Session: Description	Activities & Key Concepts	To Assess
1: *Jump Into Design* orients students to a design process that guides the work of engineers and designers. Three hands-on activities build understanding of the role of engineering and design in producing effective solutions to real world problems.	Activities: *1A: Build a Better Paper Clip* students carefully examine the form and function of standard paper clips. Given a set of wires and tools, they are challenged to design a new paper clip that meets predetermined requirements. This design challenge provides a firsthand connection with a 10-step design process that is introduced in a group activity, *1B: The Design Process*. The design process forms the foundation for work on students' own projects, and each step is revisited in greater depth in subsequent sessions. In the final hands-on design activity in this session, *1C: Toothpaste Cap Innovations*, students examine a designed solution to the problem of conventional screw-top toothpaste caps as they walk through the steps of the design process. Key Concepts: ***The Design Process***	What is the first step… Which of the following is not a step… Which of the following is a step… How many steps are there… Put the following steps in the correct order

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2: This session builds appreciation for the designed world around us and prepares students for finding a design and engineering project. Students develop skills by thinking creatively about designed things they use. They also learn to identify problems that lead to opportunities for new design solutions.	Activities: In the first activity, *2A: Potato Peeler Upgrades*, students learn about and practice a seven-part creative technique for improving existing designs known as SCAMPER. They follow the exercise with a short reading about market research on potato peelers. The next activity, *2B: SCAMPER and Backpack*, reinforces generative thinking using the SCAMPER technique with another object, a backpack. The final activity in this session, *2C: Design Opportunities Are Everywhere*, is the first step of students' project development. It involves introducing the Activity Mapping to help students identify problems, and involves a short field trip or walking tour to practice recognizing problems and needs around them. Key Concepts: ***SCAMPER*** ***Activity Mapping*** ***Brainwriting***	What does SCAMPER stand for? Which of the following is an example of Substitute? Which of the following is an example of Combine? Which of the following is an example of Adapt? Which of the following is an example of Minimize? Which of the following is an example of Magnify? Which of the following is an example of Put To Other Uses? Which of the following is an example of Eliminate? Which of the following is an example of Rearrange?

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3: In this session, students learn about the principles behind materials selection. Like materials engineers, they learn to differentiate and select materials based on their properties.	Activities: In *3A: Properties of Materials*, students test samples of metals, ceramics, polymers, and composites to compare their properties. In *3B: Materials Application*, students apply their knowledge of material properties to solve real-world problems faced by materials engineers. In *3C: Materials Choice*, students gain an understanding of the economics of material selection through a cost analysis of a beverage container made of different materials. Key Concepts: ***Materials Classes*** ***Materials Properties*** ***Material Cost*** ***Materials Recycling***	The four classes of materials are… Aluminum is an example of a metal (T/F) Glass is an example of a polymer (T/F) Plastics are polymers (T/F) Density means… (T/F) Thermal Conductivity means (T/F) If we talk about the how the material degrades in the physical environment… Which factor does not impact how much a material costs? Match the type of plastic with its correct code Which of the following cannot be recycled

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4: In this session, the participants work in pairs to explore electricity basics. These pairs can remain the same throughout the session or change with each activity.	Activities: *4A: Basic Electrical Concepts in a Flash* reviews simple circuitry using a common household item: a flashlight. The goal is to prepare them for any electrical circuitry that they may need to incorporate into their own projects later. In *4B: Turn It On and Off*, students learn the differences between a simple, series, and parallel circuit. Activity *4C: Short Circuits*, students learn about short circuits and the relationship between resistance and the current. In *4D: Light-Emitting Diodes*, students make their favorite numbers light up with an LED display. With each activity in this session, the students learn different electrical symbols and use the symbols in drawing diagrams. Key Concepts: ***Circuit*** ***Conductor*** ***Series / Parallel Circuits*** ***Ohm's Law*** ***Breadboard*** ***Short Circuit & Fuses*** ***Switches*** ***Diodes*** ***LED***	Match the following symbols with what they represent Select the diagram that would make the bulb light up What is a breadboard used for?

