BILLINGS PUBLIC SCHOOLS
PLTW – Project Lead the Way
Learner Objectives

MISSION STATEMENT

The Career Center is dedicated to providing Billings area students with an education that explores and enhances vocational and academic skills to promote critical thinking, self-discipline, and responsible citizenship.

PHILOSOPHY

PLTW's high school programs:

- meet national standards for mathematics, science, technology education, and English language arts
- offer a complete career/technical concentration with an emphasis on both mathematics and science
- link demanding mathematics and science courses with quality academic/technical courses

PLTW's curricula make math and science relevant for students. By engaging in hands-on, real-world projects, students understand how the skills they are learning in the classroom can be applied in everyday life. This approach is called activities-based learning, project-based learning, and prolem-based learning (or APPB-learning, for short). Research shows that schools practicing APPB-leaning experience an increase in student motivation, cooperative learning skills, higher-order thinking, and student achievement.
The key components of PLTW's APPB-learning include:

- Focusing students on one project over an extended period of time
- Working cooperatively and effectively as a class or in small groups
- Integrating mathematics, science, technology, and English language arts skills to solve complex problem.

LEARNING DOMAINS

Project Lead The Way curricula are designed to align with the ABET, Inc. (formerly known as the Accreditation Board for Engineering and Technology Standards). ABET, Inc., is the recognized U.S. Accreditor of college and university programs in applied science, computing, engineering, and technology. A listing of the Criterion 3: Program Outcomes and Assessment technology. A listing of the Criterion 3: Program Outcomes and Assessment are used as guides throughout the development of PLTW curricula.

Engineering pros must demonstrate that their students have attainment of ABET, Inc. requirements at the basic educational level for entry into engineering practice.

BILLINGS PUBLIC SCHOOLS
PLTW – Project Lead the Way
Learner Objectives

I. Students will demonstrate an understanding of the engineering design process.

1. Apply engineering notebook standards and protocols when documenting their work during the school year.
2. Identify and apply group brainstorming techniques and the rules of associated with brainstorming.
3. Research a product's history, develop a PowerPoint presentation, list chronologically the major innovations to a product, and present their findings to a group.
4. Use online and published works to research aspects of design problems.
5. Identify the design process steps used in given scenarios and be able to list the steps, if any are missing.

II. Students will demonstrate an understanding of technical drawing/sketching practices commonly used in the engineering field.

1. Identify, sketch, and explain the function of points, construction lines, object lines, and hidden lines.
2. Plot points on grid paper to aid in the creation of sketches and drawings.
3. Explain the concepts of technical sketching and drawing.
4. Sketch an isometric view of simple geometric solids.
5. Explain how an oblique view of simple geometric solids differs from isometric view.
6. Sketch one-point, two-point, and three-point perspectives of simple geometric solids.
7. Describe the concept of proportion as it relates to freehand sketching.
8. Sketch multi-view drawing of simple geometric solids.
9. Determine the front view for a given object.

III. Students will understand and utilize measurement and statistical analysis standards and practices.

1. Research and design a CD cover or book jacket on the origins of the measurement systems.
2. Measure and record linear distances using a scale to a precision of 1/16 inch and 1 mm.
3. Measure and record linear distances using a dial caliper to a precision of 0.001 inch.
4. Add and subtract U.S. standard and metric linear measurements.
5. Convert linear distance measurements from inches to millimeters and vice versa.
6. Apply linear dimensions to a multi-view drawing.
7. Calculate the mean, mode, median, and range of a data set.
8. Create a histogram of recorded measurements showing data elements or class intervals, and frequency.

BILLINGS PUBLIC SCHOOLS
PLTW – Project Lead the Way
Learner Objectives

IV. Students will learn how to create a product from concept to reality.

1. Brainstorm and sketch possible solutions to an existing design problem.
2. Select an approach that meets or satisfies the constraints given in a design brief.
3. Create simple extruded solid Computer Aided Design (CAD) models from dimensioned sketches.
4. Generate dimensioned multi-view drawings from simple CAD models.
5. Measure and fabricate parts for a functional prototype from the CAD multi-view drawings.
6. Assemble the product using the CAD modeling software.
7. Test and evaluate the prototype and record results.
8. Apply geometric and numeric constraints to CAD sketches.

V. Students will demonstrate the ability to use geometry to calculate properties of shapes and solids.

1. Identify common geometric shapes and forms by name.
2. Calculate the area of simple geometric shapes.
3. Calculate the surface area and volume of simple geometric forms.
4. Identify and explain the various geometric relationships that exist between the elements of two-dimensional shapes and three-dimensional forms.
5. Identify and define the axes, planes, and sign conventions associated with the Cartesian coordinate system.
6. Apply geometric and numeric constraints to CAD sketches.
7. Utilize sketch-based, work reference, and placed features to develop solid CAD models from dimensioned drawings.
8. Explain how a given object's geometry is the result of sequential additive and subtractive processes.

