This is a low-resolution printable version of the teacher-presentation information. The original PowerPoint slides are clearer and animated to assist the teacher in delivering quality content to the students.

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Licensed users of the EST Foundations curriculum have access to:

- the original animated PowerPoint files
- accompanying handouts
- detailed homework assignments
- lesson plans including online reading and research assignments, and
- suggestions on integrating this project-based curriculum.
Topic 2 (ver 1.0) Basic Project Skills-Design Method

Content of this module

- Bell Work 2.1
- Project Planning discussion
- Project Planning group exercise
- Bell Work 2.2
- Discussion of steps in our design process
- Comparison to other design methods (will require handouts)
- Bell Work 2.3
- Group exercise to apply design steps
- Bell Work 2.4
- Group exercise to prepare for group presentation
- Bell Work 2.5
- Students make group presentations with visual aids (4-6 minutes each)

Bell Work 2.1

(Always start a new Journal page for each day. It is o.k. for you to write on the back of the pages. Record the question or task and your response in your Journal.)

- Review the handout on Journal Format and prepare for taking notes in today’s class. Modify previous Journal entries to conform to the proper format as time allows. (Remember, Journals will eventually be graded.)

Today’s Agenda

- Discuss the terms:
  - Project
  - Project Plan
  - Project Life-Cycle
  - Phases of a Project
  - Deliverable
- Develop a project plan for a team project

Project Life Cycle for New Product Development

“New Product Development” is an industrial term for the complete process to bring a new product to market. As with any discrete endeavor, it is a project.

The term “Project” has also come to have special meaning in industry.

A Project is a temporary endeavor with a specific goal to generate some new product or service. (Sound just like “New Product Development”?)

In industry, “Project Managers” are valued experts who know how to initiate, plan, execute, control, and close a project effectively. In fact, “Project Management” is a rewarding technical career of which students should be aware.

Every Project is unique and has a unique set of phases that can be defined. Each phase should be marked by a tangible deliverable.

A “Project Plan” defines every aspect of the project’s entire life-cycle. This plan defines the beginning and end of a project.

Are we doing “New Product Development” or a project?

- I thought we were just building a robot!...
- Well, this is all true...but we might as well learn something as we go.
- “New Product Development” has two parallel aspects.
  - Product Engineering
  - Marketing Analysis
- Designing and Building a working robot are only two phases in the “Robot Development Project” that your team is engaging in.
- ...and we are really engaging two projects:
  - The Robot Development Project
  - The Robot Marketing Project (whose first active phase is “marketing analysis”) which should influence the type of product being developed.)
Robot Development Project: Example Phases and Deliverables

Deliverables:
1. Detailed life-cycle description including timelines, charts, and checklists
2. Organization chart with defined responsibilities for all team members
3. Clearly defined need (including function, structure, and required test performance), documented alternatives, concept that best addresses the need
4. Clearly defined need, documented alternatives, detailed documentation of the design that best addresses the need and the procedures to build it
5. Fully functional prototype
6. Material design and predictable performance
7. Product that has been accepted in the marketplace, team is informed, and members are ready for next assignment

Exercising your new knowledge

In groups of 3-5 students, develop a project plan to present a solution that addresses the need “kids need a convenient way to practice their skateboarding tricks.”

You group will have to make a presentation on Friday discussing your project plan (along with a design you create on Wednesday)... so do everything purposefully.

Today, only focus on your project plan:
- Define the phases and deliverables of each phase.
- Estimate the time you will need to spend in each phase. (You will be given time in class on Wednesday and Thursday... the rest is homework.)
- On Friday, every student must submit his/her own copy of the team’s project plan. It will be graded for neatness, how well you explain each phase and organization of information.

2.2 Design Methods

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Bell Work 2.2

[Always start a new Journal page for each day. It is o.k. for you to write on the back of the pages. Record the question or task and your response in your Journal.]

Silently read the handout discussing various design methods, (handout: design steps)

Today’s Agenda

Discuss the steps in the design method that we will use in this class
Relate these steps to other design methods

The Engineering Design Process

The Engineer’s role is generally centered on the phases that are colored light blue on the previous slide.
- Remember: As a trained problem solver, the Engineer only has three basic responsibilities:
  1) determine all possible solution options
  2) choose the best option, and
  3) implement the solution.
- Because this is theoretically impossible, we need a plan to do the best we can.
10 Design steps for Robotics Class

1. Identify and Define the Problem
   - Clearly define the problem before considering any solutions.
   - The source of the real problem is probably deceptive.

2. Assemble a Design Team
   - The optimum team will be different depending on how you define the problem.
   - If you want to design wider roads, then you'll need to get civil engineers and transportation experts involved.
   - If you want to make safer drivers, then you need to get training professionals involved (and maybe even optometrists).

3. Identify Constraints and Criteria
   - Some limitations are undeniable...we call these “Constraints.”
   - Resources are always limited (including time, materials, budget and personnel).
   - Some restrictions are externally imposed like it must be legal and we must finish before competition day.
   - Other “design requirements” are made by choice...what we call “Criteria for success.”
   - Like aesthetics, quality, safety, or reliability.

