#CareerBaltics

Handbook for Implementing Interdisciplinarity of Design, Technology and Economics in Career Guidance

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Content

Introduction

The idea of the material designed is to help secondary school teachers with the competence in career guidance based on the interdisciplinarity of design, technology and economics.

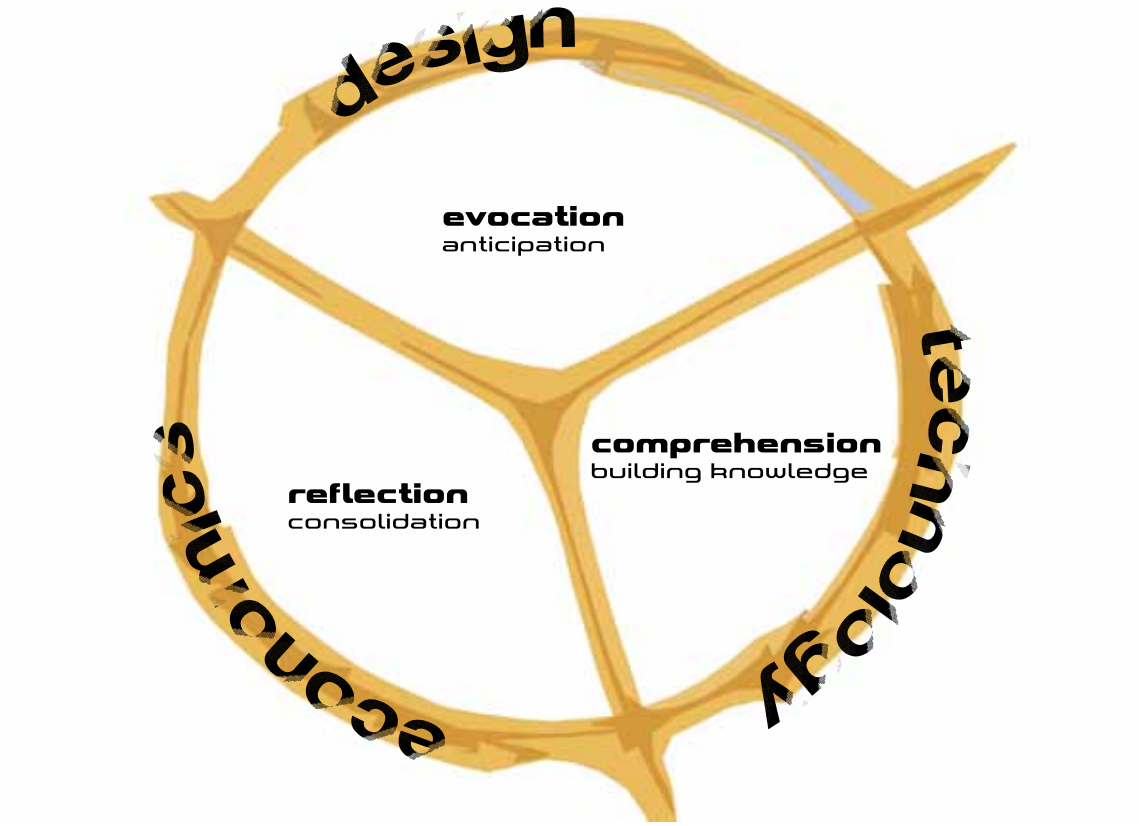
This handbook contains examples how to implement a project idea using critical thinking and learning strategies in career guidance and allow secondary school students to get acquainted with local industries through development of competencies in design, technologies and economics. There will be examples for career guidance in agriculture and food, metal and machinery, forestry and wood industry. These examples provide an opportunity to connect the demand for the competencies in design, technologies and economics with teaching and learning strategies using three phases of critical thinking – evocation/anticipation, comprehension/knowledge building, reflection/consolidation (Crawford et al., 2005).

Evocation is the phase where students identify their previous knowledge, predict the knowledge and skills to be acquired, and set learning goals. The evocation/anticipation phase is for the activation of imagination, prognosis, and to create interest. In this phase, the career counsellor can base their activities on the guidelines on competencies related to design.

Comprehension is the phase where students are looking for new knowledge and as a result of their actions form awareness and meaning. The comprehension/knowledge building phase is for posing questions and finding answers. In this phase, the career counsellor can lead students to inquire and acknowledge their activities using the guidelines on competencies related to technologies.

