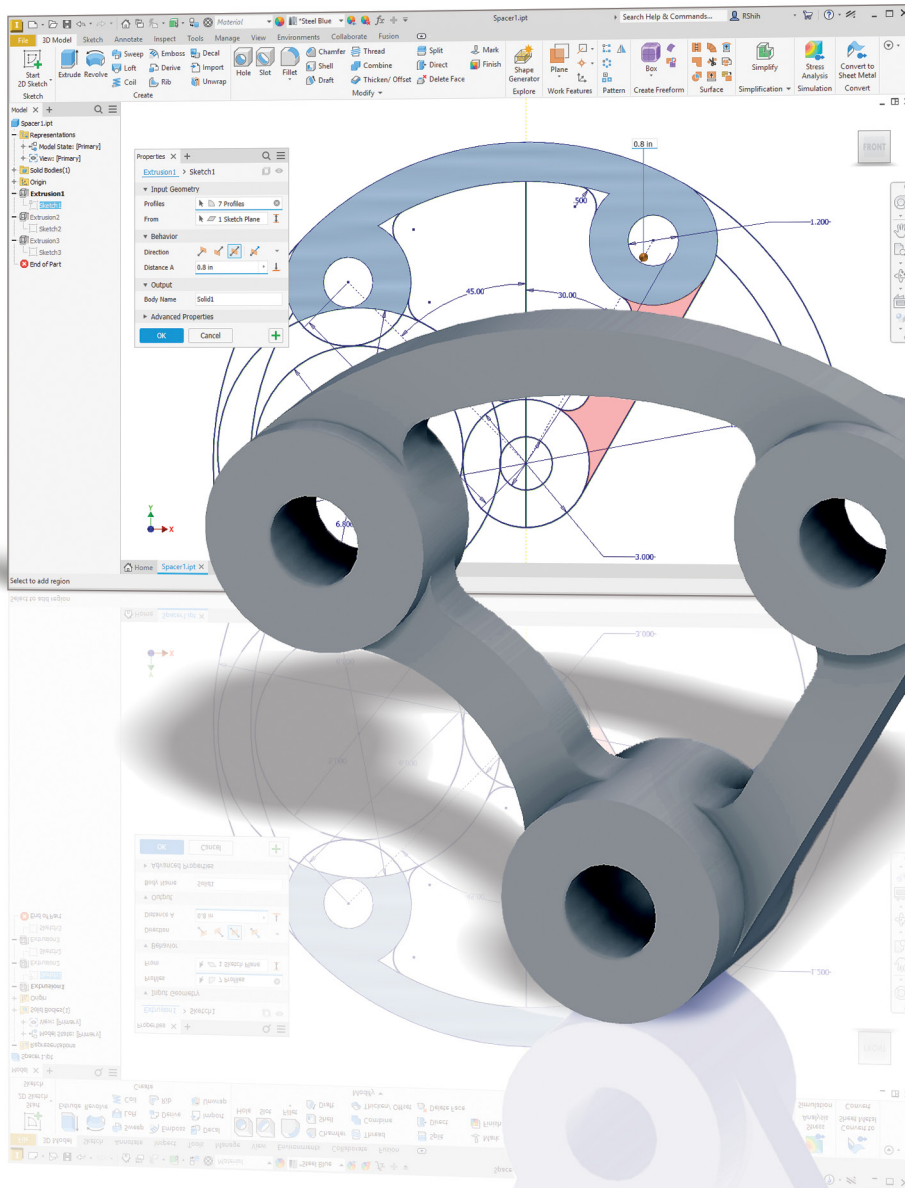


# Autodesk® Inventor® 2027 and Engineering Graphics

An Integrated Approach



Randy H. Shih

Visit the following websites to learn more about this book:



[amazon.com](https://www.amazon.com)

[Google books](https://books.google.com)

[BARNES & NOBLE](https://www.barnesandnoble.com)