VI. Students will demonstrate an understanding of the proper documentation of technical drawings utilized by engineers.

1. Explain the differences between datum dimensioning and chain dimensioning.
2. Identify and dimension fillets, rounds, diameters, chamfers, holes, slots, and screw threads in orthographic projection drawings.
3. Explain the rules that are associated with the application of dimensions to multi-view drawings.
4. Identify, sketch and explain the difference between general tolerances, limit dimensions, unilateral, and bilateral tolerances.
5. Identify, sketch, and explain the difference between general tolerances, limit dimensions, unilateral, and bilateral tolerances.
6. Differentiate between clearance and interference fits.

BILLINGS PUBLIC SCHOOLS
PLTW – Project Lead the Way
Learner Objectives

VII. Students will demonstrate an understanding of 3D functions used to develop individual and assembly CAD solid models.

1. Sketch and model an auxiliary view of a given object to communicate the true size and shape of its included surface.
2. Describe the purpose and demonstrate the application of section lines and cutting plane lines in a section view drawing.
3. Sketch a full and half section view of a given object to communicate its interior features.
4. Identify algebraic relationships between the dimensional values of a given object.
5. Apply assembly constraints to individual CAD models to create mechanical systems.
6. Perform part manipulation during the creation of an assembly model.
7. Explain how assembly constraints are used to systematically remove the degrees of freedom for a set of components in a given assembly.
8. Create an exploded model of a given assembly.
9. Determine ratios and apply algebraic formulas to animate multiple parts within an assembly model.
10. Create and describe the purpose of the following items: exploded isometric assembly view, balloons, and parts list.

VIII. Students will be able to design and apply solutions to given engineering design problems.

1. Brainstorm and sketch possible solutions to an existing design problem.
2. Create a decision making matrix.
3. Select an approach that meets or satisfies the constraints given in a design brief.
4. Create solid computer-aided design (CAD) models of each part from dimensioned sketches using a variety of methods.
5. Apply geometric numeric and parametric constraints to form CAD modeled parts.
6. Generate dimensioned multi-view drawings from simple CAD modeled parts.
7. Assemble the product using the CAD modeling software.
8. Explain what constraints are and why they are included in a design brief.
9. Create a three-fold brochure marketing the designed solution for the chosen problem, such as a consumer product, a dispensing system, a new form of control system, or extend a product design to meet a new requirement.
10. Explain the concept of fluid power, and the difference between hydraulic and pneumatic power systems.

BILLINGS PUBLIC SCHOOLS
PLTW – Project Lead the Way
Learner Objectives

IX. Students will identify the elements of design, or the components which form the structure of a product or an object, by studying products or objects common to their environment.

1. Identify visual design elements within a given object.
2. Explain how visual design principles were used to manipulate design elements within a given object.
3. Explain what aesthetics is, and how it contributes to a design's commercial success.

X. Students will manipulate the reverse engineering process as a tool to study simple and compound machines, open-and closed-loop systems, and sequential operations.

1. Identify the six simple machines that make up mechanical systems.
2. Explain the purpose of simple machines.
3. Explain the difference between a simple and compound machine.
4. Identify the reasons why engineers perform reverse engineering on products.
5. Describe the function of a given manufactured object as a sequence of operations through visual analysis and inspection (prior to dissection).

XI. Students will be able to study and analyze a product's properties and function to understand its strengths, weaknesses, and the manufacturing processes used.

1. Describe the differences between joinery, fasteners, and adhesives.
2. Identify the types of structural connections that exist in a given object.
3. Use dial calipers to precisely measure outside and inside diameter, hole depth, and object thickness.
4. Identify a given object's material type.
5. Identify material processing methods that are used to manufacture the components of a given commercial product.
6. Assign a density value to a material, and apply it to a given solid CAD model.
7. Perform computer analysis to determine mass, volume, and surface area of a given object.
8. Perform finite element analysis on a given object to predict its behavior under specified load conditions.

BILLINGS PUBLIC SCHOOLS
PLTW – Project Lead the Way
Learner Objectives

XII. Students will understand and utilize reverse engineering as a tool to drive product innovation through the identification of visual, structural and/or functional shortcomings.

1. Write design briefs that focus on product innovation.
2. Identify group brainstorming techniques and the rules associated with brainstorming.
3. Use decision matrices to make design decisions.
4. Explain the difference between invention and innovation.

XIII. Students will develop visual messages that make people in a target audience respond in predictable and favorable manner.

1. Identify the purpose of packaging in the design of consumer products.
2. Identify visual design principles and elements that are present within marketing ads.
3. Identify the intent of a given marketing ad and demographics of the target consumer group for which it was intended.

XIV. Students will perform research and recommend ways to minimize the potentially harmful consequences of choices that are made by individuals, consumers and society.

1. Create a brainstorming list of different products made from common materials that are used daily.
2. Research and construct a product impact timeline presentation of a product from the brainstorming list and present how the product may be recycled and used to make other products after its lifecycle is complete.
3. Identify the five steps of a product's lifecycle and investigate and propose recyclable uses for the material once the lifecycle of the product is complete.

XV. Students will develop an understanding of the team concept in the design process.

1. Explain why teams of people are used to solve problems.
2. Identify group norms that allow a virtual design team to function efficiently.
3. Establish file management and file revision protocols to ensure the integrity of current information.
4. Use internet resources, such as email, to communicate with a virtual design team member throughout a design challenge.
5. Identify strategies for addressing and solving conflicts that occur between team members.
6. Create a Gantt chart to manage the various phases of their design challenge.