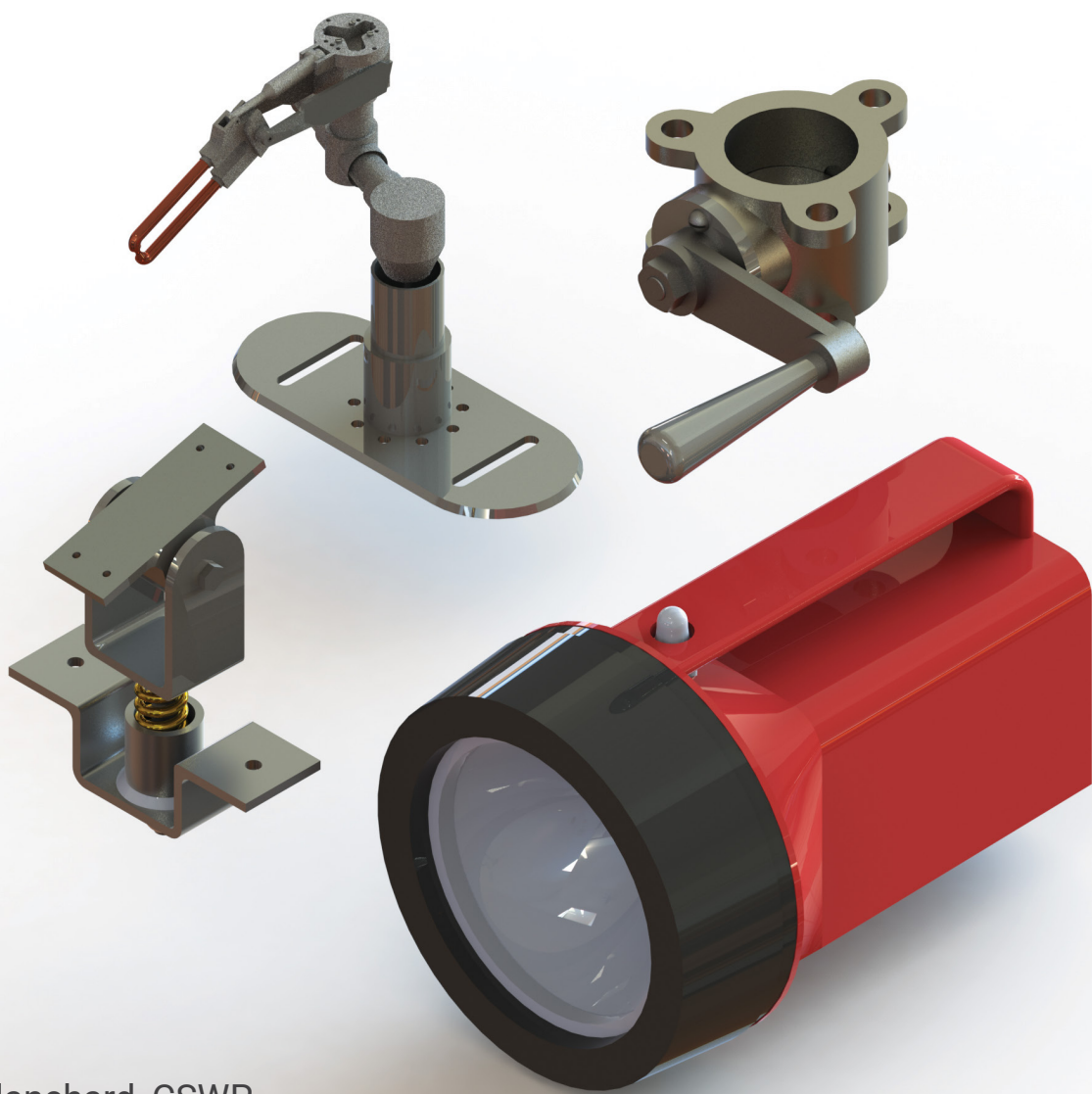


Engineering Design with SOLIDWORKS® 2022

A Step-by-Step Project Based Approach
Utilizing 3D Solid Modeling



David C. Planchard, CSWP,
SOLIDWORKS Accredited Educator

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

Introduction	I-1
About the Author	I-2
Acknowledgements	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 Projects	I-18
What is SOLIDWORKS?	I-25
About the Book	I-28
Windows Terminology in SOLIDWORKS	I-29
Project 1 - Overview of SOLIDWORKS and the User Interface	1-1
Project Objective	1-1
What is SOLIDWORKS?	1-2
Basic concepts in SOLIDWORKS	1-3
Start a SOLIDWORKS Session	1-4
<i>Tutorial: Start a SOLIDWORKS Session</i>	1-4
Welcome dialog box	1-4
Home Tab	1-5
Recent Tab	1-5
Learn Tab	1-5
Alerts Tab	1-6
SOLIDWORKS User Interface (UI) and CommandManager	1-7
Menu Bar toolbar	1-7
Menu Bar menu (No model open)	1-8
Menu Bar Menu (Model open)	1-8
Drop-down menu (Open part)	1-8
Create a New Part Document	1-9
Novice Mode	1-10
Advanced Mode	1-10
Graphic Window (Default)	1-11
View Default Sketch Planes	1-12
Open a Part	1-12
Part FeatureManager	1-13
FeatureManager Rollback Bar	1-13
Heads-up View toolbar	1-15
Dynamic Annotation Views	1-15
Zoom to Fit	1-15
Zoom to Area	1-15
Window-Select	1-15
Rotate	1-15
Front View	1-16
Right View	1-16
Top View	1-16