Reflection is the phase where students look at the ideas learned and understand their meaning, ask questions, interpret, apply, discuss, test, and extend meaning by transferring it to other areas of activity. The reflection/consolidation phase is for the reflection and personalization of findings and information. In this phase, the career counsellor can ask students to give personal responses based on competencies related to economics.

All these phases can be implemented in different ways – problem-based learning, such as group investigation, project, cooperative learning (Erasmus+ Strategic Partnership Project "Implementing Interdisciplinarity in Career Counselling", 2017).



1.1. Evocation/Anticipation Phase – Design

At the beginning of the group counselling session the counsellor gathers the answers of the students to questions: What do you know about the production processes and sectors of industry, and from what media (newspapers, magazines, TV, radio, the Internet (social networks, YouTube, company websites, …)), family members, friends, neighbours? Have you worked in this industry? Have you done summer jobs in this industry? Have you volunteered in this industry? Have you visited a company in this industry? Do you have a plan after finishing school?

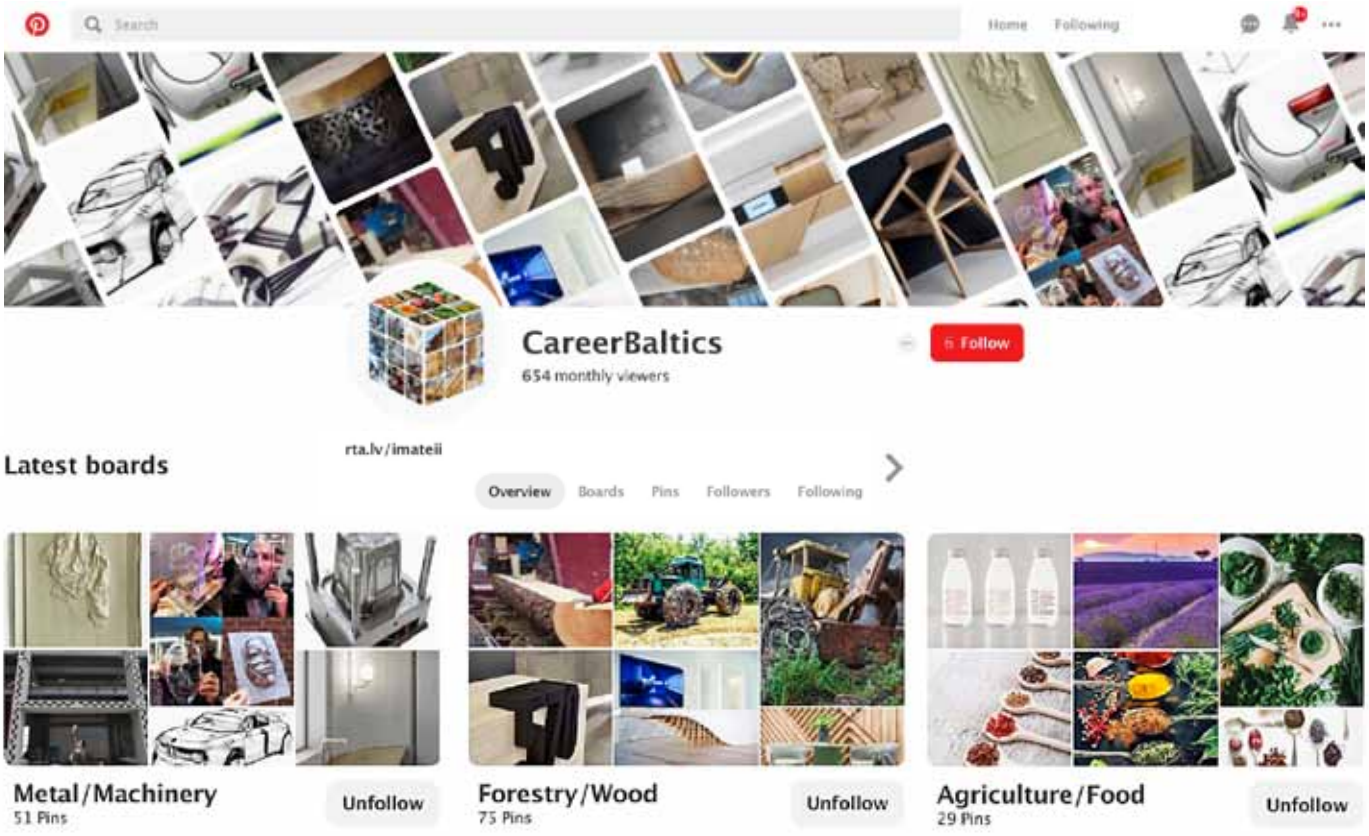
Presentations of company design of the products, technological processes, working environment, materials and business – pictures of real products of companies. Questions like: How is it made? What technologies are used? What equipment and tools are necessary? Where is this company located? How rich are the companies and their owners? Is it produced by talented hand or advanced technology?