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5: Students explore the mechanics of simple machines and then apply what they learn to make a mechanical toy of their own design.	Activities: In *5A: Design, Build, Make It Go*, students make rolling toys from a set of everyday materials in a mini-design challenge, and then recall prior experiences with simple machines. To understand that most machines are made of many smaller machines, students study the component machines in a lawnmower through a Web-based tutorial, in *5B: Not-So-Simple Machines*. The activity *5C: Gears, Cranks, Crankshafts, and Belts* is an exploration of gears, cranks, crankshafts, belts, and culminates in the design, conceptual drawing, and initial construction of a mechanical toy. Key Concepts: ***Simple Machines*** ***Compound Machines*** ***Potential Energy*** ***Kinetic Energy*** ***Friction***	Match the simple machine in the list on the left with the definition on the right A jar lid is an example of a… An escalator is an example of a… Match the compound machine in the list on the left with the definition on the right

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6: This session places students in the shoes of both engineers and product designers as they apply analytical skills to understand how the requirements of a product are met—in this case, a clock.	Activities: In *6A: Clocks Of All Varieties*, students look closely at the clocks and as a class come up with design requirements for clocks. In *6B: Form Meets Function*, they see how the requirements are met in different clock radios as they consider form and function. The activity *6C: Tick Tock: How a Clock Works* has the students disassembling the clock radios to see how the electronics and mechanics work to make a clock "tick." Key Concepts: ***Design Requirements*** ***Design Specifications***	Distinguish requirements and specifications given examples

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7: In this session, students revisit and refine their broad list of problems, needs, and improvement ideas (started in Session 1, *Jump Into Design*) to identify one design opportunity as their project. They use a variety of observation and data collection strategies to consider what exactly needs fixing, developing, or improving	Activities: In the first activity, *7A: Revisit*, students revisit their list of design opportunities started earlier in Session 2, *The Designed World*. Here, they develop the criteria for choosing a problem to pursue. In *7B: Research and Refine*, students refine their list of problems and conduct market research by gathering information about the nature of the problem. The SCAMPER brainstorm technique is used in *7C: SCAMPER to Solutions* to help students begin to think about the solutions for the design opportunity. Key Concepts: ***Product Research***	The purpose of product research is to understand how to refine your design problem Which of the following is not a method of conducting product research…

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8: In preparing a design brief, students refine and focus on a problem to solve from the perspective of the users' needs. They write a problem statement, a description of the context for the problem, and a proposed solution. They also draw a sketch of their idea, and come up with suitable materials for constructing a solution. To introduce a design brief, they look at the design brief of a former *Design and Discovery* student.	Activities: In the first activity, *8A: Sample Design Brief*, students read and discuss the parts of the design brief as a group, analyze the sample, and think about writing their own. In the second activity, *8B: My Design Brief*, students prepare their own design brief. In the next activity, *8C: The User*, they delve deeper into who the users of the product will be and how they will design the product to meet the users' needs. The final activity in this session, *8D: Mentor Matching*, gives students the opportunity to consider their mentor needs so that an appropriate mentor match can be made. Key Concepts: ***Design Brief*** ***User Considerations***	Information about the typical user of your product should be included in the design brief (T/F) Information about how to sell the product should be included in the design brief (T/F) A quick sketch of your design should be included in the design brief (T/F)

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9. This session involves online research using computers with Internet access. In this session, students plan out one of their design solutions by following Steps 5 and 6 of the design process.	Activities: The first activity of this session, *9A: Invitation to Invent*, exposes students to inventors and inventions throughout history, to see how others applied creative thinking to solve problems. In the second activity *9B: Patents*, students use the U.S. government's official patent Web site to dig into the world of patents, looking for products that might be similar to their idea. This helps them refine their solution. In the third activity, students visit the Web site, *HowStuffWorks*, which provides them with online tutorials about the inner workings of things. Key Concepts: ***Patent*** ***Trademark*** ***Copyright***	If you wrote a book, you would protect it by getting a… If you designed a symbol for your product you would protect it by getting a… If you designed a new product, you would protect it by getting a…

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10. This session uses the mechanisms of a bicycle to help students think about the systems in a product that must be designed. It offers student engineers a strategy for tackling a complex solution that they might have in mind. It provides practice with breaking big ideas into manageable, designable parts by identifying systems and/or components that need design and engineering.	Activities: In the first activity, *10A: Systems and Synergy*, students learn the difference between systems, components, and parts as they identify them on a bicycle. The second activity, *10B: Sum of the Parts*, involves a field trip to a bike store or a demonstration on a bicycle's systems, components, and parts. Key Concepts: ***System*** ***Subsystem*** ***Component*** ***Part***	Match the term on the left with the definition on the right Match the pieces of a bicycle on the left with the terms on the right