Trimetric view	1-16
SOLIDWORKS Help	1-16

SOLIDWORKS Tutorials	1-17
User Interface Tools	1-17
Right-click	1-18
Consolidated toolbar	1-18
System feedback icons	1-18
Confirmation Corner	1-19
Heads-up View toolbar	1-19
CommandManager (Default Part tab)	1-22
CommandManager (Default Drawing tab)	1-23
CommandManager (Default Assembly tab)	1-24
CommandManager (Float/Fit)	1-25
Collapse the CommandManager	1-25
FeatureManager Design Tree	1-26
FeatureManager design tree tab	1-26
PropertyManager tab	1-26
Configuration Manager tab	1-26
DimXpertManager tab	1-26
DisplayManager tab	1-26
CAM tab	1-26
Hide/Show tab	1-26
Sensors tool	1-26
Tags	1-27
Split	1-27
Fly-out FeatureManager	1-28
Task Pane	1-29
3DEXPERIENCE MARKETPLACE	1-29
SOLIDWORKS Resources	1-30
Design Library	1-30
File Explorer	1-31
View Palette	1-31
Appearances, Scenes and Decals	1-31
Custom Properties	1-32
Motion Study tab	1-32
3D Views tab	1-34
Dynamic Reference Visualization	1-34
Mouse Movements	1-35
Single-Click	1-35
Double-Click	1-35
Right-Click	1-35
Scroll Wheel	1-35
Summary	1-36
Project 2 - Fundamentals of Part Modeling	2-1
Project Objective	2-3
Project Situation	2-4
Project Overview	2-6
File Management	2-7
Start a SOLIDWORKS Session	2-8
System Options	2-8
Part Document Template and Document Properties	2-10
PLATE Part Overview	2-13

