

The Engineering byDesign™ Industry Certification Pathway

Introduction

To encourage more students to work toward a selected industry credential while in high school, the Engineering byDesign™ Industry Certification Pathway was developed by ITEEA's STEM Center for Teaching and Learning. By following the suggested pathway delineated in this document, educators can prepare students for a successful attempt at an industry certification through Certiport for the Autodesk software packages of AutoCAD, Revit, and Inventor. The Engineering byDesign™ Industry Certification Pathway includes the following courses: *Foundations of Technology*, *Technological Design*, *Advanced Design Applications*, *Advanced Technological Applications*, and *Engineering Design*.

Included in this document are infographics that provide visual representations of the Engineering byDesign™ (EbD) three- and four-year course sequences (pp. 1-3), and detailed informational documents for educator reference on facilitating the software focus—AutoCAD (pp. 4-6), Revit (pp. 7-9), and Inventor (pp. 10-12)—within each EbD™ course.

Infographics

Each individual EbD™ course is delivered in 36 weeks. Educators should follow the curriculum with specific attention to the software *focus* assigned for each course.

Three-Year Course Sequence

In Year One (red callout in Figure 1), students take *Foundations of Technology* followed by *Technological Design* in Year Two (green callout in Figure 1). Both courses have a *focus* on AutoCAD, as shown in the purple callout. Toward the end of the *Technological Design* course, students take the certification exam for AutoCAD (yellow callout in Figure 1). In Year Three (blue callout in Figure 1), students take one of the three course options; *Advanced Design Applications*, *Advanced Technological Applications*, or *Engineering Design*. The *Advanced Design Application* course has a *focus* on Revit (purple callout in Figure 1) throughout the entire course, whereas the *Advanced Technological Applications* and *Engineering Design* courses *focus* on Inventor (purple callout in Figure 1). Toward the end of the *Advanced Design Applications* course, students can take the certification exam for Revit (yellow callout in Figure 1). Upon completion of the *Advanced Technological Applications* and the *Engineering Design* courses, students can take the certification exam for Inventor (yellow callout in Figure 1).

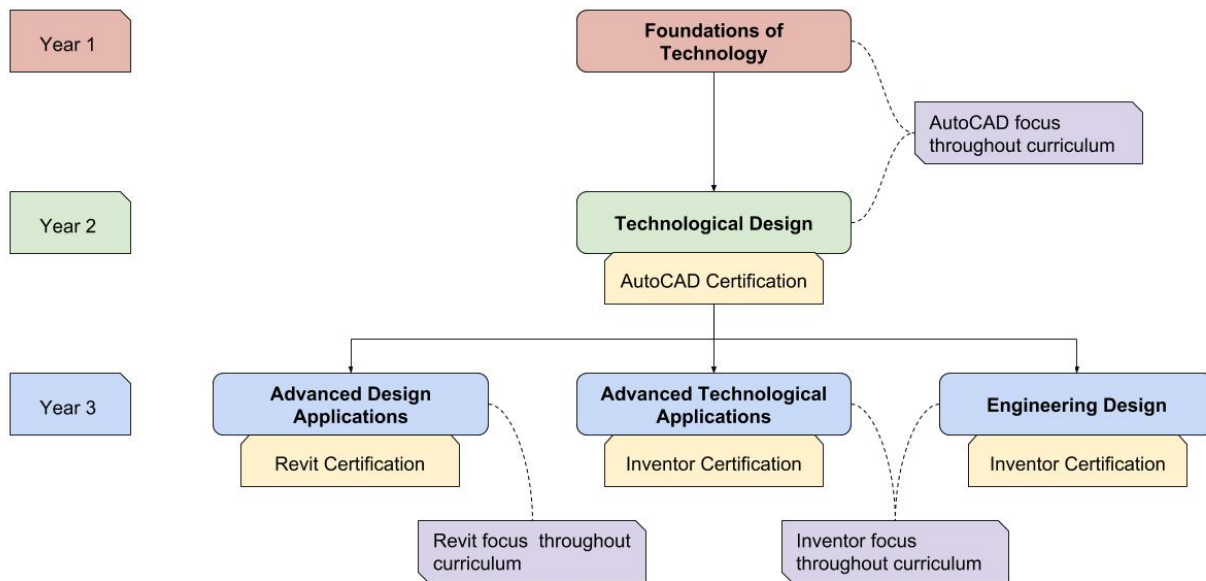


Figure 1. Three-Year Course Sequence for the Engineering byDesign™ Industry Certification Pathway.