There is a number of ways to present pictures for the group of students. Most popular way is to do your own PowerPoint presentation. The authors recommend using the social network Pinterest.com to discover hundreds of related pictures, styles, inspiration, and many other ideas to try. This method gives school students a possibility to navigate and search for pictures of their own preference, which is more effective for the evocation phase.

Visit the profile created by CareerBaltics for self-training, give a link to students for inspiration in advance before the counselling session or show it in class. Use appropriate boards for agriculture and food, metal and machinery, forestry and wood industry. Create your own account, adding pictures of local company products, select pictures of your personal competences and create boards for any other industries.

CareerBaltics Pinterest profile

https://www.pinterest.com/careerbaltics



1.2. Comprehension/Building Knowledge Phase – Technology

The comprehension and building of knowledge phase can be tightly related to the introduction and analysis of the technological processes used for the production of a particular product provided in this material. The introduction to the technological processes in the sector could be started in school by identifying particular products and analysing the technological processes used in their production. Involve subject teachers for better explanation. There is a wide range of different informative materials in the technology cards that can be used for this purpose (such as pictures and videos, introduction and information on the production processes, materials and equipment used).

The second step could be organizing visits to companies where students could see the technological processes in a live environment, considering the specificity of the technological and work processes in this sector, which limit the access to observation (e.g. safety concerns in the heavy metal and machinery industry, noise, smells, heat related to many technological production processes of metal products).

Before a visit to a company, the counsellor invites students to select a product produced in the company and introduces students to the technology used in making the product. Students get acquainted with the technology cards and prepare questions for the company staff to obtain more information about the technology. Students prepare to ask questions about the technology, economic factors, and production costs (e.g. materials, equipment, tools, salaries in different positions, sales price for production units, retail price).

1.3. Reflection/Consolidation Phase – Economics

After the visit to a company the consultant asks questions such as:
Is it worthwhile to become an expert in this field?
What benefits can entering this industry give me?

Based on the analysis of the results performed during the project, the most important competencies in the field of economics evaluated by Baltic companies are:

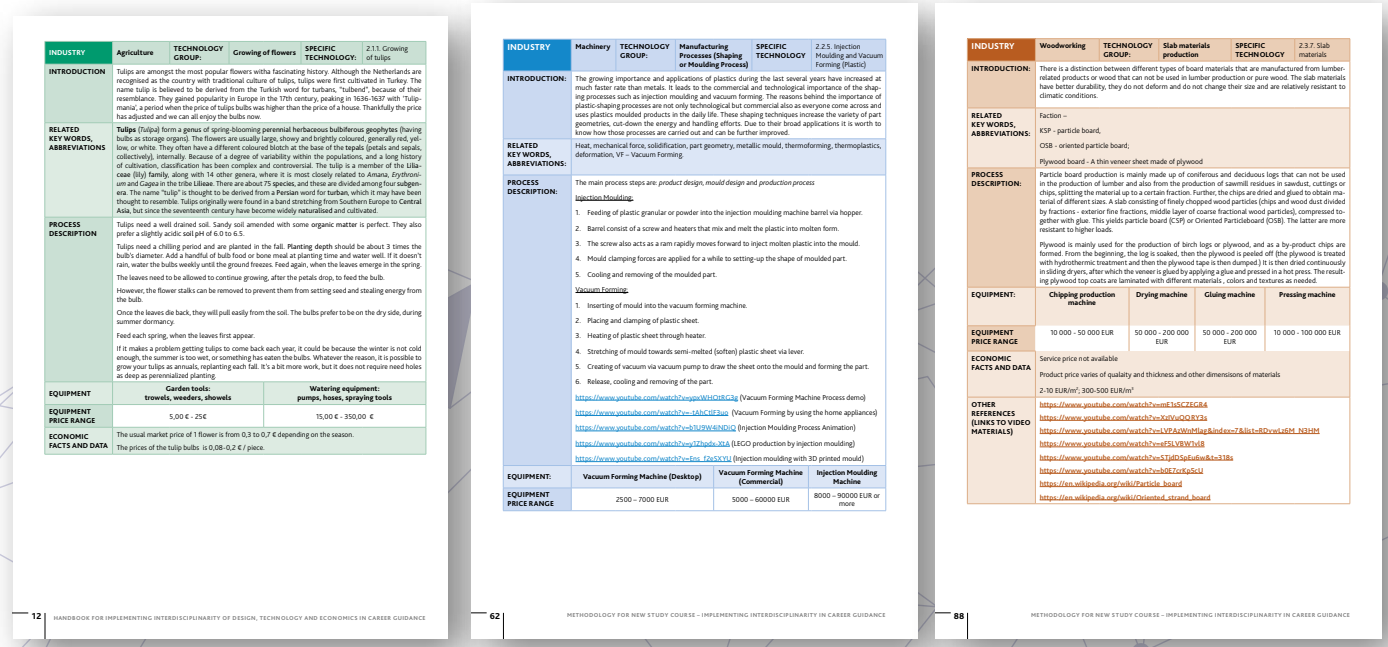
- Handling problem situations adequately and timely, taking necessary decisions.
- Setting objectives for achieving specific aims in order to produce products with high added value.
- Assessing the service cost calculations, the required investments and workforce.
- Project design and management.