# Table of Contents

Preface	i
Acknowledgments	ii
Table of Contents	iii
Autodesk Inventor Certified User Examination Overview	xv
Tips for Taking the Autodesk Inventor Certified User Examination	xx
<b>Chapter 1</b>	
<b>Introduction</b>	
Introduction	1-3
Drawing in CAD Systems	1-5
Development of Computer Aided Design	1-5
Feature-Based Parametric Modeling	1-9
Getting Started with Autodesk Inventor	1-10
The Screen Layout and Getting Started Toolbar	1-11
The New File Dialog Box and Units Setup	1-12
The Default Autodesk Inventor Screen Layout	1-13
File Menu	1-14
Quick Access Toolbar	1-14
Ribbon Tabs and Tool Panels	1-14
Online Help Panel	1-14
3D Model Toolbar	1-15
Graphics Window	1-15
Message and Status Bar	1-15
Mouse Buttons	1-16
[Esc] - Canceling Commands	1-16
Autodesk Inventor Help System	1-17
Data Management Using Inventor Project Files	1-18
Setup of a New Inventor Project	1-19
The Content of the Inventor Project File	1-22
Leaving Autodesk Inventor	1-22
<b>Chapter 2</b>	
<b>Parametric Modeling Fundamentals</b>	
Introduction	2-3
The Adjuster Design	2-4
Starting Autodesk Inventor	2-4
The Default Autodesk Inventor Screen Layout	2-6
Sketch Plane – It is an XY Monitor, but an XYZ World	2-7
Creating A Rough Sketch	2-9
Step 1: Creating a Rough Sketch	2-10

Graphics Cursors	2-10
Geometric Constraint Symbols	2-11
Step 2: Apply/Modify Constraints and Dimensions	2-12
Dynamic Viewing Functions – Zoom and Pan	2-15
Modifying the Dimensions of the Sketch	2-15
Step 3: Completing the Base Solid Feature	2-16
Isometric View	2-17
Dynamic Rotation of the 3D Block – Free Orbit	2-18
Dynamic Viewing – Quick Keys	2-20
Viewing Tools – Standard Toolbar	2-21
Full Navigation Wheel	2-23
Display Modes	2-25
Orthographic vs. Perspective	2-25
Disable the Heads-up Display Option	2-26
Step 4-1: Adding an Extruded Feature	2-27
Step 4-2: Adding a Cut Feature	2-31
Step 4-3: Adding another Cut Feature	2-34
Save the Model	2-36
Review Questions	2-38
Exercises	2-39

### **Chapter 3**

## **Constructive Solid Geometry Concepts**

Introduction	3-3
Binary Tree	3-4
The Locator Design	3-5
Modeling Strategy – CSG Binary Tree	3-6
Starting Autodesk Inventor	3-7
Base Feature	3-8
GRID Display Setup	3-9
Model Dimensions Format	3-12
Modifying the Dimensions of the Sketch	3-12
Repositioning Dimensions	3-13
Using the Measure Tools	3-14
Completing the Base Solid Feature	3-17
Creating the Next Solid Feature	3-18
Creating a Cut Feature	3-22
Creating a Placed Feature	3-25
Creating a Rectangular Cut Feature	3-27
Save the Model	3-29
Review Questions	3-30
Exercises	3-31

**Chapter 4****Geometric Constructions**

Geometric Constructions	4-3
Geometric Constructions - Classical Methods	4-4
Bisection of a Line or Arc	4-4
Bisection of an Angle	4-5
Transfer of an Angle	4-6
Dividing a Given Line into a Number of Equal Parts	4-7
Circle through Three Points	4-8
A Line Tangent to a Circle	4-9
Line Tangent to a Circle from a Given Point	4-10
Circle of a Given Radius Tangent to Two Given Lines	4-11
Circle of a Given Radius Tangent to an Arc and a Line	4-12
Circle of a Given Radius Tangent to Two Arcs	4-13
Starting Autodesk Inventor	4-14
Geometric Construction - CAD Method	4-15
Bisection of a Line or Arc	4-15
Dimensions and Relations	4-17
Applying Geometric/Dimensional Constraints	4-18
Bisection of an Angle	4-19
Dividing a Given Line into a Number of Equal Parts	4-21
Arc through Three Points	4-28
Line Tangent to a Circle from a Given Point	4-29
Circle of a Given Radius Tangent to Two Given Lines	4-30
Adding Geometric Relations and Fully Defined Geometry	4-33
Starting a New Drawing	4-33
Displaying Existing Constraints	4-34
Over-Constraining and Driven Dimensions	4-39
Deleting Existing Constraints	4-40
Using the Auto Dimension Command	4-41
Constraint and Sketch Settings	4-46
Parametric Relations	4-47
Dimensional Values and Dimensional Variables	4-49
Parametric Equations	4-50
Viewing the Established Parameters and Relations	4-52
Saving the Model File	4-53
Using the Measure Tools	4-54
Review Questions	4-58
Exercises	4-59