Four-Year Course Sequence

In Year One (red callout in Figure 2), students take the *Foundations of Technology* course followed by the *Technological Design* course in Year Two (green callout in Figure 2). Both courses have a *focus* on AutoCAD, as shown in the purple callout (Figure 2). Toward the end of the *Technological Design* course, students take the certification exam for AutoCAD (yellow callout in Figure 2). In Year Three (blue callout in Figure 2), students take either the *Advanced Design Applications* or *Advanced Technological Applications* courses. *Advanced Design Application* has a *focus* on Revit (purple callout in Figure 2) throughout the entire course whereas the *Advanced Technological Applications* course *focus* is on Inventor (purple callout in Figure 2). Toward the end of the *Advanced Design Applications* course students take the certification exam for Revit (yellow callout in Figure 2). A certification exam is not administered within the *Advanced Technological Applications* course for the four-year course sequence. During the fourth year (orange callout in Figure 2), students take the *Engineering Design* course. Toward the end of *Engineering Design* students take the certification exam for Inventor (yellow callout in Figure 2).

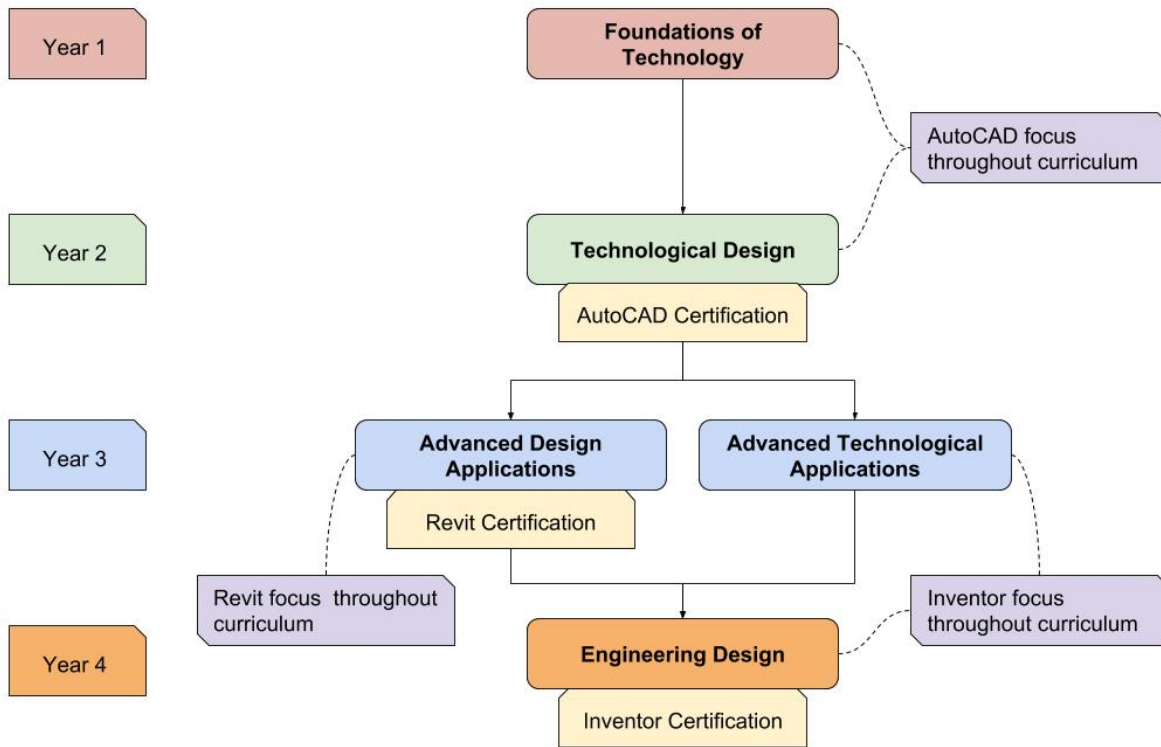


Figure 2. Four-year Course Sequence for the Engineering byDesign™ Industry Certification Pathway.

AutoCAD Certification

EbD™ Courses

Foundations of Technology

Technological Design

Overview

Students take these two courses, each for one academic year (36 weeks), in sequence with a focus on AutoCAD terminology, basic to advanced layout and modeling, and an introduction to industry drafting practices. During the final weeks of *Technological Design* each student should participate in a week-long “Certification Boot Camp” that reviews each core competency listed below. Upon successful completion of both courses and the boot camp, students should be prepared to successfully achieve an Autodesk-AutoCAD-User certification through Certiport.