PLATE Part-New SOLIDWORKS Document	2-15
Base Feature	2-16
Machined Part	2-17
Reference Planes and Orthographic Projection	2-18
PLATE Part-Extruded Boss/Base Feature	2-22
PLATE Part-Modify Dimensions and Rename	2-31
Display Modes, View Modes, View tools and Appearances	2-33
PLATE Part-Extruded Cut Feature	2-35
PLATE Part-Fillet Feature	2-41
PLATE Part-Hole Wizard Feature	2-43
ROD Part Overview	2-46
ROD Part-Extruded Boss/Base Feature	2-48
ROD Part-Hole Wizard Feature	2-50
ROD Part-Chamfer Feature	2-51
ROD Part-Extruded Cut Feature & Convert Entities Sketch Tool	2-52
ROD Part-View Orientation, Named Views & Viewport option	2-57
ROD Part-Copy/Paste Function	2-58
ROD Part-Design Changes with Rollback Bar	2-59
ROD Part-Recover from Rebuild Errors	2-61
ROD Part-Edit Part Appearance	2-65
GUIDE Part Overview	2-67
GUIDE Part-Extruded Boss/Base Feature and Dynamic Mirror	2-69
GUIDE Part-Extruded Cut Slot Profile	2-72
GUIDE Part-Mirror Feature	2-76
GUIDE Part-Holes	2-77
GUIDE Part-Linear Pattern Feature	2-80
GUIDE Part-Materials Editor and Mass Properties	2-82
Manufacturing Considerations	2-84
Project Summary	2-87
Questions/Exercises	2-89
Project 3 - Fundamentals of Assembly Modeling	3-1
Project Objective	3-3
Project Situation	3-4
Project Overview	3-5
Assembly Modeling Approach	3-5
Linear Motion and Rotational Motion	3-6
GUIDE-ROD assembly	3-7
GUIDE-ROD assembly - Insert Components	3-11
FeatureManager Syntax	3-13
Mate Types	3-16
Standard Mates	3-16
Advanced Mates	3-17
Mechanical Mates	3-18
Quick Mate	3-18
GUIDE-ROD Assembly - Mate the ROD Component	3-20
GUIDE-ROD Assembly - Mate the PLATE Component	3-22
GUIDE-ROD Assembly - Mate Errors	3-27
Collision Detection	3-29
Modify Component Dimension	3-30
SOLIDWORKS Design Library	3-31

GUIDE-ROD Assembly - Insert Mates for Flange bolts	3-34
Socket Head Cap Screw Part	3-38
SmartMates	3-44
Coincident/Concentric SmartMate	3-45
Tolerance and Fit	3-47
Exploded View	3-51
Section View	3-56
Analyze an Interference Problem	3-58
Save As Copy Option	3-59
Save as	3-59
Save as copy and continue	3-59
Save as copy and open	3-59
GUIDE-ROD Assembly-Pattern Driven Component Pattern	3-62
Linear Component Pattern Feature	3-64
Folders and Suppressed Components	3-66
Make-Buy	3-67
CUSTOMER Assembly	3-68
Copy the CUSTOMER Assembly - Apply Pack and Go	3-74
Point at the Center of Mass	3-76
Project Summary	3-78
Questions/Exercises	3-79
Project 4 - Fundamentals of Drawing	4-1
Project Objective	4-3
Project Situation	4-4
Project Overview	4-4
Drawing Template and Sheet Format	4-5
Sheet Format and Title Block	4-12
Company Logo	4-17
Save Sheet Format and Save As Drawing Template	4-18
GUIDE Part-Modify	4-22
GUIDE Part Drawing	4-23
Move Views and Properties of the Sheet	4-26
Auxiliary View, Section View and Detail View	4-29
Auxiliary View	4-30
Section View	4-31
Detail View	4-32
Partial Auxiliary Drawing View - Crop Drawing View	4-33
Display Modes and Performance	4-35
Detail Drawing	4-37
Move Dimensions in the Same View	4-40
Move Dimensions to a Different View	4-44
Dimension Holes and the Hole Callout	4-45
Center Marks and Centerlines	4-48
Modify the Dimension Scheme	4-50
GUIDE Part-Insert an Additional Feature	4-54
General Notes and Parametric Notes	4-56
Revision Table	4-59
Part Number and Document Properties	4-61
Exploded View	4-67
Balloons	4-69

