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. inquires
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.

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
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.

![Revit Bootcamp Schedule](image)

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.