More information about the study and its recommendations can be found on the project webpage: https://www.rta.lv/imateii

Career counsellors organize practical work for school students using product cost calculations in technology cards, information gathered during visits to companies, as well as other information available on the Internet. The assignments can be related to business sustainability in the selected industry. See chapter 3. Career Counselor can monitor individual evaluations of pupils after Company visit before Practical work assignments.

Self check of sensual impressions

Sense	Attitude	Comments
Smell	Like Mostly like Mostly don't like Don't like	
Sound	Like Mostly like Mostly don't like Don't like	
Touch	Like Mostly like Mostly don't like Don't like	
Visual	Like Mostly like Mostly don't like Don't like	
Temperature	Like Mostly like Mostly don't like Don't like	
Wet	Like Mostly like Mostly don't like Don't like	
Dust	Like Mostly like Mostly don't like Don't like	
Safety	Like Mostly like Mostly don't like Don't like	



INDUSTRY	Agriculture	TECHNOLOGY GROUP:	Growing of flowers	SPECIFIC TECHNOLOGY:	2.1.1. Growing of tulips
INTRODUCTION	Tulips are amongst the most popular flowers witha fascinating history. Although the Netherlands are recognised as the country with traditional culture of tulips, tulips were first cultivated in Turkey. The name tulip is believed to be derived from the Turkish word for turbans, "tulbend", because of their resemblance. They gained popularity in Europe in the 17th century, peaking in 1636–1637 with 'Tulipmania', a period when the price of tulips bulbs was higher than the price of a house. Thankfully the price has adjusted and we can all enjoy the bulbs now.				
RELATED KEY WORDS, ABBREVIATIONS	**Tulips** (*Tulipa*) form a genus of spring-blooming perennial herbaceous bulbiferous geophytes (having bulbs as storage organs). The flowers are usually large, showy and brightly coloured, generally red, yellow, or white. They often have a different coloured blotch at the base of the tepals (petals and sepals, collectively), internally. Because of a degree of variability within the populations, and a long history of cultivation, classification has been complex and controversial. The tulip is a member of the Liliaceae (lily) family, along with 14 other genera, where it is most closely related to *Amana*, *Erythronium* and *Gagea* in the tribe Lilieae. There are about 75 species, and these are divided among four subgenera. The name "tulip" is thought to be derived from a Persian word for turban, which it may have been thought to resemble. Tulips originally were found in a band stretching from Southern Europe to Central Asia, but since the seventeenth century have become widely naturalised and cultivated.				
PROCESS DESCRIPTION	Tulips need a well drained soil. Sandy soil amended with some organic matter is perfect. They also prefer a slightly acidic soil pH of 6.0 to 6.5. Tulips need a chilling period and are planted in the fall. Planting depth should be about 3 times the bulb's diameter. Add a handful of bulb food or bone meal at planting time and water well. If it doesn't rain, water the bulbs weekly until the ground freezes. Feed again, when the leaves emerge in the spring. The leaves need to be allowed to continue growing, after the petals drop, to feed the bulb. However, the flower stalks can be removed to prevent them from setting seed and stealing energy from the bulb. Once the leaves die back, they will pull easily from the soil. The bulbs prefer to be on the dry side, during summer dormancy. Feed each spring, when the leaves first appear. If it makes a problem getting tulips to come back each year, it could be because the winter is not cold enough, the summer is too wet, or something has eaten the bulbs. Whatever the reason, it is possible to grow your tulips as annuals, replanting each fall. It's a bit more work, but it does not require need holes as deep as perennialized planting.				
EQUIPMENT	Garden tools: trowels, weeders, showels		Watering equipment: pumps, hoses, spraying tools		
EQUIPMENT PRICE RANGE	5,00 € - 25€		15,00 € - 350,00 €		
ECONOMIC FACTS AND DATA	The usual market price of 1 flower is from 0,3 to 0,7 € depending on the season. The prices of the tulip bulbs is 0,08–0,2 € / piece.				