Bill of Materials	4-71
Insert a Center of Mass Point into a drawing	4-76
Project Summary	4-78
Questions/Exercises	4-78
Project 5 - Extrude and Revolve Features	5-1
Project Objective	5-3
Project Overview	5-4
Design Intent	5-6
Project Situation	5-9
Part Template	5-11
BATTERY Part	5-15
BATTERY Part - Extruded Boss/Base Feature	5-17
BATTERY Part - Fillet Feature Edge	5-21
BATTERY Part - Extruded Cut Feature	5-23
BATTERY Part - Fillet Feature	5-25
BATTERY Part - Extruded Boss/Boss Feature	5-26
Injection Molded Process	5-32
BATTERYPLATE Part	5-33
Save As, Delete, Edit Feature and Modify	5-34
BATTERYPLATE Part - Extruded Boss/Base Feature	5-36
BATTERYPLATE Part - Fillet Features: Full Round and Multiple Radius Options	5-37
Multi-body Parts and the Extruded Boss/Base Feature	5-40
LENS Part	5-42
LENS Part-Revolved Base Feature	5-43
LENS Part-Shell Feature	5-46
Extruded Boss/Base Feature and Convert Entities Sketch tool	5-47
LENS Part-Hole Wizard	5-48
LENS Part - Revolved Boss Thin Feature	5-50
LENS Part - Extruded Boss/Boss Feature and Offset Entities	5-52
LENS Part - Extruded Boss/Boss Feature and Transparency	5-54
BULB Part	5-56
BULB Part - Revolved Base Feature	5-57
BULB Part - Revolved Boss Feature and Spline Sketch tool	5-60
BULB Part - Revolved Cut Thin Feature	5-61
BULB Part - Dome Feature	5-63
BULB Part - Circular Pattern Feature	5-64
Customizing Toolbars and Short Cut Keys	5-68
Design Checklist and Goals before Plastic Manufacturing	5-70
Mold Base	5-72
Applying SOLIDWORKS Features for Mold Tooling Design	5-72
Manufacturing Design Issues	5-82
Project Summary	5-83
Questions/Exercises	5-84
Project 6 - Swept, Lofted and Additional Features	6-1
Project Objective	6-3
Project Overview	6-4
Project Situation	6-5
O-RING Part - Swept Base Feature	6-7
O-RING Part - Design Table	6-8

SWITCH Part - Lofted Base Feature	6-12
SWITCH Part - Dome Feature	6-17
Four Major Categories of Solid Features	6-19
LENSCAP Part	6-19
LENSCAP Part - Extruded Boss/Base, Extruded Cut and Shell Features	6-20
LENSCAP Part - Revolved Thin Cut Feature	6-23
LENSCAP Part - Thread, Swept Feature and Helix/Spiral Curve	6-24
HOUSING Part	6-30
HOUSING Part - Lofted Boss Feature	6-33
HOUSING Part - Second Extruded Boss/Base Feature	6-37
HOUSING Part - Shell Feature	6-38
HOUSING Part - Third Extruded Boss/Base Feature	6-39
HOUSING Part - Draft Feature	6-40
HOUSING Part - Thread with Swept Feature	6-42
HOUSING Part - Handle with Swept Feature	6-47
HOUSING Part - Extruded Cut Feature with Up To Surface	6-52
HOUSING Part - First Rib and Linear Pattern Feature	6-54
HOUSING Part - Second Rib Feature	6-57
HOUSING Part - Mirror Feature	6-60
FLASHLIGHT Assembly	6-63
Assembly Template	6-64
LENSANDBULB Sub-assembly	6-64
BATTERYANDPLATE Sub-assembly	6-69
CAPANLENS Sub-assembly	6-71
FLASHLIGHT Assembly	6-75
Addressing Interference Issues	6-81
Export Files and eDrawings	6-82
Project Summary	6-85
Questions/Exercises	6-86
Project 7 - Top-Down Assembly Modeling and Sheet Metal	7-1
Project Objective	7-3
Project Situation	7-4
Top-Down Assembly Modeling	7-5
BOX Assembly Overview	7-8
InPlace Mates and In-Context features	7-10
Part Template and Assembly Template	7-12
Box Assembly and Layout Sketch	7-13
Global Variables and Equations	7-17
MOTHERBOARD - Insert Component	7-22
POWERSUPPLY - Insert Component	7-28
Sheet Metal Overview	7-34
Bends	7-34
Relief	7-37
CABINET - Insert Component	7-37
CABINET - Rip Feature and Sheet Metal Bends	7-40
CABINET - Edge Flange	7-42
CABINET - Hole Wizard and Linear Pattern Features	7-45
CABINET - Sheetmetal Design Library Feature	7-49
CABINET - Louver Forming tool	7-53
Manufacturing Considerations	7-54

