LESSON 6-7

Aim of the cycle

To provide the conditions for students to develop creative thinking, acquire basic designing, visualization, spatial expression, computer designing skills; show the integrity and contextualization of engineering; use the acquired skills when designing certain objects and systems.

Objectives of the cycle

The objectives for students are:

- to get acquainted/ improve the application of engineering creative process while solving engineering problems;
- develop reading and visualizing skills of sight, sketches, visualizations;
- develop skills of engineering designing; learn how to design using various technical and programming tools;
- develop the skill to convey the structure, view and materialism of engineering objects, systems and processes; learn to convey proportions and scale;

Topic of the lesson. Creative engineering and design ideas. Designing and manufacturing a product/ its package.

Methods

Demonstration; use of presentations and / or digital learning objects; brainstorming; understanding students' experience; discussion; mutual teaching/learning; group work; practical research; (self) assessment; questions for reflection.

Materials

Presentations, educational presentation, computers, programming equipment - QCAD (or Adobe Illustrator, Corel Drow, SketchUP, Paintnet, etc.), transparent dishes for water, water, various types of paper (or other material for research), worksheets, internet access, paper for printing, scissors, paper cutter knives, rulers and other materials for making the packing (e.g. transparent plastic, rivets, laces, etc.)

Objectives

6. Lesson

Working individually and in groups you will perform tasks, experiment/ research about materials used for packaging, their properties; after preparing and listening to the presentations prepared by your classmates:
• you will discuss and argumentatively explain the difference between packages from synthetic and biodegradable materials;
• formulate ideas why and how to reduce the use of environmentally harmful packages.

7. Lesson

After discussing the stages of engineering creative process::
• you will learn to design with QCAD (or other design programs) and will make a product (its package);
• you will evaluate your and your friends' work, explain which packages are "acceptable"

LESSON 6-7

Content

Mechanical Enginering. Principles of the study of mechanical properties of materials, analysis and application trends.

Chemistry and Bioengineering. Investigation of chemical processes and materials properties, interpretation of possibilities of practical application in solving engineering problems.

Design Engineering. Application of mathematical calculations in the design of engineering elements. Peculiarities of designing graphic environment objects. Planning and implementation of design processes and solutions. Application of designing electronical engineering. Design basics and model production.

Computer Engineering. Construction of selected objects with computer tools; customization of objects for different media formats.

Media and Audiovisual Engineering. Unity of technology, cultural content and artistic expression; design history (history of packaging).

Business and Economical Engineering. Project budget and its calculation, financing possibilities, product demand and supply analysis.

History and Philosophy of Engineering. Description of design engineering and analysis of its application. Examples of contemporary research and engineering solutions. Analysis of engineering and environmental problems, solving possibilities. Getting to know engineering hypotheses, test values and engineering.

The main ethical provisions and evaluation of engineering. Argumentative discussion on the basic principles of engineering science, the ethical principles of engineering, and the impact of engineering science on human development. Discussion about social issues, the decisions which involve engineering. Getting familiar with engineering as a discipline for meeting human needs. Description and interpretation of interdisciplinary problem in engineering disciplines. Discussion and interpretation of the main issues of engineering science (the characteristics and purpose of the engineering product, its interaction with the user and the external environment). Analysis of engineering thinking and practical interaction.

LESSON 6-7

Activities

Lesson 6

1. ACTIVITY. PRESENTING THE TOPIC (8 MIN.)

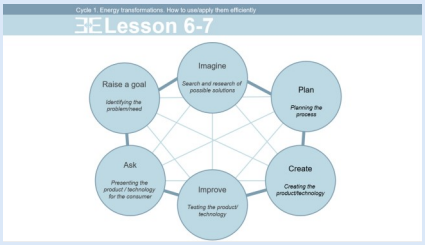
1.1. Elucidating the experience and discussion (6 min)

Question for discussion:

- How does an engineering product appear? What are the steps of engineering design?

