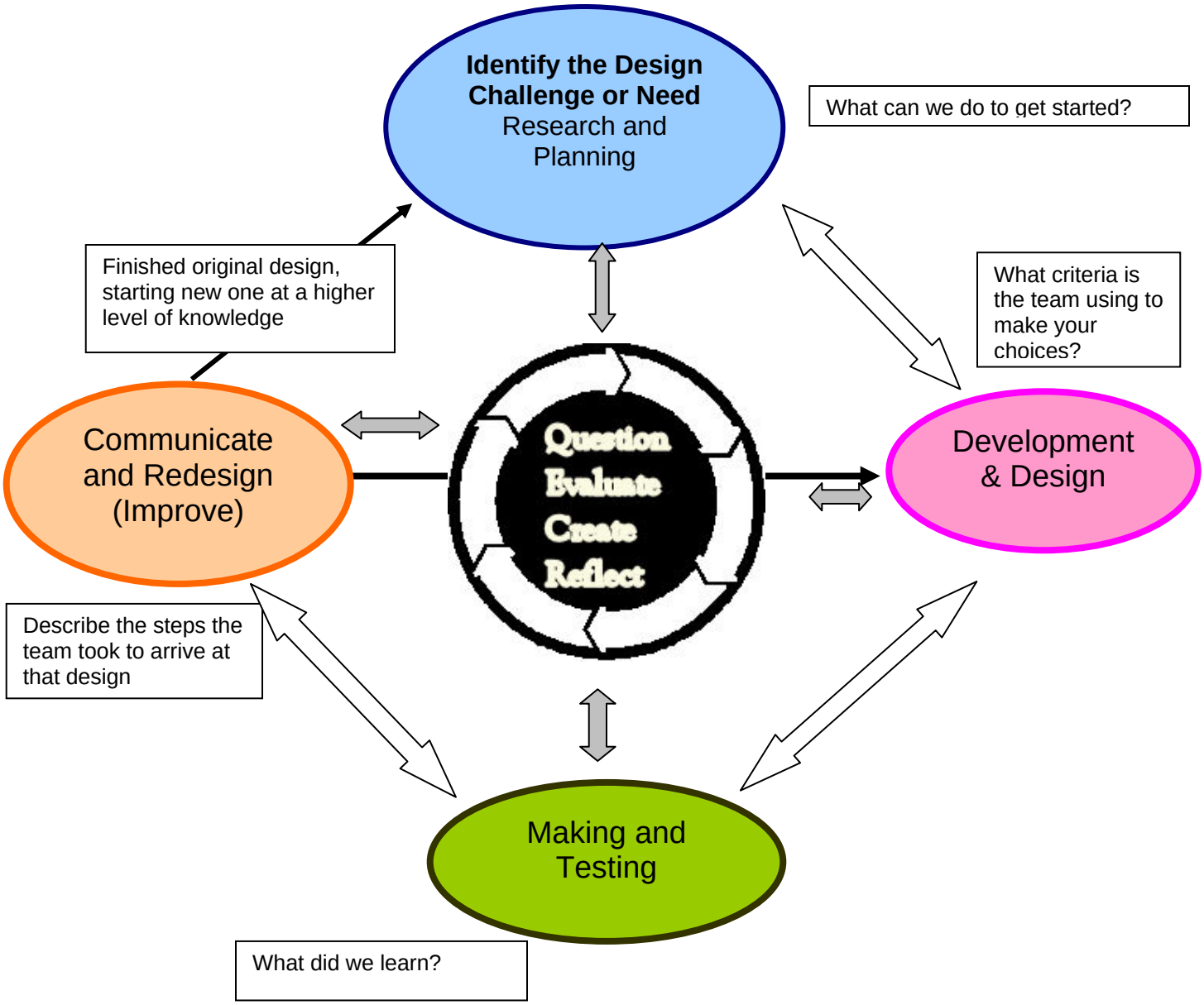
Model of the DESIGN PROCESS…

Rev	Description	Approval	Date

Engineers design useful products and processes for society based mainly on science and mathematics.



Title:	**Engineering Design process**	
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Author	Jenny Craddock/ Bill Wolfson	

Teachers Page

Our students live in a world surrounded by technologies, products of engineering design. There is a process that is used to develop and refine technologies to meet needs or solve a problem. This is named the engineering design process. As a thinking process it is similar to the writing process, where in collaboration with peers and teachers students revise and refine their work through testing (work is read), evaluation (editing) and revision.

The engineering design processes is cyclical, and is a learning process that uses creative and critical thinking skills to design technologies to solve a problem or fill a need. Ideas are generated that are responsive to the problem statement. One example is that in this process, it may be learned that the problem begin solved is not the right problem. So you go back to requirements. Another example could be that a prototype is developed, and at that point it is clear that the conceptual design is wrong. So the process returns to the design phase again.

For teachers as facilitators of learning, the engineering challenges are used as a generator of questions. The engineering design process is a great place to create "structured controversy" in student discourse, with the teacher modeling questions with more than one right answer.

Questions, evaluation, reflection and communication and are at the heart of the process. In each step, engineers evaluate what they are doing and communicate in drawings and words as well as in discussions, their ideas. These are then used in discourse with colleagues to present and evaluate the design solutions to the problem statement.

Identify the need or problem.

