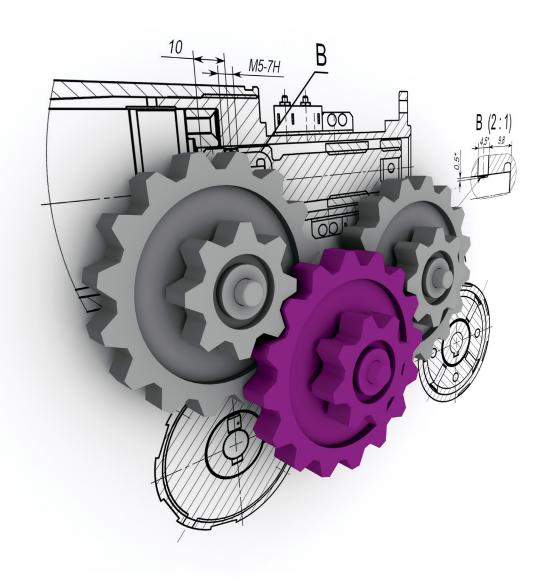
Engineering Graphics with SOLIDWORKS 2016

and Video Instruction

A Step-by-Step Project Based Approach



David C. Planchard, CSWP, SOLIDWORKS Accredited Educator





Visit the following websites to learn more about this book:



amazon.com





TABLE OF CONTENTS

Introduction	I-1
About the Cover	I-2
About the Author	I-2
Dedication	I-3
Contact the Author	I-4
Note to Instructors	I-4
Trademarks, Disclaimer and Copyrighted Material	I-4
References	I-5
Table of Contents	I-6
Overview of Chapters	I-15
Chapter 1: History of Engineering Graphics	I-15
Chapter 2: Isometric Projection and Multi View Drawings	I-15
Chapter 3: Dimensioning Practices, Scales, Tolerancing and Fasteners	I-16
Chapter 4: Overview of SOLIDWORKS and the User Interface	I-17
Chapter 5: Introduction to SOLIDWORKS Part Modeling	I-17
Chapter 6: Revolved Boss/Base Features	I-18
Chapter 7: Swept, Lofted, Rib, Mirror and Additional Features	I-18
Chapter 8: Assembly Fundamentals - Bottom-up method	I-18
Chapter 9: Fundamentals of Drawing	I-19
Chapter 10: Introduction to the Certified Associate – Mechanical Design	
(CSWA) Exam	I-19
Chapter 11: Additive Manufacturing – 3D Printing	I-20
About the Book	I-21
Windows Terminology in SOLIDWORKS	I-22
Chapter 1 - History of Engineering Graphics	1-1
Chapter Overview	1-3
History of Engineering Graphics	1-3
Global and Local Coordinate System	1-6
2 Dimensional Cartesian Coordinate System	1-7
3 Dimensional Cartesian Coordinate System	1-8
Absolute Coordinates	1-10
Relative Coordinates	1-10
Polar Coordinates	1-11
Cylindrical and Spherical Coordinates	1-11
Freehand Sketching	1-12
General Sketching Techniques	1-13
Geometric Entities	1-14
Points	1-14
Lines	1-14
Planes	1-15
Circles	1-15
Arcs	1-16
Solid Primitives	1-16
Alphabet of Lines	1-17
Visible lines	1-17
Hidden lines	1-17

Engineering Graphics with SOLIDWORKS® 2016	Introduction
Dimension lines	1-18
Extension lines	1-18
Leader lines	1-18
Break lines	1-20
Centerlines	1-20
Phantom lines	1-20
Section lines	1-21
Cutting Plane lines	1-21
Precedence of Line Types	1-23
Alphabet of Lines Exercises	1-25
Projections in General	1-27
Projection Types	1-29
Parallel Projection	1-29
Perspective Projection	1-29
Orthographic Projection	1-29
Oblique Projection	1-29
Multi-view Projection	1-30
Orient and Select the Front View	1-30
Orthographic Projection (Third Angle)	1-31
Glass Box and Six Principal Orthographic Views	1-31
Height, Width and Depth Dimensions	1-35
Transferring Dimensions	1-35
Sheet Media	1-36
ANSI Standard Sheet Sizes	1-36
Orthographic Projection Exercises	1-37
Planes (Normal, Inclined and Oblique)	1-42
Plane Exercises	1-43
Chapter Summary	1-49
Questions/Exercises	1-51
Chapter 2 - Isometric Projection and Multi View Drawings	2-1
Chapter Overview	2-3
Isometric Projections	2-3
Isometric Sketching	2-5
Circles Drawn in Axonometric View	2-7
Additional Projections	2-9
Oblique Projection	2-9
Arrangement of Views	2-13
Two View Drawing	2-14
One View Drawing	2-16
Drawing - Exercises	2-19
Drawing Views - Advanced	2-21
Section View	2-21
Detail View	2-23
Broken out View	2-24
Break or Broken View	2-25
Crop View	2-26
Auxiliary View	2-27
Exercises	2-27
History of Computer Aided Design (CAD)	2-28
Boolean Operations	2-29