4. Search for Solutions
   - This is the first place to let creativity shine:
     - Can you eliminate the need by redefining the problem?
     - Try to break down all preconceived biases and self-imposed limitations.
     - Use knowledge to find more ideas (analogy in nature, analogies in other disciplines, products already on the market).
     - Brainstorming, Synectics, and other methods can be investigated online.

5. Analyze Each Possible Solution
   - Simple Calculations to see if it is possible
   - Compare power requirements to constraints defined earlier
   - Run computer simulations
   - Perhaps build simple prototypes

Important! It is often necessary to cycle through many parts of the process...sometimes many times...to get the Best Solution.
6. Choose the "Best" Solution

- Might not be the solution that is fastest, or easiest to build, or lasts the longest.
- Must consider all the criteria and find the solution that best meets ALL the constraints and criteria that you have defined.
- Criteria should be defined with some rating on their "priority".

7. Document the Solution

- All ideas and decisions should have been documented along the way. Now it is time to polish the drawings and collect everything in a design report.
- In the real world, this documentation might fill a library.

8. Communicate the Solution to Management

- What good is a solution that Management doesn’t know about or can’t understand enough to implement the solution?
- Management needs to know everything about how the solution meets the need and how much it will cost to make...
- In this class, the team coach will serve as the manager.

9. Construct the Solution

- Though minor prototyping may have been a part of the analysis steps, now it is time to commit real resources to the product.
- A more detailed prototype should be developed. This prototype must represent the most significant characteristics of the final design.
- Since it will take a lot of resources, management will have to be on board.

10. Verify and Evaluate

- Just because you went through all the right steps doesn’t mean the product works.
- Based on the constraints and criteria, a careful testing plan should be developed to simulate all significant environments and scenarios that might be encountered.

According to James Earle

- Problem identification
- Preliminary ideas
- Refinement
- Analysis
- Decision
- Implementation
According to Shigley and Mischke

- Recognition of a Need
- Definition of the Problem
- Synthesis of Ideas
- Analysis and Optimization of Ideas
- Evaluation of Solutions
- Presentation of Final Solution

According to Pahl and Beitz

- Clarification of the Task
- Conceptual Design
- Embodiment Design
- Detail Design

Class work (Teacher: Please adapt for your class)

- Divide the class into 3-4 random groups to compare the other design methods to ours:
  - Earle’s 6-step method
  - Shigley and Mischke 6-step method
  - Pahl and Beitz 4 phases of design
- Provide each group with colored paper with Earle’s, Shigley’s and Pahl’s steps listed (one color per group so you can tell whose is whose, cut all the steps apart so there is only one step on each piece of paper).
- Print out posters for our method (one step per page with very large print) and tape pages in order on the wall.
- Have students tape their colored pieces of paper under the appropriate steps. Discuss the differences of opinion as a class.

Homework

- Now that you understand the design process. Apply it step-by-step to the need “kids need a convenient way to practice their skateboarding tricks.” (This may have been modified a little by your project plan.)
- On paper write the step number and then document what you came up with for each step in the design process. (Only do steps 1-7.)

2.3 Practice With Official Design Method

Bell Work 2.3

- (Always start a new journal page for each day. It is o.k. for you to write on the back of the pages. Record the question or task and your response in your journal.)
- Silently prepare to describe your homework solution to your small group. Be prepared to defend your decision, but also be willing to adopt other ideas...
Today's Agenda

- Get into your 3-5 person group
- Each person take 2 minutes to describe their solution to the homework.
- Spend 5 minutes to discuss all the solutions and choose one single solution.
- As a group, create written descriptions and sketches to completely “explain your solution to management.”

2.4 Organizing a Presentation for Management

- Get into your 3-5 person group
- Develop the presentation that your group will make to the class tomorrow.
  - Every person must have equal share in the presentation
  - The presentation must be between 4 and 6 minutes (points taken off for shorter or longer presentations)
  - Don’t forget to open with an introduction and close with a summary
  - Visual aids must either be large posters or drawn on overheads for the projector
  - Don’t forget you are presenting your project plan AND your chosen design.
  - You will NOT be given any time to get ready tomorrow. Plan today!
- Homework: Each person should write out what they plan to say, practice it, and make sure it fits in the amount of time that the group has allotted for their topic.

Bell Work 2.4

- (Always start a new Journal page for each day. It is o.k. for you to write on the back of the pages. Record the question or task and your response in your Journal.)
- Question: Make a list of the topics that you would include in a five minute presentation on your group’s project plan and resulting design solution.

Bell Work 2.5

- (Always start a new Journal page for each day. It is o.k. for you to write on the back of the pages. Record the question or task and your response in your Journal.)
- Silently practice your part of your group’s presentation.
- Make sure your part of the visual aids are ready and available... groups will have to quickly take the “stage” as soon as the previous group has finished.
Today’s Agenda

- Groups will make 4-6 minute presentations.
- Quickly and quietly take your positions when it is your turn.
- If you delay, your grade may suffer.

- At five minutes per presentation, we will barely have time to hear from every group.

- Teacher: It is recommended that you video tape the presentations for later evaluation.