**Chapter 5****Model History Tree**

Introduction	5-3
The Saddle Bracket Design	5-4
Starting Autodesk Inventor	5-4

Modeling Strategy	5-5
The Autodesk Inventor Browser	5-6
Creating the Base Feature	5-6
Adding the Second Solid Feature	5-9
Creating a 2D Sketch	5-10
Renaming the Part Features	5-12
Adjusting the Width of the Base Feature	5-13
Adding a Placed Feature	5-14
Creating a Rectangular Cut Feature	5-16
History-Based Part Modifications	5-17
A Design Change	5-18
Assigning and Calculating the Associated Physical Properties	5-21
Review Questions	5-23
Exercises	5-24

## **Chapter 6**

### **Geometric Construction Tools**

Introduction	6-3
The Gasket Design	6-3
Modeling Strategy	6-4
Starting Autodesk Inventor	6-5
Create a 2D Sketch	6-6
Edit the Sketch by Dragging the Sketched Entities	6-8
Add Additional Constraints	6-10
Use the Trim and Extend Commands	6-11
The Auto Dimension Command	6-13
Create Fillets and Completing the Sketch	6-15
Fully Constrained Geometry	6-16
Profile Sketch	6-18
Redefine the Sketch and Profile	6-19
Create an Offset Cut Feature	6-23
Review Questions	6-26
Exercises	6-27

## **Chapter 7**

### **Orthographic Projection and Multiview Constructions**

Introduction	7-3
Basic Principles of Projection	7-4
Orthographic Projection	7-4
Multiview Orthographic Projection	7-5
First-Angle Projection	7-6
Rotation of the Horizontal and Profile Planes	7-7
The 3D Adjuster Model and 1st Angle Projection	7-8
General Procedure: 1st Angle Orthographic Projection	7-9

---

Example 1: 1st Angle Orthographic Projection	7-10
Orthographic Sketching Exercises	7-11
Third-Angle Projection	7-17
Rotation of the Horizontal and Profile Planes	7-18
The 3D Adjuster Model and 3rd Angle Projection	7-19
The Glass Box and the Six Principal Views	7-20
General Procedure: 3rd Angle Orthographic Projection	7-22
Example 2: 3rd Angle Orthographic Projection	7-23
Example 3: 3rd Angle Orthographic Projection	7-24
3rd Angle Orthographic Sketching Exercises	7-25
Alphabet of Lines	7-31
Precedence of Lines	7-33
The U-Bracket Design	7-34
The BORN Technique	7-35
Starting Autodesk Inventor	7-35
Sketch Plane Settings	7-36
Apply the BORN Technique	7-37
Create the 2D Sketch for the Base Feature	7-39
Create the First Extrude Feature	7-42
The Implied Parent/Child Relationships	7-43
Create the Second Solid Feature	7-43
Create a Cut Feature	7-47
The Second Cut Feature	7-48
Examine the Parent/Child Relationships	7-50
Modify a Parent Dimension	7-51
A Design Change	7-52
Feature Suppression	7-53
A Different Approach to the Center_Drill Feature	7-54
Suppress the Rect_Cut Feature	7-56
Create a Circular Cut Feature	7-57
A Flexible Design Approach	7-59
View and Edit Material Properties	7-60
Drawings from Parts and Associative Functionality	7-62
Drawing Mode	7-63
Drawing Sheet Format	7-64
Using the Pre-defined Drawing Sheet Formats	7-66
Activate, Delete, and Edit Drawing Sheets	7-67
Add a Base View	7-68
Create Projected Views	7-69
Adjust the View Scale	7-70
Repositioning Views	7-71
Review Questions	7-73
Exercises	7-74