INDUSTRY	Machinery	TECHNOLOGY GROUP:	Manufacturing Processes (Shaping or Moulding Process)	SPECIFIC TECHNOLOGY	2.2.5. Injection Moulding and Vacuum Forming (Plastic)
INTRODUCTION:	The growing importance and applications of plastics during the last several years have increased at much faster rate than metals. It leads to the commercial and technological importance of the shaping processes such as injection moulding and vacuum forming. The reasons behind the importance of plastic-shaping processes are not only technological but commercial also as everyone come across and uses plastics moulded products in the daily life. These shaping techniques increase the variety of part geometries, cut-down the energy and handling efforts. Due to their broad applications it is worth to know how those processes are carried out and can be further improved.				
RELATED KEY WORDS, ABBREVIATIONS:	Heat, mechanical force, solidification, part geometry, metallic mould, thermoforming, thermoplastics, deformation, VF – Vacuum Forming.				
PROCESS DESCRIPTION:	The main process steps are: *product design*, *mould design* and *production process* Injection Moulding: 1. Feeding of plastic granular or powder into the injection moulding machine barrel via hopper. 2. Barrel consist of a screw and heaters that mix and melt the plastic into molten form. 3. The screw also acts as a ram rapidly moves forward to inject molten plastic into the mould. 4. Mould clamping forces are applied for a while to setting-up the shape of moulded part. 5. Cooling and removing of the moulded part. Vacuum Forming: 1. Inserting of mould into the vacuum forming machine. 2. Placing and clamping of plastic sheet. 3. Heating of plastic sheet through heater. 4. Stretching of mould towards semi-melted (soften) plastic sheet via lever. 5. Creating of vacuum via vacuum pump to draw the sheet onto the mould and forming the part. 6. Release, cooling and removing of the part. https://www.youtube.com/watch?v=gvpxWHOtEG3g (Vacuum Forming Machine Process demo) https://www.youtube.com/watch?v=-tAhC1EF3uo (Vacuum Forming by using the home appliances) https://www.youtube.com/watch?v=b1U9W4ENDiQ (Injection Moulding Process Animation) https://www.youtube.com/watch?v=y1ZhpdxJtIA (LEGO production by injection moulding) https://www.youtube.com/watch?v=Eos_f2eSX1U (Injection moulding with 3D printed mould)				
EQUIPMENT:	Vacuum Forming Machine (Desktop)		Vacuum Forming Machine (Commercial)		Injection Moulding Machine
EQUIPMENT PRICE RANGE	2500 – 7000 EUR		5000 – 60000 EUR		8000 – 90000 EUR or more

INDUSTRY	Woodworking	TECHNOLOGY GROUP:	Slab materials production	SPECIFIC TECHNOLOGY	2.3.7. Slab materials
INTRODUCTION:	There is a distinction between different types of board materials that are manufactured from lumber-related products or wood that can not be used in lumber production or pure wood. The slab materials have better durability, they do not deform and do not change their size and are relatively resistant to climatic conditions.				
RELATED KEY WORDS, ABBREVIATIONS:	Faction – KSP – particle board, OSB - oriented particle board; Plywood board - A thin veneer sheet made of plywood				
PROCESS DESCRIPTION:	Particle board production is mainly made up of coniferous and deciduous logs that can not be used in the production of lumber and also from the production of sawmill residues in sawdust, cuttings or chips, splitting the material up to a certain fraction. Further, the chips are dried and glued to obtain material of different sizes. A slab consisting of finely chopped wood particles (chips and wood dust divided by fractions - exterior fine fractions, middle layer of coarse fractional wood particles), compressed together with glue. This yields particle board (CSP) or Oriented Particleboard (OSB). The latter are more resistant to higher loads. Plywood is mainly used for the production of birch logs or plywood, and as a by-product chips are formed. From the beginning, the log is soaked, then the plywood is peeled off (the plywood is treated with hydrothermic treatment and then the plywood tape is then dumped.) It is then dried continuously in sliding dryers, after which the veneer is glued by applying a glue and pressed in a hot press. The resulting plywood top coats are laminated with different materials , colors and textures as needed.				
EQUIPMENT:	Chipping production machine		Drying machine	Gluing machine	Pressing machine
EQUIPMENT PRICE RANGE	10 000 - 50 000 EUR		50 000 - 200 000 EUR	50 000 - 200 000 EUR	10 000 - 100 000 EUR
ECONOMIC FACTS AND DATA	Service price not available Product price varies of qualaity and thickness and other dimensisons of materials 2-10 EUR/m²; 300-500 EUR/m³				
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=mE1uSCZEGR4 https://www.youtube.com/watch?v=XolVuOQORY3s https://www.youtube.com/watch?v=LVPAsWnMIag&index=7&list=RDvwLs6M_N3HM https://www.youtube.com/watch?v=eFSLV8W1vI8 https://www.youtube.com/watch?v=STqRDpFu6w&t=318s https://www.youtube.com/watch?v=h0E7cKpSkLI https://en.wikipedia.org/wiki/Particle_board https://en.wikipedia.org/wiki/Oriented_strand_board				