/ Identifying the problem/need (aim); search for possible solutions of the problem and research (imagine); planning the process (plan); creation of the product (create); testing the product (improve); presenting the product for a consumer (ask) /

The scheme *Lesson No. 6– 7. Appendix No. 1. Scheme of engineering design process* is presented and discussed with students.



Lesson No. 6– 7. Appendix No. 1. Scheme of engineering design process

Recommendation for discussion

Teaching engineering design process

The engineering design process requires attention and perseverance. Students often do not understand why they should design an engineering product using engineering design steps. The engineering design process is an adequate guide for engineering design, but not a recipe or requirement. The engineering design process can take many stages. Engineers in the workplace can take actions as needed, for example, to skip a step depending on the specifics of a specific project. However, all the steps are important to achieve a good result.

Questions for discussion:

1. What determines the attractiveness, safety and durability of a product?

/ Package and its design /

2. Who creates packages?

/ Engineers—designers /

1.2. Announcing the topic of a series of lessons and discussing the aim and the objectives (2 min.)

CYCLE
CREATIVE ENGINEERING AND DESIGN IDEAS (LESSONS 6-7) (CHECK CYCLE 1 OBJECTIVES)

Tip for the teacher
•To get students interested while letting them see benefits, necessity, perceptibility of what will be taught; to think about what, how and why you were studying in the previous lesson.

Tip for the teacher
• During the discussion specific questions might be given to students in order to receive correct answers.

Tips for the teacher
•The aim and objectives are discussed with students.
•The students' motivation is emphasized – why we concentrate on these objectives; e.g. it is useful in everyday activities, it is interesting, etc.
•The aim and objectives should be not only discussed but it also be attempted to raise them together with students.

LESSON 6-7

1.3. Announcing the topic of the lesson and raising the objective (1 min.)

Topic. Design. Creative engineering and design ideas. Designing and manufacturing a product/ its package

The objectives of the lesson are raised and discussed.

Objective

Working individually and in groups you will perform tasks, experiment/ research about materials used for packaging, their properties; after preparing and listening to the presentations prepared by your classmates:
• you will discuss and argumentatively explain the difference between packages from synthetic and biodegradable materials;
• formulate ideas why and how to reduce the use of environmentally harmful packages.

Tip for the teacher
• *Brainstorming*

2. ACTIVITY. DISCUSSION (4 MIN.)

Questions for discussion:

1. From what materials product packages are most often made? Why?
/ Paper / cardboard, plastic and other synthetic materials, wood /

/ Paper – cheap, biodegradable (the material which decomposes fast in the nature); plastic– mosture resistant, obtaining the required shapes, easy material; tree - durable, reusable, environmentally friendly material /

2. Which of these materials are the most environment friendly and why?

/ Natural materials because they decompose quickly or can be recycled, do not pollute the environment /

3. Which materials, though being recycled, cause the greatest environmental damage?

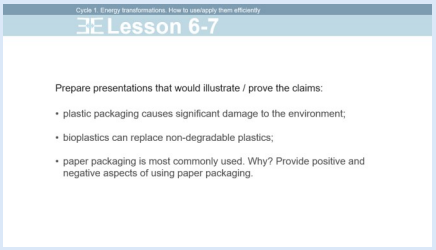
/ Various polymeric materials ⓘ (useful information), including plastic /

Tips for the teacher
• *In case no answer is received, students might be given specific questions.*
• *Students might be suggested to use available resources, e.g. mobile phones, computers with internet access, etc.*

3. ACTIVITY. ANNOUNCING AND PERFORMING THE TASK (15 MIN.)

3.1. Announcing the task (2 min.)

Students are shown the slide *Lesson No. 6 -7. Appendix No. 2. Task.*



Lesson No. 6 -7. Appendix No. 2. Task.