What is SOLIDWORKS?	2-31
Design Intent	2-33
Design Intent in a Sketch	2-33
Design Intent in a Feature	2-34
Design Intent in a Part	2-34
Design Intent in an Assembly	2-35
Design Intent in a Drawing	2-35
Chapter Summary	2-36
Questions/Exercises	2-37
Chapter 3 - Dimensioning Practices, Scales, Tolerancing and Fasteners	3-1
Chapter Overview	3-3
American National Standards Institute (ANSI)	3-3
Dimensioning	3-4
Location Dimension	3-4
Size Dimension	3-4
Measurement - units	3-5
Metric/SI	3-5
English	3-5
Dual Dimensioning	3-6
Scale	3-7
Architect's Scale	3-7
Engineer's Scale	3-7
Linear Encoder	3-7
Linear Scale	3-7
Vernier Scale	3-7
Standards for Dimensioning	3-8
Linear Dimension	3-8
Stagger Dimension	3-8
Aligned Dimension	3-9
Angular Dimension	3-9
Chamfer Dimension	3-10
Slot Dimension	3-10
Radius Dimension (Leader line)	3-11
Simple Hole Dimension (Leader line)	3-12
Fastener Hole Dimension (Annotations)	3-13
Cylindrical Dimension	3-13
Equally Spaced Hole Dimension	3-15
Hole Dimension Location	3-15
Point/Center of a Circle Dimension	3-16
Arc Dimension	3-16
Order of Preference - Linear Dimension Line	3-17
Precision	3-17
Size Dimension	3-18
Continuous Dimensions	3-19
Principles of good Dimensioning	3-20
Precision and Tolerance	3-26
Tolerance for a Drawing	3-27
General Tolerance - Title Block	3-27
Local Tolerance - Dimension	3-28
Limit Tolerance	3-28

Engineering Graphics with SOLIDWORKS® 2016	Introduction
Unilateral Tolerance	3-29
Bilateral Tolerance	3-29
Formatting Inch Tolerances	3-29
Metric Dimension Specifications	3-30
Tolerance Parts and Important Terms	3-30
Fit - Hole Tolerance	3-32
Fit Types between Mating Parts	3-32
Clearance Fit	3-33
Interference Fit	3-33
Transition Fit	3-33
Fasteners in General	3-34
Representing External (Male) Threads	3-37
Cutting External (Male) Threads	3-38
Die	3-38
Lathe	3-38
Representing Internal (Female) Threads	3-39
Cutting Internal (Female) Threads	3-39
Taper	3-40
Plug	3-40
Bottoming	3-40
American National Standard and Unified Screw Threads	3-41
Single vs. Double or Triple Threads	3-41
Pitch and Major Diameter	3-42
Thread Class of Fit	3-42
Class 1	3-42
Class 2	3-42
Class 3	3-42
General Thread Notes	3-43
Dimensioning a CounterBore Hole	3-44
Dimensioning a CounterSunk Hole	3-44
Chapter Summary	3-45
Questions/Exercises	3-46
Chapter 4 - Overview of SOLIDWORKS and the User Interface	4-1
Chapter Objective	4-3
What is SOLIDWORKS?	4-3
Start a SOLIDWORKS Session	4-4
Menu Bar Toolbar	4-5
Menu Bar Menu	4-5
Drop-down Menu Create a new Part Document	4-6 4-6
Novice Mode	4-7 4-7
Advanced Mode	
Graphic Interface	4-8
Open a Part	4-9 4-10
FeatureManager Rollback Bar	4-10 4-10
	4-10 4-12
Heads-up View toolbar Zoom to Fit	4-12 4-12
Zoom to Area	4-12 4-12
Zoom In	4-12 4-12
ZOUII III	4-12

