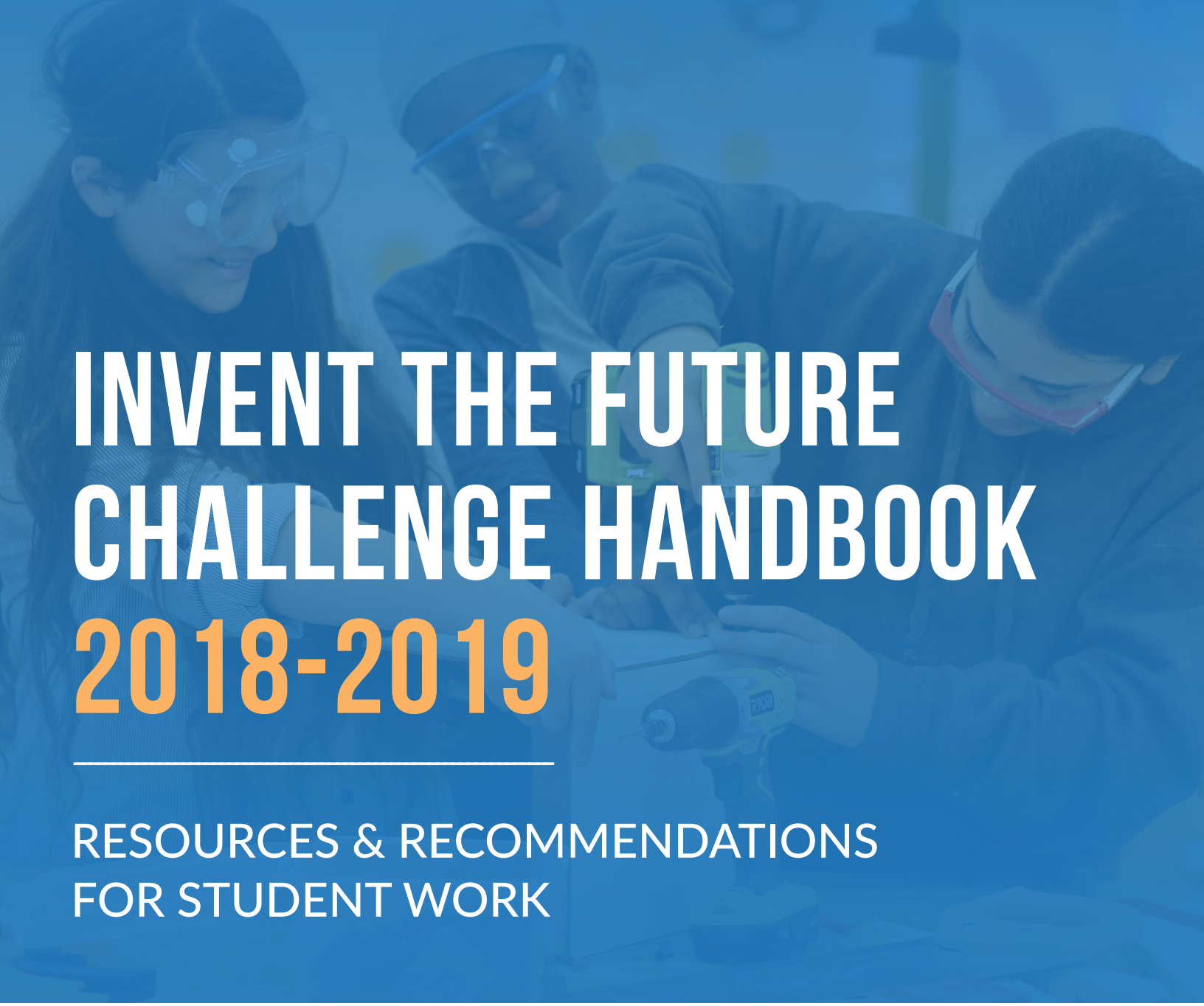

INVENT THE FUTURE CHALLENGE HANDBOOK 2018-2019

RESOURCES & RECOMMENDATIONS FOR STUDENT WORK

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For schools participating in Invention Studio, a series of skill-building workshops that help prepare for the Challenge, there is work that can be done at school prior to each visit to help maximize the time spent at KID Museum. For schools not participating in Invention Studio, these activities will help students progress through the challenge.