Tips for the teacher
• *Students are suggested in work in pairs/ groups. If students wish, they might work individually.*
• *Separate pairs/ groups of students are suggested to choose one statement.*

Task

Working in pairs/groups, using various sources, prepare presentations which prove the statements:

• plastic packages cause significant environmental damage;

• bioplastics can replace non-degradable plastics;

• the most commonly used packaging is paper. Why? Discuss advantages and disadvantages of using paper packages.

Tip for the teacher
• *There might be other materials analyzed in the task, regarding the experience of a teacher and students, subject curriculum,it is recommended to choose the materials which later might be linked to the design process/ designing.*

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3.2. Performing the task (10 min.)

Students are suggested to perform the task.

When the time is finished, students are asked to prepare for presenting their works and (self) assessment.

3.3. Presenting and summarizing the results (3 min.)

Pairs/ groups of students present their creative works.

Questions for reflection:

1. Did everyone manage to find the right answers? Why?
2. Which presentations revealed more details about the problem? Why?
3. What could have been done better? Why?

Summarizing: plastic has a very significant harmful environmental impact. The task of engineers is to create less harmful substances for the environment and for people to use them responsibly and economically, creatively / purposefully use secondary raw materials.

When testing on selected materials (various types of paper or others), students will be able to use what they will find out or already know about material properties. Students should combine their knowledge of testing results and their hypotheses in order to decide which materials are best used for designing their products (packages).

Tip for the teacher

• *Feedback is important for a quality process, so it is recommended that students would be able to ask each other questions, discuss, etc. Active activities will encourage students' thinking (to make decisions, argue, evaluate, etc.), to critically assess and self-assess.*

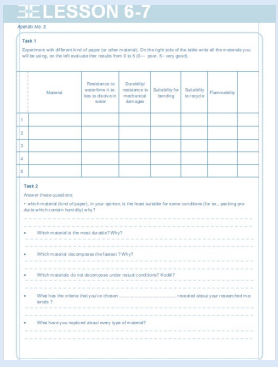
4. ACITIVITY. EXPERIMENT (18 MIN.)

4.1. Task—experiment (14 min.)

Announcing the task

To research and decide the most suitable type of paper for designing a package according to the stated criteria/ standards.

Students are given worksheets *Lesson No. 6-7. Appendix No. 3* and tools for conducting the experiment.


LESSON 6-7

Worksheets *Lesson No. 6-7. Appendix No. 3.*

Students are suggested to conduct the experiment in pairs. The materials used during the experiment are discussed together with students and the criteria of their features which students mark down in their worksheets. **Types of paper for the experiment:** a water-soluble toilet paper roll; copying paper; cartons of different thicknesses and textures; the newspaper; magazine cover paper, candy wrapping paper, etc.

Tip for the teacher

- *If there is a need, a teacher might consult students or complete the task together with them.*

Tip for the teacher

• *It is recommended to start testing and observe water-resistant materials 3-7 days before the actual lesson (the tested materials should be soaked in water).*

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Possible criteria for studying materials: water resistance / water disruption; durability / resistance to mechanical damage; flexibility; suitability for recycling; combustibility and others.

4.2. Presenting and discussing the task—experiment (4 min.)

When the time for completing the task is finished, students present their works and discuss/ comment on the answers.

Questions for discussion

1. Specify the material (type of paper) that you think is the most unsuitable for certain conditions (for example, when packaging moisture-containing products) Why?
2. Which material is most durable? Why?
3. Which material is likely to degrade? Why?
4. Which materials do not degrade under natural conditions? Why?
5. What did the criteria ..... reveal about your chosen materials?
6. What else have you noticed about each type of material?

Lesson 7

5. ACTIVITY. DESIGNING AND MANUFACTURING THE PRODUCT/ ITS PACKAGE (34 MIN.)

5.1. Raising the objective (2 min.)
Raising and discussing the objective of the lesson.

Objective

After discussing the stages of engineering creative process:

• you will learn to design with QCAD (or other design programs) and will make a product (its package);

• you will evaluate your and your friends' work, explain which packages are "acceptable"

5.2. Discussion (4 min.)

Question for discussion:

• How can our creativity and engineering design process be used in order to create a product/ package?