**Chapter 8****Dimensioning and Notes**

Introduction	8-3
Dimensioning Standards and Basic Terminology	8-4
Selection and Placement of Dimensions and Notes	8-5
Metric Dimensioning versus English Dimensioning	8-12
Machined Holes	8-13
Baseline and Chain Dimensioning	8-16
Dimensioning and Tolerance Accumulation	8-17
(1) Tolerance Accumulation - Baseline Dimensioning	8-18
(2) Tolerance Accumulation - Chain Dimensioning	8-19
(3) Avoid Tolerance Accumulation - Dimensioning Features	8-20
Dimensioning Tools in Autodesk Inventor	8-21
The U-Bracket Design	8-21
Starting Autodesk Inventor	8-22
Display Feature Dimensions	8-23
Repositioning and Hiding Feature Dimensions	8-25
Add Additional Dimensions – Reference Dimensions	8-27
Add Center Marks and Center Lines	8-28
Complete the Drawing Sheet	8-31
Associative Functionality – Modifying Feature Dimensions	8-32
3D Model Based Definition	8-35
Review Questions	8-43
Exercises	8-44

**Chapter 9****Tolerancing and Fits**

Precision and Tolerance	9-2
Methods of Specifying Tolerances – English System	9-3
Nomenclature	9-4
Example 9.1	9-5
Fits between Mating Parts	9-6
Selective Assembly	9-7
Basic Hole and Basic Shaft Systems	9-7
American National Standard Limits and Fits – Inches	9-8
Example 9.2 Basic Hole System	9-13
Example 9.3 Basic Hole System	9-14
Example 9.4 Basic Shaft System	9-15
Example 9.5 Basic Shaft System	9-16
Tolerancing – Metric System	9-17
Metric Tolerances and Fits Designation	9-18
Preferred ISO Metric Fits	9-19
Example 9.6 Metric Hole Basis System	9-20
Example 9.7 Shaft Basis System	9-21
Updating the U-Bracket Drawing	9-22

---

Determining the Tolerances Required	9-23
Review Questions	9-25
Exercises	9-26

## **Chapter 10**

### **Pictorials and Sketching**

Engineering Drawings, Pictorials and Sketching	10-2
Isometric Sketching	10-7
Chapter 10 - Isometric Sketching Exercises	10-9
Oblique Sketching	10-19
Chapter 10 - Oblique Sketching Exercises	10-20
Perspective Sketching	10-26
One-Point Perspective	10-27
Two-Point Perspective	10-28
Chapter 10 - Perspective Sketching Exercises	10-29
Review Questions	10-35
Exercises	10-36

## **Chapter 11**

### **Auxiliary Views and Reference Geometry**

Introduction	11-3
Normal View of an Inclined Surface	11-4
Construction Method I – Folding Line Method	11-6
Construction Method II – Reference Plane Method	11-8
Partial Views	11-10
Work Features	11-11
Auxiliary Views in 2D Drawings	11-11
The Rod-Guide Design	11-11
Modeling Strategy	11-12
Starting Autodesk Inventor	11-13
Apply the BORN Technique	11-13
Creating the Base Feature	11-15
Create an Angled Work Plane	11-17
Create a 2D Sketch on the Work Plane	11-18
Use the Projected Geometry Option	11-18
Complete the Solid Feature	11-22
Create an Offset Work Plane	11-23
Create another Cut Feature Using the Work Plane	11-24
Start a New 2D Drawing	11-26
Add a Base View	11-27
Create an Auxiliary View	11-28
Display Feature Dimensions	11-30
Adjust the View Scale	11-32
Retrieving Dimensions in the Auxiliary View	11-33

Add Center Marks and Center Lines	11-35
Complete the Title Block with iProperties	11-38
Edit the Isometric view	11-40
Review Questions	11-41
Exercises	11-42

