

Sheet Metal Design

Autodesk Official Training Courseware (AOTC)

Autodesk[®]
Inventor[®]

2009

© 2008 Autodesk, Inc. All rights reserved.

Except as otherwise permitted by Autodesk, Inc., this publication, or parts thereof, may not be reproduced in any form, by any method, for any purpose.

Certain materials included in this publication are reprinted with the permission of the copyright holder.

Trademarks

The following are registered trademarks or trademarks of Autodesk, Inc., in the USA and other countries: 3DEC (design/logo), 3December, 3December.com, 3ds Max, ActiveShapes, Actrix, ADI, Alias, Alias (swirl design/logo), AliasStudio, Alias|Wavefront (design/logo), ATC, AUGI, AutoCAD, AutoCAD Learning Assistance, AutoCAD LT, AutoCAD Simulator, AutoCAD SQL Extension, AutoCAD SQL Interface, Autodesk, Autodesk Envision, Autodesk Insight, Autodesk Intent, Autodesk Inventor, Autodesk Map, Autodesk MapGuide, Autodesk Streamline, AutoLISP, AutoSnap, AutoSketch, AutoTrack, Backdraft, Built with ObjectARX (logo), Burn, Buzzsaw, CAiCE, Can You Imagine, Character Studio, Cinestream, Civil 3D, Cleaner, Cleaner Central, ClearScale, Colour Warper, Combustion, Communication Specification, Constructware, Content Explorer, Create>what's>Next> (design/logo), Dancing Baby (image), DesignCenter, Design Doctor, Designer's Toolkit, DesignKids, DesignProf, DesignServer, DesignStudio, Design|Studio (design/logo), Design Web Format, Design Your World, Design Your World (design/logo), DWF, DWG, DWG (logo), DWG TrueConvert, DWG TrueView, DXF, EditDV, Education by Design, Exposure, Extending the Design Team, FBX, Filmbox, FMDesktop, Freewheel, GDX Driver, Gmax, Heads-up Design, Heidi, HOOPS, HumanIK, i-drop, iMOUT, Incinerator, IntroDV, Inventor, Inventor LT, Kaydara, Kaydara (design/logo), LocationLogic, Lustre, Maya, Mechanical Desktop, MotionBuilder, Mudbox, NavisWorks, ObjectARX, ObjectDBX, Open Reality, Opticore, Opticore Opus, PolarSnap, PortfolioWall, Powered with Autodesk Technology, Productstream, ProjectPoint, ProMaterials, Reactor, RealDWG, Real-time Roto, Recognize, Render Queue, Reveal, Revit, Showcase, ShowMotion, SketchBook, SteeringWheels, StudioTools, Topobase, Toxik, ViewCube, Visual, Visual Bridge, Visual Construction, Visual Drainage, Visual Hydro, Visual Landscape, Visual Roads, Visual Survey, Visual Syllabus, Visual Toolbox, Visual Tugboat, Visual LISP, Voice Reality, Volo, Wiretap, and WiretapCentral.

The following are registered trademarks or trademarks of Autodesk Canada Co. in the USA and/or Canada and other countries: Backburner, Discreet, Fire, Flame, Flint, Frost, Inferno, Multi-Master Editing, River, Smoke, Sparks, Stone, and Wire.

All other brand names, product names, or trademarks belong to their respective holders.

Disclaimer

THIS PUBLICATION AND THE INFORMATION CONTAINED HEREIN IS MADE AVAILABLE BY AUTODESK, INC. "AS IS." AUTODESK, INC. DISCLAIMS ALL WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE REGARDING THESE MATERIALS.