BEFORE INVENTION STUDIO VISIT 1:

GROUPS SHOULD COMPLETE:

Introduce the Invent the Future Challenge by viewing this video:
https://www.youtube.com/watch?v=lyolrlkz01Q&feature=youtu.be

LANGUAGE FOR STUDENTS:

- The Invent the Future Challenge is a chance for you to work with a team to design, develop, and prototype an invention that answers the Challenge Question: What will you make to protect life on this planet?
- In a team of 3-6 people, you will collaborate to build a physical prototype that illustrates your solution to the challenge question. Throughout the year, you will go through a process of designing prototypes, building them, testing, and building them again as you continue to refine your ideas.
- On May 11th, your team will showcase your prototypes and ideas at the Challenge Summit. You'll have the opportunity to share your inventions with the whole community, and present them to panels of experts. The Challenge Summit is a celebration of the awesome work you'll do throughout the year, and a chance for all of you to show everyone how you will Invent the Future.
- Invention Studio Overview: We will be doing work on this throughout the year in school, but also participating in Invention Studio at KID Museum:
  - » 5 visits to KID Museum
  - » Design, engineering, electronics, coding
- KID Museum is a different kind of museum, a makerspace, where we will do hands-on workshops and learn about design, engineering, woodshop, and electronics.

GROUPS ARE ENCOURAGED TO COMPLETE:

Discuss the importance of documenting the design process throughout the whole experience.

- What does it mean to document a process?
- What are some strategies for documentation?
  - » Writing, drawing, taking photos

ACTIVITY:

In groups of 4–6 students, conduct a mini design challenge.

For example: In 10 minutes, design and build something to get a ball to cross a distance of approximately 6 feet without touching it. You can launch, roll, slide, make a chain reaction, or trigger a machine, but not touch the ball itself.

- Using a limited set of common and inexpensive materials, build a solution to the above challenge: Sample materials could include masking tape, paper, straws, popsicle sticks, rubber bands, paper clips, plastic cups, etc.
- Assign one documentation strategy to each group (ex: only writing, only drawing, only taking pictures). During the 10 minutes, each group must document their work and try to answer the following questions:
  - » What did you make?
  - » How did you make it?
  - » What materials did you use?
  - » Who did what?
  - » Were there any challenges? Solutions to those challenges?
  - » Were there any improvements or changes to what you built?
- At the end of the mini design challenge, share out and reflect on each documentation strategy. Groups can swap their documentation with another group and try to figure out the process, or have a whole group discussion.

As a group, reflect on the experience and brainstorm a list of other ways to document your own work throughout the Invent the Future Challenge?

MAIN TAKEAWAYS:

- The most effective methods of documentation likely incorporate more than one of these strategies!
- How are we going to use this throughout the year? Why do we not wait until the end to document our work?
- The goal is to be able to communicate your whole process, not just your final product. We want to share and explain each step along the way, and documenting throughout is the best way to do that.

INVENTION STUDIO VISIT 1: DESIGN & ENGINEERING

Concepts Covered:

- Design as a tool for communicating ideas
- Iterative Design Process
- Making prototypes to help convey ideas to other
- Using basic tools and materials to build prototypes

BEFORE INVENTION STUDIO VISIT 2:

GROUPS SHOULD COMPLETE:

1. Make TinkerCad Accounts

At KID Museum, students will be using TinkerCad, a free online resource, to build circuit diagrams and code. **Each student should make a TinkerCad account before Invention Studio Visit 2: Electricity & Circuits.**

2. Review the Design Process

- During Invention Studio Visit 1, we discuss an Iterative Design Process: **Define, Develop Solutions, Optimize**.
- Facilitate a discussion about this cycle. Why do we repeat this process multiple times? How does this repetition help us throughout the process of creating our projects? Important points include:
  - » Identifying problems with our solutions and prototypes
  - » Improving designs and prototypes
  - » Refining ideas
- Emphasize that students aren't working toward one "final" project. They will make a series of prototypes that improve on their solution.