Rotate	4-12
Standard Views	4-13
SOLIDWORKS Help	4-13
SOLIDWORKS Tutorials	4-14
SOLIDWORKS New Icon Style	4-14
Additional User Interface Tools	4-14
Right-click Context toolbar	4-15
Consolidated Toolbar	4-15
System Feedback Icons	4-15
Confirmation Corner	4-16
Heads-up View Toolbar	4-16
CommandManager	4-19
Part (default tab)	4-19
Drawing (default tab)	4-20
Assembly (default tab)	4-21
Float/Dock	4-22
Selection Enhancements	4-22
FeatureManager Design Tree	4-23
Fly-out FeatureManager	4-25
Task Pane	4-26
SOLIDWORKS Resources	4-26
Design Library	4-27
File Explorer	4-27
Search	4-28
View Palette	4-28
Appearances, Scenes and Decals	4-29
Custom Properties	4-29
SOLIDWORKS Forum	4-29
User Interface for Scaling High Resolution Screens	4-29
Motion Study tab	4-30
3D Views tab	4-31
Dynamic Reference Visualization	4-31
Mouse Movements	4-32
Chapter Summary	4-33
Chapter 5 - Introduction to SOLIDWORKS Part Modeling	5-1
Chapter Overview	5-3
File Management	5-4
Start a SOLIDWORKS Session and Open a New Part Document	5-5
Part Template	5-5
BATTERY Part	5-11
BATTERY Part-Extruded Boss/Base Feature	5-13
BATTERY Part-Fillet Feature Edge	5-17
BATTERY Part-Extruded Cut Feature	5-19
BATTERY Part-Second Fillet Feature	5-21
BATTERY Part Extruded-Boss/Base Feature	5-22
BATTERYPLATE Part	5-28
Save As, Delete, Edit Feature and Modify	5-29
BATTERYPLATE Part-Extruded Boss Feature	5-31
BATTERYPLATE Part-Fillet Features: Full Round and Multiple Radius Options	5-32
Multi-body Parts and Extruded Boss/Base Feature	5-35

Engineering Graphics with SOLIDWORKS® 2016	Introduction
Chapter Summary	5-36
Questions/Exercises	5-39
Chapter 6 - Revolved Boss/Base Features	6-1
Chapter Overview	6-3
LENS Part	6-4
LENS Part Revolved Boss/Base Feature	6-5
LENS Part-Shell Feature	6-8
LENS Part-Extruded Boss/Base Feature and Convert Entities Sketch tool	6-9
LENS Part-Hole Wizard Feature LENS Part-Revolved Boss Thin Feature	6-10 6-12
LENS Part-Revolved Boss Thin Feature LENS Part-Extruded Boss/Base Feature and Offset Entities	6-12 6-14
LENS Part-Extruded Boss/Base Feature and Offset Entitles LENS Part-Extruded Boss Feature and Transparency	6-16
LENS Part-Transparent Optical Property	6-16
BULB Part	6-18
BULB Part-Revolved Base Feature	6-19
BULB Part-Revolved Base Feature and Spline Sketch tool	6-21
BULB Part-Revolved Cut Thin Feature	6-23
BULB Part-Dome Feature	6-25
BULB Part-Circular Pattern Feature	6-26
BULB Part-Seed Cut Feature	6-26
BULB Part-Extruded Cut Feature	6-28
BULB Part-Circular Pattern Feature	6-29
Customizing Toolbars and Short Cut Keys	6-30
Chapter Summary	6-32
Questions/Exercises	6-33
Chapter 7 - Swept, Lofted, Rib, Mirror and Additional Features	7-1
Chapter Overview	7-3
O-RING Part-Swept Base Feature	7-4
SWITCH Part-Lofted Base Feature	7-7
SWITCH Part-Dome Feature	7-12
Four Major Categories of Solid Features	7-14
LENSCAP Part	7-14
LENSCAP Part-Extruded Boss/Base, Extruded Cut and Shell Features	7-15
LENSCAP Part-Revolved Thin Cut Feature	7-18
LENSCAP Part-Thread, Swept Feature and Helix/Spiral Curve	7-19
HOUSING Part	7-25
HOUSING Part-Extruded Base Feature	7-27
HOUSING Part-Lofted Boss Feature	7-28
HOUSING Part-Second Extruded Boss/Base Feature	7-32
HOUSING Part-Shell Feature	7-33
HOUSING Part-Third Extruded Boss/Base Feature	7-34
HOUSING Part Three de and Severet Francisco	7-35
HOUSING Part-Threads and Swept Feature	7-37
HOUSING Part-Handle with Swept Feature	7-42
HOUSING Part-Extruded Cut Feature with Up To Surface Option HOUSING Part-First Rib and Linear Pattern Feature	7-47 7-49
HOUSING Part-First Rib and Linear Pattern Feature HOUSING Part-Second Rib Feature	7-49 7-52
HOUSING Part-Mirror Feature	7-32 7-55
Chapter Summary	7-58
Chapter Summary	/ - 30