2. Technology Cards for Comprehension Phase

2.1. Food processing and Agriculture

2.1.1. Growing of tulips

INDUSTRY	Agriculture	TECHNOLOGY GROUP:	Growing of flowers	SPECIFIC TECHNOLOGY:	2.1.1. Growing of tulips
INTRODUCTION	Tulips are amongst the most popular flowers witha fascinating history. Although the Netherlands are recognised as the country with traditional culture of tulips, tulips were first cultivated in Turkey. The name tulip is believed to be derived from the Turkish word for turbans, "tulbend", because of their resemblance. They gained popularity in Europe in the 17th century, peaking in 1636-1637 with 'Tulip-mania', a period when the price of tulips bulbs was higher than the price of a house. Thankfully the price has adjusted and we can all enjoy the bulbs now.				
RELATED KEY WORDS, ABBREVIATIONS	**Tulips** (*Tulipa*) form a **genus** of spring-blooming **perennial herbaceous bulbiferous geophytes** (having bulbs as storage organs). The flowers are usually large, showy and brightly coloured, generally red, yellow, or white. They often have a different coloured blotch at the base of the **tepals** (petals and sepals, collectively), internally. Because of a degree of variability within the populations, and a long history of cultivation, classification has been complex and controversial. The tulip is a member of the **Liliaceae** (lily) **family**, along with 14 other genera, where it is most closely related to *Amana*, *Erythronium* and *Gagea* in the tribe **Lilieae**. There are about 75 **species**, and these are divided among four **subgenera**. The name "tulip" is thought to be derived from a **Persian** word for **turban**, which it may have been thought to resemble. Tulips originally were found in a band stretching from Southern Europe to **Central Asia**, but since the seventeenth century have become widely **naturalised** and cultivated.				
PROCESS DESCRIPTION	Tulips need a well drained soil. Sandy soil amended with some **organic matter** is perfect. They also prefer a slightly acidic **soil pH** of 6.0 to 6.5. Tulips need a chilling period and are planted in the fall. **Planting depth** should be about 3 times the bulb's diameter. Add a handful of bulb food or bone meal at planting time and water well. If it doesn't rain, water the bulbs weekly until the ground freezes. Feed again, when the leaves emerge in the spring. The leaves need to be allowed to continue growing, after the petals drop, to feed the bulb. However, the flower stalks can be removed to prevent them from setting seed and stealing energy from the bulb. Once the leaves die back, they will pull easily from the soil. The bulbs prefer to be on the dry side, during summer dormancy. Feed each spring, when the leaves first appear. If it makes a problem getting tulips to come back each year, it could be because the winter is not cold enough, the summer is too wet, or something has eaten the bulbs. Whatever the reason, it is possible to grow your tulips as annuals, replanting each fall. It's a bit more work, but it does not require need holes as deep as perennialized planting.				
EQUIPMENT	**Garden tools: trowels, weeders, showels**		**Watering equipment: pumps, hoses, spraying tools**		
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ECONOMIC FACTS AND DATA	The usual market price of 1 flower is from 0,3 to 0,7 € depending on the season. The prices of the tulip bulbs is 0,08-0,2 € / piece.				