There are many ways to lay out the steps of a design process. One way, the Human Centered design process, includes the following steps: **Empathize, Define, Ideate, Prototype, Test**

- Human centered design helps us identify the needs of the audience (people) that our invention will impact.
- Empathy is a crucial step in this version of the design cycle. The "empathize" phase involves engaging in research with the goal of understanding a problem from the intended audience's perspective. This work leads us to defining a specific and narrow problem that has opportunity for creative and actionable solutions.
  - » For example, if the problem is: very few people in a school are recycling. One solution might be to provide more recycling bins.
  - » Instead, if we ask why people are not recycling, there is more opportunity for creative solutions that address the same problem. We might identify that the real problem is that people do not know what to recycle, and we would solve that problem in a different way.

3. Brainstorming Potential Problems

Individually and as a group, students should begin brainstorming lists of problems that need solving. Use the following questions as guidance:

- What are environmental problems that affect me?
- What are environmental problems that affect my community?
- What are environmental problems that are important to me? Why are they important to me?

Remember that brainstorming is about quantity over quality. Students can write down anything that pops into their head.

Please use these tutorials from TinkerCad in order to get students signed up with their own accounts.

- **Inviting Students to TinkerCad as a Teacher:**
  https://tinkercad.zendesk.com/hc/en-us/articles/115012665408-As-a-teacher-how-do-I-invite-students-to-use-Tinkercad-
- **I'm a Teacher, how do I get my students signed up and approved?**
  https://tinkercad.zendesk.com/hc/en-us/articles/226566228-I-m-a-teacher-how-do-I-get-my-students-signed-up-and-approved-
- **Video Tutorial:**
  https://www.youtube.com/watch?v=EEg5cfIHAOo
- **TinkerCad Webinar:**
  This webinar is an in-depth overview and introduction to TinkerCad. We recommend specifically the section between 15:45–28:00, where they walk through the registration process for teachers and students step by step.
  https://www.youtube.com/watch?v=XSd_d8FRS0A&list=PLV6cmKvnKRs4I7FF0kieb84rl3C3L2sbS

GROUPS ARE ENCOURAGED TO COMPLETE:

1. Affinity Mapping

In small groups or as a class, take all of the potential problems that were generated in brainstorming, and try to sort them into categories of students' own choosing. Using themes and similarities that arise from the group of ideas, define the categories and groupings. These categories will show major areas of interest and importance. This can be used as a "short list" of problems that need to be addressed.

2. Review Markers of Success and Rubric

All students should be very familiar with the rubric before they begin substantive work on the Challenge. It will provide guidance and priorities for success.

INVENTION STUDIO VISIT 2: ELECTRICITY & CIRCUITS

Concepts Covered:

- What is a circuit? What can circuits do?
- Tools & Skills: Heat shrink, breadboarding, TinkerCad circuits

BEFORE INVENTION STUDIO VISIT 3:

GROUPS SHOULD COMPLETE:

1. Students should identify and define a set of problems that they could solve. They don't need to select one yet, but they should have a few substantive ideas.

- Do these problems satisfy the Markers of Success?
- Are the problems narrow enough to solve feasibly?
- Is there aneed for the problems to be solved?

In order to define and select these problems, encourage students to:

- Research the problem to see if others have tried to address this problem. If so, have previous solutions been effective? Could you improve upon an existing solution? Is there a more specific version of this problem that you could solve?
- Research the environmental impact this problem causes. Have those problems been solved? If so, how?
- Talk to others to see: How does this problem affect other people? How might a solution to this problem benefit people or the environment? If you can, ask experts in the problem's field for their take on the problem.
- Think about: What science have you learned in or out of school that helps you understand this problem?