## **Chapter 12**

### **Section Views & Symmetrical Features in Designs**

Introduction	12-3
General Rules of Section Views	12-5
Section Drawing Types	12-6
Full Section	12-6
Half Section	12-6
Offset Section	12-7
Broken-Out Section	12-7
Aligned Section	12-8
Half Views	12-8
Thin Sections	12-8
Revolved Section	12-9
Removed Section	12-9
Conventional Breaks	12-10
Ribs and Webs in Sections	12-10
Parts Not Sectioned	12-10
Section Views in Autodesk Inventor	12-11
A Revolved Design: Pulley	12-11
Modeling Strategy - A Revolved Design	12-12
Starting Autodesk Inventor	12-13
Set Up the Display of the Sketch Plane	12-13
Creating the 2D Sketch for the Base Feature	12-14
Create the Revolved Feature	12-18
Mirroring Features	12-19
Create a Pattern Leader Using Construction Geometry	12-21
Circular Pattern	12-26
Examine the Design Parameters	12-28
Drawing Mode – Defining a New Border and Title Block	12-28
Create a Drawing Template	12-32
Create the Necessary Views	12-33
Retrieve Model Annotations – Features Option	12-36
Associative Functionality – A Design Change	12-38
Add Centerlines to the Pattern Feature	12-40
Complete the Drawing	12-41
Additional Title Blocks	12-44
Review Questions	12-46
Exercises	12-47

**Chapter 13****Threads and Fasteners**

Introduction	13-3
Screw-Thread Terminology	13-4
Thread Forms	13-6
Thread Representations	13-7
Detailed Representation	13-8
Schematic Representation	13-9
Simplified Representation	13-10
Thread Specification – English Units	13-11
Unified Thread Series	13-12
Thread Fits	13-13
Thread Specification – Metric	13-13
Thread Notes Examples	13-14
Specifying Fasteners	13-15
Commonly Used Fasteners	13-16
Drawing Standard Bolts	13-18
Bolt and Screw Clearances	13-18
Fasteners Using Autodesk Inventor’s Content Center	13-19
Starting Autodesk Inventor	13-19
Review Questions	13-25

**Chapter 14****Assembly Modeling and Working Drawings**

General Engineering Design Process	14-3
Working Drawings	14-4
Detail Drawings	14-4
Assembly Drawings	14-5
Bill of Materials (BOM) and Parts List	14-5
Drawing Sizes	14-6
Drawing Sheet Borders and Revisions Block	14-6
Title Blocks	14-7
Working Drawings with Autodesk Inventor	14-8
Assembly Modeling Methodology	14-9
The Shaft Support Assembly	14-10
Additional Parts	14-10
Starting Autodesk Inventor	14-13
Placing the First Component	14-14
Placing the Second Component	14-15
Degrees of Freedom and Constraints	14-16
Assembly Constraints	14-17
Apply the First Assembly Constraint	14-20
Apply a Second Mate Constraint	14-21
Constrained Move	14-22
Apply a Flush Constraint	14-23

Placing the Third Component	14-25
Applying an Insert Constraint	14-26
Assemble the Cap-Screws	14-27
Exploded View of the Assembly	14-28
Editing the Components	14-30
Adaptive Design Approach	14-31
Delete and Re-apply Assembly Constraints	14-35
Setup a Drawing of the Assembly Model	14-37
Creating a Parts List	14-39
Edit the Parts List	14-40
Change the Material Type	14-42
Add the Balloon Callouts	14-44
Completing the Title Block Using the iProperties Option	14-44
Bill of Materials	14-46
Review Questions	14-48
Exercises	14-49

## **Chapter 15**

### **Introduction to Stress Analysis**

Introduction	15-2
Problem Statement	15-4
Preliminary Analysis	15-4
Maximum Normal Stress Analysis	15-4
Maximum Displacement	15-5
Finite Element Analysis Procedure	15-6
Create the Autodesk Inventor Part	15-7
Create the 2D Sketch for the Plate	15-7
Assigning the Material Properties	15-10
Switch to the Stress Analysis Module	15-11
Apply Constraints and Loads	15-14
Create a Mesh and Run the Solver	15-16
Refinement of the FEA Mesh – Global Element Size	15-18
Refinement of the FEA Mesh – Local Element Size	15-20
Comparison of Results	15-23
Create an HTML Report	15-24
Geometric Considerations of Finite Elements	15-25
Conclusion	15-26
Summary of Modeling Considerations	15-26
Review Questions	15-27
Exercises	15-28

## **Appendix**

- A. Running and Sliding Fits – American National Standard
- B. METRIC LIMITS AND FITS
- C. UNIFIED NATIONAL THREAD FORM
- D. METRIC THREAD FORM
- E. FASTENERS (INCH SERIES)
- F. METRIC FASTENERS
- G. FASTENERS
- H. REFERENCES

## **Index**