Additional Pattern Options	7-60
CABINET - Formed and Flat States	7-62
CABINET - Sheet Metal Drawing with Configurations	7-64
PEM Fasteners and IGES Components	7-70
Pattern Driven Component Pattern	7-74
MOTHERBOARD - Assembly Hole Feature	7-76
Assembly FeatureManager and External References	7-77
Replace Components	7-79
Equations	7-82
Design Tables	7-86
BRACKET Part - Sheet Metal Features	7-89
BRACKET Part - In-Content Features	7-91
BRACKET Part - Edge, Tab, Break Corner and Miter Flange Features	7-93
BRACKET Part - Mirror Component	7-98
MirrorBRACKET Part - Bends, Fold, Unfold and Jog Features	7-101
Project Summary	7-106
Questions/Exercises	7-107
Project 8 - SOLIDWORKS Simulation	8-1
Chapter Objective	8-1
Finite Element Modeling	8-1
Introduction	8-1
CSWA-S Audience	8-3
Basic CSWA-S Concepts	8-5
Simulation Advisor	8-6
Simulation Help & Tutorials	8-7
Linear Static Analysis	8-8
General Procedure to Perform a Linear Static Analysis	8-8
Sequence of Calculations in General	8-12
Stress Calculations in General	8-12
Overview of the Yield or Inflection Point in a Stress-Strain Curve	8-12
Material Properties in General	8-13
Connections in General	8-14
Restraint Types	8-14
Loads and Restraints in General	8-16
Meshing in General	8-17
Meshing Types	8-18
SOLIDWORKS Simulation meshing Tips	8-21
Running the Study	8-23
Displacement Plot - Output of Linear Static Analysis	8-23
Adaptive Methods for Static Studies	8-24
Sample Exam Questions	8-25
FEA Modeling Section	8-42
Tutorial FEA Model 8-1	8-42
Tutorial FEA Model 8-2	8-49
Tutorial FEA Model 8-3	8-56
Tutorial FEA Model 8-4	8-60
Tutorial FEA Model 8-4 Part 2	8-66
Tutorial FEA Model 8-4 Part 3	8-66
Tutorial FEA Model 8-5	8-67
Tutorial FEA Model 8-5 Part 2	8-71

Tutorial FEA Model 8-5 Part 3	8-72
Definitions	8-73
Project 9 - Intelligent Modeling Techniques	9-1
Project Objective	9-3
Design Intent	9-4
Sketch	9-4
Fully Defined Sketch tool	9-5
SketchXpert	9-8
Equations	9-11
Dimension Driven Equations	9-11
Equation Driven Curve	9-14
Explicit Equation Driven Curve	9-14
Parametric Equation Driven Curve	9-16
Curves	9-18
Curve Through XYZ Points	9-19
Projected Composite Curves	9-21
Feature - End Conditions	9-23
Along A Vector	9-26
FeatureXpert (Constant Radius)	9-27
Symmetry	9-28
Bodies to mirror	9-28
Planes	9-30
Conic Sections and Planes	9-31
Assembly	9-32
Assembly Visualization	9-32
SOLIDWORKS Sustainability - Assembly	9-33
MateXpert	9-34
Drawing	9-34
DimXpert	9-35
Project Summary	9-38
Exclusive Bonus Content - Instructions for download on inside front cover of book	
Project 10 - Additive Manufacturing - 3D Printing	10-1
Project Objective	10-3
Additive vs. Subtractive Manufacturing	10-4
3D Printer Technology	10-5
Stages of 3D Printing	10-5
Fused Filament Fabrication (FFF)	10-6
Stereolithography (SLA)	10-9
Selective Laser Sintering (SLS)	10-11
Select the Correct Filament Material for FFF	10-12
PLA (Polylactic Acid)	10-13
Flex/Soft PLA	10-13
PLA Storage	10-14
PLA Part Accuracy	10-14
ABS (Acrylonitrile-Butadiene-Styrene)	10-14
ABS Storage	10-15
ABS Part Accuracy	10-15
Nylon	10-16