Published by:
Autodesk, Inc.
111 McInnis Parkway
San Rafael, CA 94903, USA

Contents

- Introduction..... xi**

- Chapter 1: Sheet Metal Overview 1**
 - Lesson: Introduction to Sheet Metal..... 2
 - Overview..... 2
 - Sheet Metal Concepts and Terminology..... 3
 - Sheet Metal Manufacturing Equipment..... 6
 - Designing Sheet Metal Parts with Inventor..... 8
 - Exercise: Create a Simple Sheet Metal Part..... 13
 - Lesson: Sheet Metal Design Methods..... 16
 - Overview..... 16
 - Sheet Metal Design Methods..... 17
 - Using Two Different Design Methods..... 20
 - Exercise: Use Sheet Metal Design Methods..... 26
 - Lesson: Sheet Metal Rules..... 29
 - Overview..... 29
 - Manage Bend Tables..... 30
 - About Sheet Metal Defaults..... 32
 - About Sheet Metal Rules..... 34
 - Creating and Using Sheet Metal Rules..... 35
 - Managing Sheet Metal Rules..... 40
 - Exercise: Create a Sheet Metal Rule..... 44
 - Chapter Summary..... 47

- Chapter 2: The Sheet Metal Environment..... 49**
 - Lesson: Faces..... 50
 - Overview..... 50
 - About Sheet Metal Faces..... 51
 - Creating Sheet Metal Faces..... 54
 - Exercise: Create a Sheet Metal Face..... 62
 - Lesson: Flanges..... 64
 - Overview..... 64
 - About Flanges..... 65
 - Flange Tool..... 66
 - Creating Single Flanges..... 72
 - Automatic Corner Conditions and Mitering..... 75
 - Creating Multiple Flanges..... 77
 - Using Multi-Edge Corner Overrides..... 80
 - Exercise: Create Multiple and Single Flange Features..... 82

Lesson: Contour Flanges	85
Overview	85
About Contour Flanges	86
Contour Flange Tool	88
Automatic Corner Conditions and Mitering	92
Creating Single Contour Flanges	94
Creating Multiple Contour Flanges	96
Exercise: Create Contour Flanges	100
Lesson: Hems	103
Overview	103
About Sheet Metal Hems	104
Creating a Sheet Metal Hem	107
Exercise: Create a Sheet Metal Hem	118
Chapter Summary	120

Chapter 3: Sheet Metal Operations 121

Lesson: Cutting	122
Overview	122
About Sheet Metal Cuts	123
Creating Sheet Metal Cuts	124
Exercise: Create Sheet Metal Cuts	129
Lesson: Sheet Metal Punching	131
Overview	131
About Sheet Metal Punch iFeatures	132
Inserting Sheet Metal Punch iFeatures	134
Exercise: Use the Punch Tool	138
Lesson: Corner Seams	141
Overview	141
About Corner Seams	142
Creating Corner Seams	143
Exercise: Create Corner Seams	150
Lesson: Folding	152
Overview	152
Designing Sheet Metal Parts in the Flat	153
Using the Fold Tool	154
Exercise: Use the Fold Tool	159
Lesson: Bending	161
Overview	161
About Sheet Metal Bends	162
Creating Sheet Metal Bends	164
Exercise: Create Sheet Metal Bends	169
Lesson: Creating Holes	172
Overview	172
About Hole Features	173
Creating Holes	175
Exercise: Create Holes	187

Lesson: Creating Corner Rounds and Corner Chamfers	190
Overview	190
About Corner Rounds and Corner Chamfers	191
Creating Corner Rounds	192
Creating Corner Chamfers	195
Exercise: Create Corner Rounds and Chamfers	200
Lesson: Work Features	202
Overview	202
About Work Features	203
Creating Work Features	206
Exercise: Create Work Features	210
Lesson: Pattern Features	214
Overview	214
About Patterns	215
Creating Rectangular and Circular Patterns	217
Exercise: Create Rectangular and Circular Patterns	226
Lesson: Mirror Features	228
Overview	228
About Mirroring Sheet Metal Features	229
Mirroring Sheet Metal Features	230
Exercise: Mirror Sheet Metal Features	233
Chapter Summary	236

