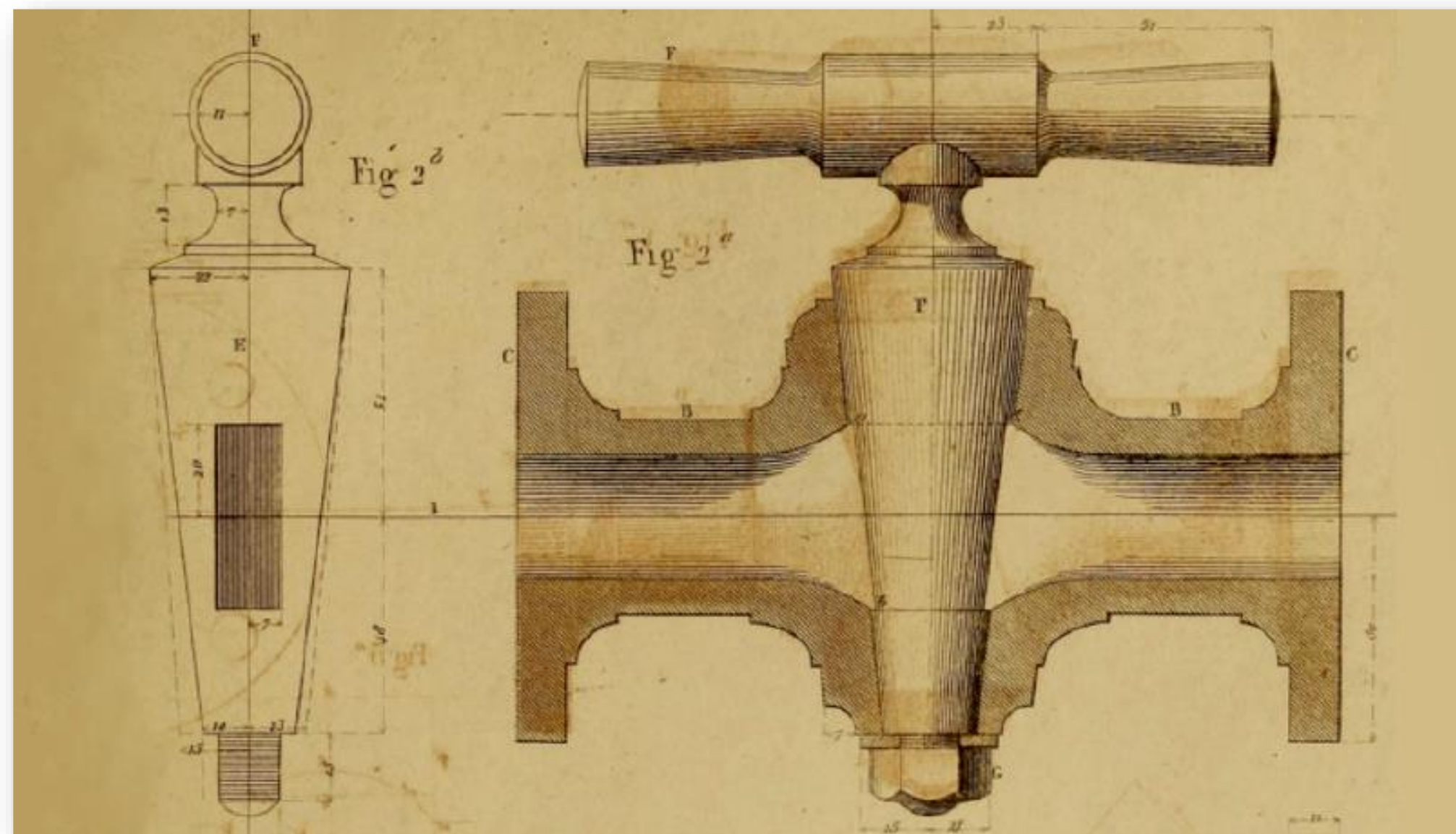
Recommended Shop Projects

Volume I : Chapter 11



End of Volume I : Chapter 11

Next: Chapter 12, Pictorial Views



These Lessons Inspired By

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Helping Children Develop a Biblical Worldview



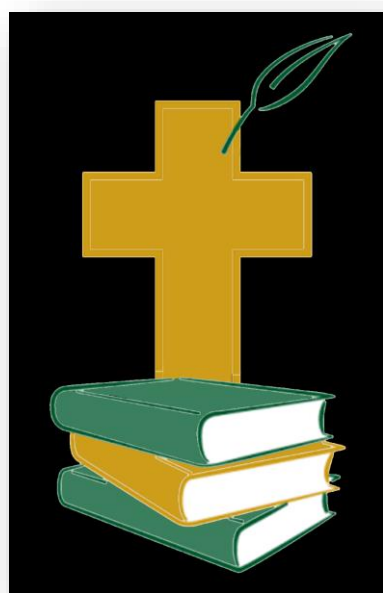
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The Author – Kent Paul Misegades



The author's 1952 Cessna 170B



Glen-L "Tuffy" built by author

- Christian, Husband, Father, Grandfather
- 40+ years engineering experience, much as manager, director and business owner
- Pilot, aircraft & boat builder since teenage years
- BSc Mechanical Engineering, Auburn University - *War Eagle!*
- MSc Applied Aerodynamics, Von Karman Institute for Fluid Dynamics
- Helped establish world-class K-12 schools, Thales Academies
- Co-founded world-class apprenticeships, NCTAP.org
- Developed and taught high school shop & engineering curricula
- Passion is flying, sailing, designing & making things - and teaching young people skills
- Founder and President of AeroSouth.net, Seven Lakes, North Carolina