2. Review Markers of Success and Rubric

- Students should spend time reviewing the rubric and discussing what it means for their project. Options include: developing examples, matching criteria to categories, evaluating an old project.

GROUPS ARE ENCOURAGED TO COMPLETE:

1. Practice TinkerCad circuits
https://www.tinkercad.com/learn/#/learn/project-gallery;collectionId=OIYJ88OJ3OPN3EA

2. Journey Mapping Exercise

- In small groups, choose a problem or area of focus. For example: recycling items in cafeteria.
- In about 15 minutes, write AND draw each step of the process that is a part of that problem. Use index cards or sticky notes. Drawings and notes can be simple and imperfect, but encourage students to be as detailed as possible in defining steps! Every little step is important. For example: (1) Finish eating lunch. (2) Stand up from cafeteria table. (3) Walk away from table with tray. (4) Stop to talk to friend at different table. (5) Bell rings. (6) Run to trash can. (7) Throw away everything into trash can. (8) Rush to class.
- Put each action in order. Add any steps that might have been left out and assess the process as a whole.

Reflect on the processes that the small groups created. Have students discuss the steps and identify pain points, parts of the process that are causing it to be problematic.

- Are these pain points problems that could be solved? Why are these steps problematic? Who are the people that are impacted? What is the impact beyond those people?

3. Form Teams

- Teams must be between 3-6 students. Team formation could be based on:
  - » Interest in problem or topic
  - » Friends and social dynamics
  - » Grade level
  - » Technical skill interest or experience (woodshop, design, electronics, coding, etc.)
  - » Combination of these factors

4. Set goals and norms as a group.

- While students will be using the Markers of Success and rubric in order to set priorities for their work on their solution and prototype, it might also be beneficial to set group goals around KID Museum's Mind of a Maker framework.

- This is important to help students develop more personal motivation and recognize deeper kinds of success. A crucial part of the Challenge is that students persist through failure, work collaboratively on teams, and explore new ideas. While this is captured in the rubric to some degree, it may be helpful to specifically call out these competencies and have students set personal and group goals for how they can grow through this process.

INVENTION STUDIO VISIT 3: SENSORS & CODING

Concepts Covered:

- What is a microcontroller?
- Sensors
- Coding in TinkerCad blocks and Arduino
- If statements and for loops

BEFORE INVENTION STUDIO VISIT 4:

GROUPS SHOULD COMPLETE:

1. Form teams.

If students are not yet on teams of 3–6 people, they should form teams before choosing problems and developing solutions. Collaboration is a very important part of the Invent the Future Challenge, and it is important that students are working collaboratively at this point. The rubric provides some specific criteria for team collaboration.

2. Select a specific problem to solve. Students should:

- Practice explaining the problem and why they chose it
- Go through the rubric *Idea* section with their chosen problem. Does it satisfy all the criteria? If not, how can it be improved?
- Ensure that the whole team has input on the selected problem. Is every student involved in the decision making process in some way?

GROUPS ARE ENCOURAGED TO COMPLETE:

Students can begin shifting into the Ideate/Developing Solutions phase of the Design Process

- It is likely that students have begun to think through possible solutions throughout the process of choosing a specific problem. Students should be considering the research they have done about possible problems and existing solutions to those problems when developing their own original solution.
- Once all students on a team understand and are comfortable with the selected problem, they should all have the opportunity to brainstorm a variety of solutions. Even if students feel like they have a strong idea already, encourage them to brainstorm other solutions. They might be surprised with what they come up with, and even incorporate more than one idea into their prototype.
- Students can do similar brainstorming exercises to those from the problem definition phase in order to develop innovation ideas for solutions to their problem.

Example brainstorming strategies:

- Have each student write and/or draw 3-5 different ideas. Then, have other teammates add to and elaborate on those ideas. Continue this process until multiple students have had the opportunity to contribute to the same idea. Do any of the collaborative ideas have similarities? Are there some that are more practical, exciting, or original?
- Have each student on the team develop a solution by thinking about the problem from a different perspective. For example, if the problem is students not recycling in the school cafeteria, have one student develop solutions as a student, another as a teacher, another as a building services staff, and another as the principal. How do these different perspectives impact the kinds of solutions that are developed?