Chapter 4: Sheet Metal Design Techniques 237

Lesson: Sheet Metal Design Approaches	238
Overview	238
Stand-Alone Sheet Metal Design	239
Creating Stand-Alone Sheet Metal Parts	241
In-Place Part Creation	243
Creating Sheet Metal Parts in the Context of an Assembly	245
Exercise: Use Different Sheet Metal Design Approaches	248
Lesson: Using Skeletal Models	252
Overview	252
About Derived Designs	253
Creating a Sheet Metal Part Using a Skeletal Model	256
Exercise: Create Sheet Metal Parts Using a Skeletal Model	258
Lesson: Using Legacy DXF/DWG Flat Layout Geometry	264
Overview	264
About Legacy Flat Layout Data	265
Utilizing Legacy Flat Layout Data	266
Exercise: Use Legacy Flat Layout Data	273
Lesson: Using Legacy 3D Geometry	278
Overview	278
About Legacy 3D Geometry	279
Using Imported 3D Geometry	280
Convert a Composite Feature to a Base Feature	288
Exercise: Import 3D Geometry	295

Lesson: Complex Sheet Metal Creation Techniques	298
Overview	298
About Complex Sheet Metal Shapes	299
Creating Complex Sheet Metal Shapes	300
About iMates	306
Applying iMates to Constrain Sheet Metal Parts	307
Process for Matching iMates During Placement	311
Inferring iMates from Constraints	314
Exercise: Create and Use iMates	316
Exercise: Create Complex Sheet Metal Shapes	320
Lesson: Punch Library Setup	326
Overview	326
Extracting Sheet Metal Punch iFeatures	327
Authoring Table-Driven Punch iFeatures	333
Punch Libraries	336
Exercise: Create and Reuse Punch iFeatures	338
Chapter Summary	342

Chapter 5: Using Flat Patterns 343

Lesson: Flat Pattern Creation and Cleanup	344
Overview	344
About Flat Patterns	345
Creating and Editing Flat Patterns	346
Cleaning Up Flat Patterns	352
Exercise: Create, Edit, and Clean Up Flat Patterns	357
Lesson: DXF/DWG Export	360
Overview	360
About DXF/DWG Export	361
Export Sheet Metal Face	363
Export Sheet Metal Flat Pattern	369
Exercise: Export a Sheet Metal Part	375
Chapter Summary	377

Chapter 6: Documenting Sheet Metal Designs 379

Lesson: Creating Sheet Metal Drawings	380
Overview	380
About Sheet Metal Drawings	381
About 2D Flat Patterns	383
Creating Sheet Metal Drawings	385
Exercise: Create Sheet Metal Drawings	389
Lesson: Sheet Metal Documentation	391
Overview	391
About Bend Annotations	392
Create Bend Notes	394
Display Model Objects in Drawing Views	396
Exercise: Sheet Metal Documentation	400

Lesson: Notating Bends and Punches.....	403
Overview	403
About Bend Notation	404
Creating Bend Tables	405
About Punch Notation	407
Creating Punch Tables	410
Process of Configuring Punch Notes.....	412
Adding Punch Notes.....	415
Editing Punch Notes	416
Exercise: Create Bend and Punch Tables	417
Exercise: Add, Configure, and Edit Punch Notes.....	420
Lesson: Chapter Summary	422

Appendix A: Additional Support and Resources 423

Courseware from Autodesk	424
Autodesk Services & Support.....	425
Autodesk Subscription.....	426
Autodesk Consulting	426
Autodesk Partners	426
Autodesk Authorized Training Centers	427
Autodesk Student Community	427
Autodesk Certification	428
Autodesk Store	428
Useful Links	428

Acknowledgements

The Autodesk Official Training Courseware (AOTC) team wishes to thank everyone who participated in the development of this project, with special acknowledgement to the authoring contributions and subject matter expertise of Ron Myers and CrWare, LP.

CrWare, LP began publishing courseware for Autodesk Inventor in 2001. Since that time, the company has grown to include full-time curriculum developers, subject matter experts, and technical writers, each with a unique set of industry experiences and talents that enables CrWare to create content that is both accurate and relevant to meeting the learning needs of its readers and customers.

The company's Founder and General Partner, Ron Myers, has been using Autodesk® products since 1989. During that time, Ron Myers worked in all disciplines of drafting and design, until 1996 when he began a career as an Applications Engineer, Instructor, and Author. Ron Myers has been creating courseware and other training material for Autodesk since 1996 and has written and created training material for AutoCAD®, Autodesk® Inventor®, AutoCAD® Mechanical, Mechanical Desktop, and Autodesk® Impression.