People often think of giving engineers a problem, and then asking the engineer to come up with a solution. But design is not just about taking a problem statement and coming up with requirements and specifications, it is also about deciding what the problem is; communicating and evaluating the problem statement and refining it so that it is clear they are addressing the right problem, and craft a revised problem statement. Next they write a design challenge description. The students have to be part of the design challenge description.

Research the need or problem.

Questions are generated to inform the design plan. Who are the customers of this design? Have you had a conversation with them (even if they are characters in the story**)?** Have you determined credibility of the source? Have you thought about costs to do this and the necessary time needed? Why is this, the design we need to do? Again, at the heart is evaluating what is the need or problem to be solved and communicating the research to answer these questions.

Develop (Identify) possible solution (s).

As the design is proposed, one way to test it is to make prototypes in order to learn about the design; to that extent, making quick-and-dirty prototypes of more than one concept is often a good idea during this phase. Modeling is used in science and in engineering to try out an idea – a way of testing. What science would the students know or is planned to be learned that could be integrated in this design? How can the science inform the design plan and the design plan be an application of the science?

Select the best possible solution(s).

Communication and evaluation are at the heart of the process. Each group presents their design and through discourse, they determine the best element(s) of each design to solve the problem statement. Is there a way to combine the best elements into one design concept?

Construct a prototype.

There are many levels of prototyping, from quick sketch models to non-functional mockups to looks-like, acts-like. Decide what level will work best for your purposes.
What do you want to learn from the prototype? You're not building it for the sake of building something; you're building it to improve your design.

- Do you need to build it at each stage, or can you use a plan?
- What media do you think will best present your design?
- What way could you build it in modules and then put together?

Test and evaluate the solution(s).

Key idea here is not just to ask "did we succeed", but to ask "What did we learn / what should we change?", and then to decide how many steps "backwards" they should take.

- Look to control the variables in your test. What will you keep the same and what one element will you change? How will you measure this? How will you record this data?
- Focus on using data to justify decisions and conclusions.
- Have we written the test plan and planned a way to record the results? (illustrations, notes, tables with data, graphs from the data)
- What resources do you think we will need?
- What do we think we can learn for this evaluation?
- What things happened that we did not expect, what surprised us?
- Why do we think this happened? What do we think this tells us?

Communicate the solution(s).

Make an engineering presentation that includes a discussion of how the solution(s) best meet(s) the needs of the initial problem, opportunity, or need. Discuss societal impact and tradeoffs of the solution(s). How have you used the science that underlines the constraints of the design challenge?

Redesign.

Overhaul the solution(s) based on information gathered during the tests and presentation. Like revision in the writing process, the engineering evaluation could continue on and on! This can be a place for students to reflect on the process and review their recording of their work.

- What did they used to think and what is their thinking now?
- What helped them to change their thinking?
- How was that helpful?

Design Process / Thinking Skills	Example Questions
Identify the need or problem • Identify/ recognize • Claims and evidence • Illustrate/ explain • Creative thinking • Classify/ categorize	What do we notice about the problem that can give us clues on a way to design a solution? How would we describe the need (of the character) in the story? How do we think we can describe the problem to be solved? Can we break the problem/need design into parts?
Research the need or problem • Classification • Sequencing • Comprehension	What do we think we know? What are we not sure about? What do you think we should ask questions about? What evidence do we have to support that is true? How do we could check for evidence to support that as true or

• Analysis • Evaluation	as a “fact”?
Develop possible solution (s) • Brainstorm (creative thinking) • Root Cause • Distinguish • Analysis • Claims/ Evidence	Can we think about all the things the design has to do so we can create a list? Have we taking all assumptions, thoughts into consideration? What do we need to understand about (*can be specific*) science to apply to this design? How can we use the (*can be specific*) science we understand to build this design?
Select the best possible solution(s) • Compare / Contrast • Classification • Evaluation • Drawing Conclusions • Problem Solving	How do we think it meets all the requirements of the design? What would happen if…? Is there a way we can test the solution so we can provide information about the design? What do we notice might be a problem with the design plan? What else could we do to solve this problem?
Construct a prototype • Classification • Claims and evidence • Model/ Illustrate • Explain • Drawing Conclusions • Problem Solving	Does the team think we need to build it or can we build a model? What materials, skills & tools do we need? What ways could we use to test the materials to know what ones are best? How can we record the design and the design plan? How can we record any changes we make to the design and the design plan?
Test and evaluate the solution(s) • Compare / Contrast • Classification • Evaluation • Claims/ evidence • Drawing Conclusions • Problem Solving • Brainstorm	What ways could we use to test the plan? Do you think we need to evaluate the design? When we test, what should we be keeping the same? What is the one that are we changing? (Variable)? What tools do you think we need to test it? How can we design this solution so we can easily reproduce it? How has our thinking change about the design solution/ solving the problem? What have we learned by testing?
Communicate the solution(s) • Compare / Contrast • Classification • Claims/ Evidence • Drawing Conclusions	Who are our audience and what are they expecting to hear? Do you notice any conclusions or facts we have not tested? Is there anything we could change so everyone can understand the ideas we have? Do you think we could use graphs or tables to show our results? How could we revise this to make it clearer to the audience?
Redesign • Compare / Contrast • Classification • Drawing Conclusions • Reflective thinking	What does the team notice we have learned? What do we could do differently? What was our thought process? What did you used to think and what do you think now? What did you notice was helpful to you in this process?