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11. In this session, students refine their design efforts with product requirements and drawings. By the end of the session, students have a more fully developed project, and are ready for the next steps, modeling and testing their ideas.	Activities: In *11A: Checking in on the Design Process*, they look at a checklist of steps that follow the design process to determine how far they've come, and look ahead to the next steps. Next, in activity *11B: The Perfect Fit: Meeting Needs Through Design*, students learn how a designer considers the needs of the user to define minimum requirements for a design, and students then develop design requirements for their own projects. In a third activity, *11C: Conceptual Drawing: Thinking on Paper*, students learn how drawing helps the thinking process, then put pen to paper to make a series of conceptual drawings. Key Concepts: ***Orthographic Sketches*** ***Isometric Sketches*** ***Oblique Sketches*** ***Perspective Sketches***	Match the kind of sketch on the left with the definition on the right Engineers make different kinds of sketches to help refine designs (T/F) Most engineers make their sketches with a pencil and paper (T/F) Match the sketches on the left with the names of sketches on the right

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12. This session prepares students for building models and testing systems or components of their design project. This is Step 8 of the design process.	Activities: This session prepares students for building models and testing systems or components of their design project. This is Step 8 of the design process. In an opening activity, *12A: Thinking Again About Design*, students review their experience of the design process and think about their revisions up to now. They see that the design process is not linear; there are cycles or iterations of review, testing, revision, and change. In the second activity, *12B: Materials and Modeling Plans*, students survey available materials for constructing models and plan their first constructions. In the final activity *12C: Structural Considerations*, students learn about collapsible objects and the principles of collapsibility. They then review structural considerations related to storing, moving, and assembling their projects. Key Concepts: ***Model*** ***Prototype***	Models and prototypes help engineers to see how a product will look (T/F) Models and prototypes help engineers to test components (T/F) A model is a visual representation of a product that doesn't have to work like the real thing (T/F) A prototype is a working representation of a product (T/F)

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13. Students' design projects move to the tangible and testable. This session provides time to build and test models of components, systems, or the product itself. This is a session where mentors can support students' work and help them take time to reflect on results and be thoughtful about appropriate next steps.	Activities: In the single activity for the session, *13A: Making Models*, students are encouraged to be methodical as they build and report on their models, tests, and results in their design notebooks. Key Concepts:	

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14. In this session students begin planning how they will construct their prototypes.	Activities: In *14A: Prototype Planning*, prototypes are reintroduced as students strategize plans and create their specifications for developing a prototype. In *14B: Prototype Materials*, students consider what materials they will use to develop their prototypes. Finally, in *14C: Budget*, they use a spreadsheet program to develop budgets for the project. Key Concepts:	

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15. Student designers' ideas take on new forms as they develop their prototypes. These should be working prototypes with full functionality. Of course, students may find that as they refine and test their ideas they develop several working prototypes.	Activities: This session has one activity, *15A: Prototype Work Session*, devoted to prototype development. Key Concepts:	

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16. Being an engineer requires trial and error! Students learn this as they continue with the design process: Step 9 Build the Prototype and Step 10 Improve Your Solution: Test, Evaluate, and Revise. As they develop working prototypes, students test and evaluate the prototypes for function, feasibility, safety, and aesthetics, and make modifications. This process of testing and modification continues until they have a final working prototype.	Activities: In the first activity, *16A: User Testing*, students gather feedback from users as they try out their ideas on an audience. In*16B: Evaluation and Revisions*, they consider the feedback from the user testing and prioritize the revisions. Key Concepts:	If an engineer designs a product well they don't have to revise the design (T/F) Without a test of the product, an engineer won't know how well it works (T/F) Sometimes an engineer has to revise and test a design several times before it works properly (T/F)

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17. *Fairly There* helps students prepare for the fair. Before beginning the session, facilitators should read through the session and decide what type of fair they wish to have the students do: a Solutions Showcase or a Mini-Engineering Fair. They should also familiarize themselves with the Intel International Science and Engineering Fair (Intel ISEF).	Activities: In the first activity, *17A: Fair Choices*, students learn from past fair participants and an engineer about the benefits of participating in a science fair. This introduces fairs to the students, and they organize committees to begin planning for the event. The second activity, *17B: Design Your Display*, is a work session where students prepare display boards for the fair. Key Concepts:	

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18. Get ready for the big event!	Activities: In this session, students plan their presentations in *18A: Presentation Prep* and practice them before their peers in *18B: Take One!* Friendly feedback from peers helps students further refine their presentations and get ready for the fair. In *18C: Fair Logistics*, the final details are worked out, and the venue is prepared for the fair.	