REFERENCE PICTURES	
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=Z_CYJO2rbsg https://www.youtube.com/watch?v=DAOVuSuQ4Ro https://www.youtube.com/watch?v=alzjtnU2PkY https://www.almanac.com/plant/tulips https://www.britannica.com/plant/tulip

2.1.2. Bee-keeping

INDUSTRY	Agriculture	TECHNOLOGY GROUP:	Bee-keeping	SPECIFIC TECHNOLOGY:	2.1.2. Bee-keeping
INTRODUCTION	Apiculture and bee-keeping is one of the oldest crafts and sectors of the agriculture. It has avery strong traditions in Lithuania and other Baltic countries. Besides, apiculture is highly important for the whole agriculture and natural environment. Honeybee colonies are essential for agriculture and environment, ensuring plant reproduction by pollination, while beekeeping participates to the development of rural areas.				
RELATED KEY WORDS, ABBREVIATIONS	Api-culture – bee-keeping. Pellen, propolis, beeswax – secondary products of the apiculture (besides honey) widely used in pharmacy, cosmetology, chemical industry and other sectors. Swarming – split and migration of the bee colony for the propagation and increase.				
PROCESS DESCRIPTION:	**Honeybees.** Honeybees belong to the order Hymenoptera and to one of the Apis species. (For a complete discussion of honeybees, see the article hymenopteran.) Honeybees are social insects noted for providing their nests with large amounts of honey. A colony of honeybees is a highly complex cluster of individuals that functions virtually as a single organism. It usually consists of the queen bee, a fertilized female capable of laying a thousand or more eggs per day; from a few to 60,000 sexually undeveloped females, the worker bees; and from none to 1,000 male bees, or drones. The female of most species of bees is equipped with a venomous sting. Honeybees collect nectar, a sugary solution, from nectaries in blossoms and sometimes from nectaries on the leaves or stems of plants. Nectar may consist of 50 to 80 percent water, but when the bees convert it into honey it will contain only about 16 to 18 percent water. Sometimes they collect honeydew, an exudate from certain plant-sucking insects, and store it as honey. The primary carbohydrate diet of bees is honey. They also collect pollen, the dustlike male element, from the anthers of flowers. Pollen provides the essential proteins necessary for the rearing of young bees. In the act of collecting nectar and pollen to provision the nest, the bees pollinate the flowers they visit. Honeybees also collect propolis, a resinous material from buds of trees, for sealing cracks in the hive or for covering foreign objects in the hive that they cannot remove. They collect water to air-condition the hive and to dilute the honey when they consume it. A populous colony in a desirable location may, in a year's time, collect and carry into the hive as much as 1,000 pounds (450 kilograms) of nectar, water, and pollen. Bees secrete beeswax in tiny flakes on the underside of the abdomen and mold it into honeycomb, thin-walled, back-to-back, six-sided cells. The use of the cell varies depending on the needs of the colony. Honey or pollen may be stored in some cells, while the queen lays eggs, normally one per cell, in others. The area where the bees develop from the eggs is called the broodnest. Generally, honey is stored toward the top of the combs and pollen in cells around the broodnest below the honey. The bees maintain a uniform temperature of about 93 °F (34 °C) in the broodnest regardless of outside temperature. The colony can survive daily maximum temperatures of 120 °F (49 °C) if water is available with which they can air-condition the cluster. When the temperature falls below about 57 °F (14 °C), the bees cease flying, form a tight cluster to conserve heat, and await the return of warm weather. They can survive for several weeks in temperatures of –50 °F (–46 °C). When summer flowers bloom in profusion, the queen's egg-laying is stimulated, the cluster expands, and honey accumulates in the combs. When the large number of young bees emerge, the domicile becomes crowded. **Swarming.** When the colony becomes crowded with adult bees and there are insufficient cells in which the queen can lay large numbers of eggs, the worker bees select a dozen or so tiny larvae that would otherwise develop into worker bees. These larvae are fed copiously with royal jelly, a whitish food with the consistency of mayonnaise, produced by certain brood-food glands in the heads of the worker bees. The cell in which the larva is developing is drawn out downward and enlarged to permit development of the queen. Shortly before these virgin queens emerge as adults from their queen cells, the mother queen departs from the beehive with the swarm. Swarming usually occurs during the middle of a warm day, when the queen and a portion of the worker bees (usually from 5,000 to 25,000) suddenly swirl out of the hive and into the air. After a few minutes' flight, the queen alights, preferably on a branch of a tree but sometimes on a roof, a parked automobile, or even a fire hydrant. All the bees settle into a tight cluster around her while a handful of scouts reconnoitre a new homesite.				