Introduction

Welcome to the *Autodesk Inventor 2009: Sheet Metal Design* Autodesk Official Training Courseware (AOTC), training courseware for use in Authorized Training Center (ATC®) locations, corporate training settings, and other classroom settings.

Although this courseware is designed for instructor-led courses, you can also use it for self-paced learning. The courseware encourages self-learning through the use of the Autodesk® Inventor® 2009 Help system.

This introduction covers the following topics:

- Course objectives
- Prerequisites
- Using this courseware
- CD contents
- Completing the exercises
- Installing the exercise data files from the CD
- Projects
- Notes, tips, and warnings
- Feedback

This courseware is complementary to the software documentation. For detailed explanations of features and functionality, refer to the Help in the software.

Course Objectives

After completing this course, you will be able to:

- Describe the terms and concepts of sheet metal design, create a sheet metal part using two different creation methods, and create and manage sheet metal styles.
- Explain the characteristics of a face, flange, contour flange, and hem sheet metal feature and create sheet metal parts consisting of those features.
- Produce sheet metal part designs that consist of cuts, punches, corner seams, bends, holes, corner rounds, corner chamfers, and duplicated features.
- Create sheet metal designs by using various approaches to sheet metal design, employing skeletal modeling, using legacy flat pattern and 3D models, and implementing custom sheet metal punch features.
- Create and edit flat pattern geometry and export your sheet metal parts or faces to DXF™ and DWG™ formats.
- Create and edit sheet metal drawings and document them using annotation tools designed specifically for sheet metal drawings.

Prerequisites

This course is designed for Autodesk Inventor users who want to learn the essential tools and best practices for sheet metal design using Autodesk Inventor 2009.

It is recommended that you have a working knowledge of:

- Microsoft® Windows® 2000 or Microsoft® Windows® XP.
- Parametric solid modeling concepts.
- Design or mechanical engineering experience is a plus.

Students should have completed the *Autodesk Inventor 2009: Essentials* course or have an equivalent understanding of the Autodesk Inventor 2009 user interface and working environments.

Using This Courseware

The lessons are independent of each other. However, it is recommended that you complete these lessons in the order that they are presented unless you are familiar with the concepts and functionality described in those lessons.

Each chapter contains:

- **Lessons**
Usually two or more lessons in each chapter.
- **Exercises**
Practical, real-world examples for you to practice using the functionality you have just learned. Each exercise contains step-by-step procedures and graphics to help you complete the exercise successfully.