Exam Objectives (adapted from Certiport.com)

1. Basic Drawing Skills
 - a. Selection sets
 - b. Coordinate systems
 - c. Inputs
 - d. Shortcuts
 - e. inquiries
2. Objects
 - a. Lines / rectangles
 - b. Circles / arcs
 - c. P-lines / polygons
3. Drawing Accuracy
 - a. Snap / grid
 - b. Object tracking
4. Modifications
 - a. Move / copy
 - b. Rotate / scale
 - c. Arrays
 - d. Trim / extend
 - e. Offset / mirror
 - f. Grips
 - g. Fillet / chamfer
5. Drawing Techniques
 - a. Edit p-lines
 - b. Hatching
6. Organization

- a. Object properties
- b. Layering
- 7. Reusing Established Content
 - a. Block editing
- 8. Annotate
 - a. Text
 - b. Dimensions
- 9. Plotting
 - a. Print settings
 - b. Plot options

Curriculum Adaptation Example (adaptation and enrichment are in addition to the current EbD™ curriculum)

❖ Foundations of Technology

- Unit 2 - Engineering Design Process
 - Learning Cycle 3
 - Big Idea = Design Principles
 - Objective = Marshmallow Design Brief
- Adaptation (in-class contact)
 - Lay out each component within AutoCAD
 - Using a variety of drawing and modification tools
 - Dimension each component within AutoCAD
 - Modify text of dimensions per teacher instruction
- Enrichment (out-of-class contact)
 - Create drawings (paper space) for each component within AutoCAD
 - Print a packet of A-size drawings to complete the design brief

❖ Technological Design

- Unit 6 - Design Challenge
 - Learning Cycle 4
 - Big Idea = Design Limitations
 - Objective = Lunar Plant Growth Chamber
- Adaptation (in-class contact)
 - Lay out each component within AutoCAD
 - Using a variety of drawing and modification tools
 - Dimension each component within AutoCAD
 - Modify text of dimensions per teacher instruction
 - Create drawings (paper space) for each component within AutoCAD
 - Print a packet of A-size drawings to complete the design brief
- Enrichment (out of class contact)
 - Instructor adds additional constraints and limitations to the student's original design, which will require a design modification
 - Students will assign layers to each component within AutoCAD
 - Layer color
 - Layer line type
 - Layer line weight

Bootcamp Example (from “AutoCAD Certification Bootcamp” by Douglas Lecorchick, III)

Monday through Friday should have a daily checklist of objectives to meet.

<p>AutoCAD Bootcamp</p> <p>Monday</p> <ul style="list-style-type: none"><input type="checkbox"/> Resizing/scaling on different axis<input type="checkbox"/> Area<input type="checkbox"/> Grip editing<input type="checkbox"/> Snap values<input type="checkbox"/> Offsetting <p>Tuesday</p> <ul style="list-style-type: none"><input type="checkbox"/> Patterns<input type="checkbox"/> Layering & changing layers<input type="checkbox"/> Rotating drawing around points<input type="checkbox"/> Trim & extend

Notes:

- A minimum of two contact hours (in class) of AutoCAD each week for each course.
- Cover all objectives in the *Foundations of Technology* course in Year One (Figure 1 or Figure 2), and then again in the *Technological Design* course in Year Two (Figure 1 or Figure 2).
- Enrichment assignments should be given throughout the Year Two (*Technological Design*, Figure 1 or Figure 2) to equal three contact hours (outside of class).
- The week-long “Certification Boot Camp” should be for one hour each day for a week with an additional three contact hours of enrichment for a total of eight contact hours.

Revit Certification

EbD™ Course

Advanced Design Applications

Overview

Students take this course for one academic year (36 weeks), with a focus on Revit terminology, basic to advanced 3D architectural modeling, and an advanced understanding of architectural drafting practices. During the final week of this course, each student should participate in a week-long “Certification Boot Camp” that reviews each core competency listed below. Upon successful completion of this course and the boot camp, students should be prepared to successfully achieve an Autodesk-Revit-User certification through Certiport.

Exam Objectives (adapted from Certiport.com)

1. Elements
 - a. Grid
 - b. Trim / Extend
 - c. Hide / reveal
 - d. Place components
2. Families
 - a. Modify walls
 - b. Modify doors
 - c. Modify windows
 - d. Door / window tags
3. Modeling
 - a. Roof / properties
 - b. Stair / landings
 - c. Railings
 - d. Floors / rooms
 - e. Move / copy
 - f. Align / mirror / array
4. Views
 - a. Scale
 - b. Detail
 - c. Visibility
 - d. Cut plane
 - e. Levels
 - f. Plan views

- g. Sections views
- h. Elevation views
- i. 3D vies
- 5. Documentation
 - a. Text
 - b. Dimensions
 - c. Sheets
 - d. View placement
 - e. Door schedules
 - f. Window schedules

Curriculum Adaptation Example (adaptation and enrichment are in addition to the current EbD™ curriculum)

- ❖ Advanced Design Applications
 - Unit 1 - Construction
 - Learning Cycle 1
 - Big Idea = Scales, Measurement, Conversion
 - Objective = Residential Design
 - Adaptation (in-class contact)
 - Explore architect scale features within Revit
 - Modify scale settings
 - Explore measurement tools within Revit
 - Design and model one room within Revit (English measurement)
 - Enrichment (out-of-class contact)
 - Design and model an additional room within Revit (Metric measurement)
 - Modify the scale of an existing room within Revit

Bootcamp Example (from “Revit Certification Boot Camp” by Douglas Lecorchick, III)

Monday through Friday should have a daily checklist of objectives to meet.