Nylon 618	10-16
Nylon 645	10-16
Nylon Storage	10-17
Nylon Accuracy	10-17
PVA (Polyvinyl Alcohol)	10-17
STereoLithography (*.stl) file	10-18
Save an STL (*.stl) file	10-18
Additive Manufacturing (*.amf) file	10-19
Save an Additive Manufacturing (*.amf) file	10-19
3D Manufacturing Format (*.3mf) file	10-20
Save a 3D Manufacturing Format (*.3mf) file	10-20
What is a Slicer?	10-21
How does a Slicer Work?	10-21
Slicer Parameters	10-21
Layer Height	10-21
Shell (Wall) Thickness	10-22
Infill Density/Overlap	10-22
Infill Patterns	10-22
Print Speed	10-23
Support Types	10-23
Touching Buildplate	10-23
Everywhere	10-24
Bed Platform Adhesion	10-24
Raft	10-24
Skirt	10-24
Brim	10-24
Part Orientation	10-25
Example 1	10-25
Example 2	10-26
Optimize Print Direction	10-26
Thin Region	10-26
Area of Overhang	10-26
Amount of needed Support	10-26
Remove Model from the Build Plate	10-28
Non-heated Build Plate	10-28
Heated Build Plate	10-28
Know the Printer's Limitations	10-29
Tolerance for Interlocking Parts	10-29
General Printing Tips	10-29
Reduce Infill/Overlap	10-29
Control Build Area Temperature	10-30
Add Pads	10-31
Safe Zone Rule	10-31
First Layer Not Sticking	10-31
Level Build Platform	10-32
Minimize Internal Support	10-32
Design a Water Tight Mesh	10-32
Clearance	10-32
In General	10-33

Print Directly from SOLIDWORKS	10-34
Add-in	10-34
SOLIDWORKS Additive Manufacturing Certification (CSWA-AM)	10-35
Summary	10-36
Project 11 - Introduction to the Certified Associated – Mechanical Design Exam	11-1
Project Objective	11-3
Introduction	11-3
Part 1 of the Exam	11-4
Basic Part Creation and Modification, Intermediate Part Creation and Modification	11-4
Assembly Creation and Modification	11-4
Part 2 of the Exam	11-7
Introduction and Drafting Competencies	11-7
Advanced Part Creating and Modification	11-7
Assembly Creation and Modification	11-9
Intended Audience	11-10
During the Exam	11-11
Drafting Competencies	11-12
Example 1	11-12
Example 2	11-12
Example 3	11-13
Example 4	11-13
Example 5	11-13
Example 6	11-13
Basic Part Creation and Modification, Intermediate Part Creation and Modification	11-14
Example 1	11-15
Example 2	11-16
Example 3	11-17
Example 4	11-18
Example 5	11-19
Example 6	11-20
Example 6A	11-22
Example 6B	11-22
Advanced Part Creation and Modification	11-23
Example 1	11-25
Example 2	11-25
Example 3	11-26
Example 4	11-27
Example 5	11-28
Example 6	11-30
Example 6A	11-31
Assembly Creation and Modification	11-32
Example 1	11-33

Appendix	A-1
SOLIDWORKS Keyboard Shortcuts	A-1
Modeling - Best Practices	A-3
Helpful On-Line information	A-5
SOLIDWORKS Document types	A-6
Project 8: Answer key	A-7
Glossary	G-1
Index	I-1

Instructor's information contains over 60 classroom presentations along with helpful hints, what's new, sample quizzes, motion files of assemblies, projects and all initial and final SOLIDWORKS models.

Download all needed model files from the SDC Publication website To obtain additional CSWA exam information and to take an exam, visit <https://3dexperience.virtualtester.com/#home>.

The book provides information on creating and storing special Part, Assembly and Drawing templates in the MY-TEMPLATES folder. The MY-TEMPLATES folder is added to the New SOLIDWORKS Document dialog box. Talk to your IT department *before you set* any new locations on a network system. The procedure in the book is designed for your personal computer.



If you do not create the MY-TEMPLATE tab or the special part, drawing, or assembly templates, use the standard SOLIDWORKS default template and apply all of the needed document properties and custom properties.