Students summarize what they have found out about engineering design process.

Suggestions for discussion:

• Creating several different sketches/ design variants of a product/ package;
• Creating (planning) the design and manufacturing process of a product/ package, calculating how much it will cost to create and implement the project;
• Design and manufacturing of a product/package according to the criteria stated in the plan;
• Testing and improving the product regarding the results;

Patarimas mokytojui
• *Lead and inspire students' discussion, remind of engineering creation possibilities;*
• *encourage students showing the exemplary works created by their fellow students (or other examples).*

LESSON 6-7

5.3. Announcing the task (1 min.)

Task

Create and design the package,

5.4. Introduction for performing the task (3 min.)

In order to prepare a product / packaging for production, it is necessary to turn the created sketch into a precise drawing using hand-drawing tools or technical, programmed design tools.

Questions for discussion:

1. What tools do designers use?

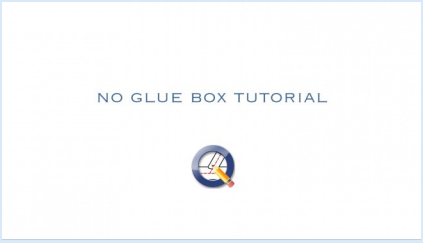
/ Manual, for example, various rulers, tuners, scrolls and more; computer programs and tools /

2. What computer programs can design drawings?

/ QCAD, Adobe Illustrator, Corel Drow, SketchUP, Paintnet or others /

5.5. Performing the task (20 min.)

Students are suggested to open the presentation *Lesson No. 6 - 7. Appendix No. 5. Design of the package and its preparation for printing*



Lesson No. 6 - 7. Appendix No. 4. Design of the package and its preparation for printing

The work process is discussed.

Students are told that following the steps stated in the instruction, they will be able to design and prepare the package model for printing.

5.6. Presenting and discussing the task (4 min.)

When the time is finished, students present their works and discuss/ comment on the answers.

Tip for the teacher
- *Help and consult students if needed.*

Tip for the teacher
- *Students are asked if they understood the task and, if it is needed, the task is explained once again.*

6. DISCUSSION. PACKAGES AND THEIR DESIGN (8 MIN.)

Questions for discussion:

1. What package is “acceptable”?

/ Attractive, durable, safe, environmentally friendly, inexpensive /

2. Does a good design always meet the criteria to solve the engineering problem?

/ Sometimes the increase in design efficiency (utility) according to some criteria (for example, multifunctionality, eco-design, design quality) may reduce its performance (utility) according to other criteria (for example, price) /

Tip for the teacher
- *If needed, the discussion about design and originality might be continued; students might be given another task, e.g. to give presentations about original packages, discuss original creative works done by other students, etc.*

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Suggestions for discussion:

• Good (original) packaging often takes longer to invent / create or produce. Why?

• Paper is the most commonly used environmentally friendly packaging material. Why?

• What else do you know about packaging materials that are superior to existing packaging materials?

/ For example, protein biofilms that cover food products are a surprisingly good choice of material for food packaging because they can be consumed / eaten together with the product /

Tip for the teacher
• *The importance of time management should be emphasized.*

7. ACTIVITY. (SELF) ASSESSMENT, REFLECTION (3 MIN.)

Students (self) assess their and their friends' creative works, for example, in what they succeeded, if there were any failures, what they would do differently next time, etc.

Questions for reflection:

1. What did you find out during this lesson?
2. In what way this knowledge will be useful in your future? Why?
3. How has you attitude during the consumer culture changed? Why?
4. How did you succeed in completing the tasks? What would you differently next time? Why?