<h2>Revit Bootcamp</h2> <p>Monday</p> <ul style="list-style-type: none"><input type="checkbox"/> Grids<input type="checkbox"/> Walls<input type="checkbox"/> Floors<input type="checkbox"/> Elements <p>Tuesday</p> <ul style="list-style-type: none"><input type="checkbox"/> Roof<input type="checkbox"/> Layouts

Notes:

- A minimum of three contact hours (in class) of Revit each week for each course.
- Cover all objectives in the *Advanced Design Applications* course (a modification will need to be made to accommodate Revit on modules that are focused on using Inventor).
- Enrichment assignments should be given throughout each course for a minimum of three additional contact hours each week.
- The week-long “Certification Boot Camp” should be for one hour each day for a week with an additional three contact hours of enrichment for a total eight contact hours.

Inventor Certification

Courses

Advanced Technological Applications
Engineering Design

Overview

Students take either one or both courses, each for one academic year (36 weeks), with a focus on Inventor terminology, basic to advanced 3D modeling, and a continuation of understanding of industry drafting practices. During the final weeks of either course, each student should participate in a week long “Certification Boot Camp” that reviews each core competency listed below. Upon successful completion of one course (both courses for a four-year track) and the boot camp, students should be prepared to successfully achieve an Autodesk-Inventor-User certification through Certiport.

Exam Objectives (adapted from Certiport.com)

1. User Interface
 - a. Navigation
 - b. Viewcube
 - c. Environment
 - d. Views
2. Basic / Advanced Modeling
 - a. Sweep / draft
 - b. Fillets / chamfers
 - c. Patterns
 - d. Rib / shell
 - e. Extrude / cut
 - f. Holes
3. Created Part Features
 - a. Revolve
 - b. Work
4. Assembly Models
 - a. Constraints
 - b. Created parts in assembly
5. Drawings
 - a. Centerline
 - b. Styles
 - c. Balloons
6. Sketching
 - a. Parameter

- b. Dimension type
 - c. Sharing
 - d. Sketch constraints
 - e. Project geometry
7. Editing
- a. Reorder
 - b. Delete
 - c. Suppress / hide

Curriculum Adaptation Example (adaptation and enrichment are in addition to the current EbD™ curriculum)

- ❖ Advanced Technological Applications
 - Unit 5 - Robotics
 - Learning Cycle 2
 - Big Idea = Elastic material modifiability
 - Objective = Investigate design failure
 - Adaptation (in class contact)
 - Model parts within Inventor
 - Create an actuator assembly
 - Perform a stress analysis to detect weakness within the design/material selection
 - Enrichment (out of class contact)
 - Modify material selection
 - Perform stress analysis from different points of contact
 - Calculate actual (model) design failure compared to anticipated design failure
- ❖ Engineering Design
 - Unit 2 - Elements of Design
 - Learning Cycle 2
 - Big Idea = Robot Construction
 - Objective = Engineering Design Process
 - Adaptation (in-class contact)
 - Model each part within Inventor
 - Create a detail drawing for each part
 - Create the robot assembly
 - Enrichment (out-of-class contact)
 - Create an assembly drawing for the robot
 - Add mechanical motion to the assembly

Boot Camp Example (from “Inventor Certification Boot Camp” by Douglas Lecorchick, III)

Monday through Friday should have a daily checklist of objectives to meet.

Inventor Bootcamp

Monday

- Bill of materials & the structured tab to see the part # in a drawing
- Measuring a loop or perimeter
- Deleting features while leaving all the other features
- Measuring mass & center of gravity
- Parameters & adding equations

Tuesday

- Adding draft to extrusions
- Changing material

Notes:

- A minimum of three contact hours (in class) of Inventor each week for each course.
- Cover all objectives in the *Advanced Technological Applications* and *Engineering Design* courses for both three and four-year tracks.
- Enrichment assignments should be given throughout each course for a minimum of two additional contact hours each week.
- The week-long “Certification Boot Camp” should be for one hour each day for a week with an additional three contact hours of enrichment for a total eight contact hours.