Questions/Exercises	7-60
Chapter 8 - Assembly Modeling - Bottom up method	8-1
Chapter Overview	8-3
Assembly Modeling Overview	8-4
FLASHLIGHT Assembly	8-6
Assembly Techniques	8-7
Assembly Template	8-8
Assembly Templates-ASM-IN-ANSI	8-8
Assembly Templates-ASM-MM-ISO	8-9
LENSANDBULB Sub-assembly	8-10
BATTERYANDPLATE Sub-assembly	8-14
CAPANDLENS Sub-assembly	8-16
FLASHLIGHT Assembly	8-20
FLASHLIGHT Assembly-Addressing Interference Issues	8-26
FLASHLIGHT Assembly-Exploded View	8-27
FLASHLIGHT Assembly-Export Files and eDrawings	8-30
Chapter Summary	8-33
Questions/Exercises	8-34
Chapter 9 - Fundamentals of Drawing	9-1
Chapter Overview	9-3
New Drawing and the Drawing Template	9-4
Title Block	9-7
Company Logo and Save Sheet Format	9-11
BATTERY Drawing	9-15
BATTERY Drawing - Insert a View	9-16
BATTERY Drawing - Detail View	9-19
BATTERY Drawing - View Display	9-20
BATTERY Drawing - Insert Model Items and Move Dimensions	9-21
BATTERY Drawing - Insert a Note	9-23
New Assembly Drawing and Exploded View	9-25
FLASHLIGHT Drawing - Bill of Materials and Balloons	9-27
Part Numbers	9-29
FLASHLIGHT Drawing - ConfigurationManager	9-30
FLASHLIGHT Drawing - Update the Bill of Materials	9-30
Design Tables and O-RING Design-Table Drawing	9-32
O-RING Drawing	9-34
O-RING Drawing - Design Table	9-34
Add a Center of Mass point	9-36
Chapter Summary	9-37
Ouestions/Exercises	9-38

Chapter 10 - Introduction to the Certified Associate - Mechanical Design (CSWA)	
Exam	10-1
Chapter Objective	10-3
Introduction	10-3
Intended Audience	10-4
Exam Content	10-5
Drafting Competencies	10-10
Basic and Intermediate Part Creation and Modification	10-12
Advanced Part Creation and Modification	10-18
Assembly Creation and Modification	10-24
Chapter 11 - Additive Manufacturing - 3D Printing	11-1
Chapter Objective	11-3
Additive Manufacturing	11-3
Save a SOLIDWORKS Model to STL File	11-4
Discuss Potential Problem Areas	11-6
Non-Heated Build Plate	11-6
Heated Build Plate	11-6
Clean Build Surface	11-7
Level Build Plate	11-7
Control Build Area Temperature	11-7
3D Printer Filament	11-8
Prepare the Model	11-10
Add/Insert	11-10
Scale	11-10
Example 1: Part Orientation	11-11
Example 2: Part Orientation	11-13
Key 3D Print terminology	11-15
Rafts	11-15
Supports	11-16
Resolution	11-17
Slicer Engine	11-17
Quality	11-17
Infill	11-17
Number of Shells	11-17
Layer Height	11-18
Slicer Temperature	11-18
Slicer Speed	11-18
Create Profile	11-18
3D Printer Filament Materials	11-19
ABS - Storage	11-19
ABS - Smell	11-19
ABS - Part Accuracy	11-19
PLA - Storage	11-20
PLA - Smell	11-20
PLA - Part Accuracy	11-20
Summary of ABS and PLA Material	11-20
ABS	11-20
PLA	11-20
Flex PLA	11-21
Remove the Model from the Build Plate	11-21

Name

Bench Vice Assembly Project

Pulley Assembly Project

Butterfly Valve Assembly ProjectDrill Guide Assembly Project

Know the Printer's Limitation	11-21
Understand Fit Tolerances for Interlocking Parts	11-21
General Printing Tips	11-22
Chapter Summary	11-25
Appendix	
Engineering Change Order (ECO)	A-1
Types of Decimal Dimensions (ASME Y14.5)	A-2
SOLIDWORKS Keyboard Shortcuts	A-3
Windows Shortcuts	A-4
Helpful On-Line information	A-5
SOLIDWORKS Document types	A-6
Glossary	G-1
Index	I-1

View the video instructions in the book for additional help. Additional projects are included in the exercise section. Copy the components from the Homework folder. Create and insert all needed components and mates to assemble the assembly and to simulate proper movement per the provided avi file located in the folders.