ADITIONAL TASK (45 MIN)

1. Raising the objective and discussing the criteria of completing the task (3 min.)

Task

Create and design a package.

The objective is raised and discussed.

Objective

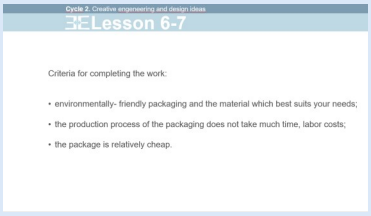
Using the stages of engineering creative process:

• you will create a sketch of an original package;

• using the QCAD design program, you will design the model of a package according to the stated criteria.

Students are given the presentation *Lessons No. 6 -7. Appendix No. 6. Instructions for task fulfilment.* The task is discussed with students.

Tip for the teacher
• *If there is a possibility, a creative task might be performed during an additional lesson.*



Lessons No. 6 -7. Appendix No. 5. Instructions for task fulfilment.

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Criteria for task fulfilment:

• the package is "environmentally friendly"; material that best suits your chosen concept should be used;

• the production process of the packaging does not take much time and labor costs;

• the package is relatively cheap.

The students are given worksheets *Lessons No. 6 -7. Appendix No. 7. Original package.*


Cycle 2. Creative engeneering and design ideas

LESSON 6-7

Lessons No. 6 -7. Appendix No. 6. Original package.

2. Performing the task (30 min.)

Students are suggested to perform the task.

3. Presenting and discussing the task (10 min.)

When the time is finished, students present their works and discuss/ comment on the answers.

4. (Self) assessment (2 min.)

Students (self) assess their and their friends' creative works, for example, in what they succeeded, if there were any failures, what they would do differently next time, etc.

Tip for the teacher

• *Firstly, find something positive to say about the work of each student and only then provide suggestions how the work might be improved.*

Tips for the teacher

• *Encourage a student to think what he/she was learning, how they learned and what they found out during the lesson.*

• *To provide a possibility for students to ask each other questions, discuss, show, etc. Active activities will encourage students' thinking (to make decisions, argue, evaluate, etc.), to critically assess and self-assess.*

LESSON 6-7

TERMS AND USEFUL INFORMATION

Plastic in the food chain
Over the course of the year, about 300 million tons of plastic are produced in the world, and about 7 million tons are found in the oceans. According to some organizations, the oceans contain 100 million tons of plastic.
Most plastic wastes consist of plastic packaging. If the plastic is buried in the trash, it becomes almost eternal, because the bacteria do not break down plastic. In the oceans, the process of decomposition occurs much faster - the rays of the sun break long plastics-forming atomic chains. In the long run, the plastic turns into small grains. Even though it is broken up into almost invisible parts, the plastic still contaminates oceans. These small particles are difficult to detect and therefore they enter the food chain.
Animals in the ocean often take floating larger, colored pieces of plastic as their prey and swallow it. Some types of plastics accumulate in animal stomachs. It is not digested and causes a variety of diseases. Plastics can travel up in the food chain. When smaller animals are swallowed by bigger ones, the same amount of plastic is consumed, so it can also appear on our table.

Biodegradable plastics
The waste of plastic is a huge problem - the plastic in the landfill does not degrade for centuries. When trying to solve this problem, scientists are looking for materials that could produce biodegradable plastics, which collapse much faster. One of the solutions was proposed by Harvard researchers, who made bioplastics from shrimp shells. This substance is called chitosan - a form of polymer chitin, which determines the hardness of shrimp kernels. Since it is the second largest organic matter on Earth, there should be plenty of it. In addition, materials that decompose in just a few weeks might be useful to plants.
Another offer is made by the Indonesian company “Avani” which made not only plastic bags but also other objects from a manioc - an edible plant growing in South America. This bioplastic is not only fully degradable but also suitable for composting. Moreover, the bags and disposable dishes made from this plastic almost do not differ from the usual ones.

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BASED ON

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