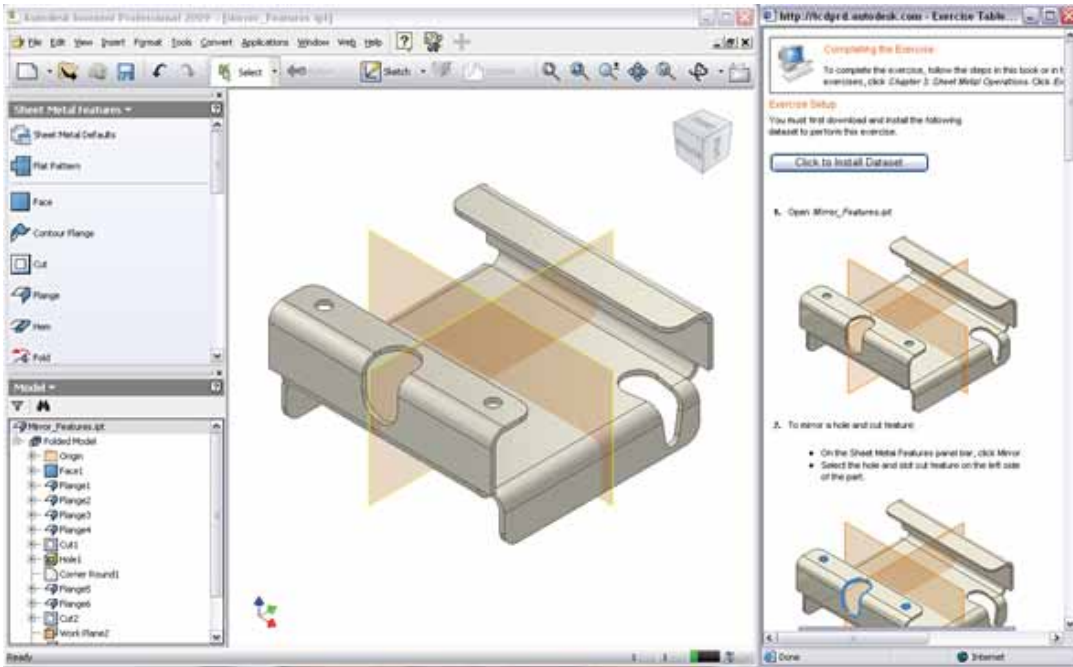
CD Contents

The CD attached to the back cover of this book contains all the data and drawings you need to complete the exercises in this course.

Completing the Exercises

You can complete the exercise in two ways: using the book or on screen.

- **Using the book**
Follow the step-by-step exercises in the book.
- **On screen**
Click the AOTC - Autodesk Inventor 2009 Sheet Metal Design icon on your desktop, installed from the CD, and follow the step-by-step exercises on screen. The onscreen exercises are the same as those in the book. The onscreen version has the advantage that you can concentrate on the screen without having to glance down at your book.



After launching the onscreen exercises, you might need to alter the size of your application window to align both windows.

Installing the Exercise Data Files from the CD

To install the data files for the exercises:

1. Insert the courseware CD.
2. When the setup wizard begins, follow the instructions on screen to install the data.
3. If the wizard does not start automatically, browse to the root directory of the CD and double-click *Setup.exe*.

Unless you specify a different folder, the exercise files are installed in the following folder:

C:\Documents and Settings\All Users\Autodesk Learning\Inventor 2009\Sheet Metal Design

After you install the data from the CD, this folder contains all the files necessary to complete each exercise in this course.

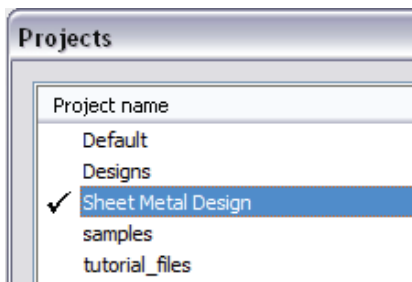
Projects

Most engineers work on several projects at a time, and each project might consist of a number of files. You can use Autodesk Inventor projects to organize related files and maintain links between files. This courseware has a project file that stores the paths to all the files that are related to the exercises. When you open a file, Autodesk Inventor uses the paths in the current project file to locate other required files. To work on a different project, you make a new project active in the Project Editor. Follow the instructions in the courseware to locate the project file for the course and make it active.

Follow the instructions below to locate the *Inventor 2009 Sheet Metal Design* project file for this courseware and make it active.

1. Start Autodesk Inventor.
2. Click File menu > Projects.
 - In the Projects dialog box, click Browse.
 - In the Choose project file dialog box, navigate to *C:\Documents and Settings\All Users\Autodesk Learning\Inventor 2009\Sheet Metal Design*.
 - Select *Sheet Metal Design.ipj*.
 - Click Open.
3. In the Projects dialog box, double-click *Sheet Metal Design* to activate the project. Click Done.

Note: The check mark designates the active project.



Notes, Tips, and Warnings

Throughout this courseware, notes, tips, and warnings are called out for special attention.



Notes contain guidelines, constraints, and other explanatory information.



Tips provide information to enhance your productivity.



Warnings provide information about actions that might result in the loss of data, system failures, or other serious consequences.

Feedback

We always welcome feedback on Autodesk Official Training Courseware. After completing this course, if you have suggestions for improvements or if you want to report an error in the book or on the CD, please send your comments to AOTC.feedback@autodesk.com.