As solutions are developed, keep in mind the following:

- How do the solutions meet the rubric criteria? How can you use the rubric to continue to refine and improve the solution?
- What skills have we learned that will help prototype the solutions? How can we represent the solution in a prototype? Will we build a model of the whole solution, a particular portion of the solution, or a combination?
- What kinds of materials and tools can we use to build the prototype?

INVENTION STUDIO VISIT 4: FABRICATION

Concepts Covered:

- Relationship between design and fabrication
- Technical Skills: Drills and power drivers
- Materials choice

BEFORE INVENTION STUDIO VISIT 5:

GROUPS SHOULD COMPLETE:

1. Students should design and develop solution ideas. If they have already done so, continue to research and refine solutions.

2. Students should figure out how they can build and communicate their unique solution.

- What are the important components that need to be communicated to other people? What pieces of this solution are most exciting to others? How can we help people understand our chosen problem, and how this solution solves that problem?

3. Students should have the following prepared for their final visit to KID Museum:

- Specific, narrow problem that the team is addressing
- A solution to that problem that the team has developed
- Sketches, plans, and ideas of the prototype the team wants to build
  - » Students should understand if they are building a prototype of the whole solution, a model of the solution, a component of a larger invention, etc.
- List of possible materials to use in building the prototype (wood, cardboard, recycled materials, electronics, Arduino board, etc.)

GROUPS ARE ENCOURAGED TO COMPLETE:

1. Students are encouraged to build early stage prototypes as they develop ideas for solutions. These can be out of simple materials (paper, masking tape, popsicle sticks, etc.)

2. They are also highly encouraged to take advantage of TinkerCad circuits! They can create and test, circuits, sensors, and code. Students can decide whether to present their digital models or create physical prototypes of their circuits.

3. Students can get feedback from others including teachers, STEM professionals, and other relevant experts on their ideas and prototypes. Seeking and incorporating this feedback is an important step in the design process.

*Building several simple prototypes will help students visualize their ideas. Once they have something tangible, they will have a better sense of what to build at KID Museum and how to improve upon their protytpes.

INVENTION STUDIO VISIT 5: RAPID PROTOTYPING

Concepts Covered:

- Why do we build prototypes?
- Rapid prototyping is a technique that can help work out design ideas and issues quickly and cheaply
- Building prototypes using tools and materials that we have learned throughout the year

BEFORE CHALLENGE SUMMIT:

GROUPS SHOULD COMPLETE:

1. Students should continue to test and refine their built prototypes. Student should also try to get feedback from others on their ideas and prototypes. They can share their ideas with other students, teachers, community members, etc. It is also a good idea to talk to people who are impacted by their chosen problem.

2. Prepare to present at Challenge Summit

How can students present their work to others?

- What is most compelling about the project?
- How will you communicate the ideas to others?

What does the team need to practice or create for the Summit?

- Will the team utilize visuals? Poster, slideshow on laptop, handout, etc.
- Does every team member understand all aspects of the problem, solution, and prototype? Everyone should be prepared to discuss these points.
- Review the rubric: each team member should understand and be prepared to discuss how their project satisfies the criteria.
- Does the team have documentation of their process throughout the Challenge? Teams must show evidence of their design process including brainstorming, developing solutions, prototyping, and testing.

It is important to remind students that their projects do not need to be "finished." The Summit is an event at which they should present their **process** and share ideas of how they could **continue to improve their prototype.**

GROUPS ARE ENCOURAGED TO COMPLETE:

Rubric Self-Assessments

- Students should try looking at their project as if they don't know anything about it. They can even have one team member be the "judge" and another be the "presenter". Students should try to rate their project honestly on the rubric, and then use those results to continue to refine and elaborate on their project.