When the scout bees have located a new domicile, the cluster breaks. The swarm takes to the air and in a swirling mass proceeds to the new home. Swarming is the bees' natural method of propagation or increase.

Queen bee. Back in the parent colony, the first queen to emerge after the mother queen departs with the swarm immediately attempts to destroy the others. If two or more emerge at the same time, they fight to the death. When the surviving virgin is about a week old, she soars off on her mating flight. To maintain genetic diversity within a colony, a queen frequently mates with more than one drone (called polyandry) while in the air. She may repeat the mating flights for two or three successive days, after which she begins egg laying. She rarely ever leaves the hive again except with a swarm. Normally, sufficient sperm are stored in her sperm pouch, or spermatheca, to fertilize all the eggs she will lay for the rest of her life. The drones die in the act of mating.

The queen can live up to five years, although many beekeepers replace the queen every year or two. If she is accidentally killed or begins to falter in her egg-laying efficiency, the worker bees will rear a "supersedure" queen that will mate and begin egg laying without a swarm emerging. She ignores the mother queen, who soon disappears from the colony.

Worker bees. Worker bees live about six weeks during the active season but may live for several months if they emerge as adults in the fall and spend the winter in the cluster. As the name implies, worker bees do all the work of the hive, except the egg laying.

Drones. Drones are reared only when the colony is populous and there are plentiful sources of nectar and pollen. They usually live a few weeks, but they are driven from the hive to perish when fall or an extended period of adversity comes upon the colony. The only duty of the drone is to mate with the queen.

The queen can lay drone (unfertilized) eggs in the drone cells. If she is not allowed to mate or if her supply of sperm is exhausted, she will lay unfertilized eggs in worker cells. The development of unfertilized eggs into adult drones is known as parthenogenesis. Occasionally a colony may become queenless and unable to develop another queen. Then some of the worker bees begin to lay eggs, often several to a cell, and these develop into drones. A colony that has developed laying workers is difficult to requeen with a laying queen.

Colony manipulation. The yearly work cycle. The beekeeper's year starts in early fall. At that time he requeens the colonies whose queens are not producing adequate amounts of brood and makes sure that each colony has sufficient stores: at least 50 pounds (22 kilograms) of honey and several frames filled with pollen. Some beekeepers also feed the drug fumagillin to reduce possible damage to the adult bees by nosema disease (see below Disease and pest control). The colonies need a sunny exposure and protection from cold winds. Some beekeepers in northern and mountainous areas wrap their colonies with insulating material in winter. A few beekeepers kill their bees in the fall, harvest the honey, store the empty equipment, then restock with a two- or three-pound (0.8- or 1.4-kilogram) package of bees and a young queen the following spring.

If the colonies are well prepared in the fall, they need little attention during the winter. But in early spring an examination of the colonies by the beekeeper is important. Frequently, strong colonies exhaust their food supply and starve only a few days before flowers begin to bloom in abundance. Only a few pounds of sugar syrup, 50-50 sugar water, or a honey-filled comb from another more prosperous colony might save such a starving colony. Again fumagillin may be fed to the colony, and some beekeepers also feed a cake of pollen substitute or pollen supplement. Honey is not fed to the colonies unless the beekeeper is sure about its source. Honey from colonies affected by the brood disease American foulbrood could infect his colonies and cause a serious loss.

As the spring season advances, the cluster size increases from the low population of 10,000 to 20,000 bees that survived the winter. To accommodate the increased size of the cluster and broodnest, the keeper adds more supers, or boxes of combs. If the combs are so manipulated that the queen can continually expand her egg-laying area upward, the colony is unlikely to swarm. This can be achieved by placing empty combs or combs in which brood is about ready to emerge at the top of the cluster and combs filled with eggs or young brood toward the lower part of the broodnest. The beekeeper wants the colony to reach its peak of population, 50,000 to 60,000 bees, at the beginning of the major nectar flow.

	The bees in a swarm, having departed the hive with a full stomach of honey, rarely sting. The usual way to capture them is to place a hive or upturned box beneath or nearby, then shake or smoke the bees to force the queen and a majority of the bees into it. The others follow. After the swarm is safely inside the box, it can be removed to a permanent location. Regulations governing the keeping of bees usually require the bees to be kept in hives with movable combs. If the bees are captured in a box, they are generally transferred into a movable-frame hive within a few days so the new honey and comb will not be lost in the transfer. **Requeening a colony.** When a beekeeper requeens a colony, he removes the failing or otherwise undesirable queen and places a new one in a screen cage in the broodnest. After a few days the colony becomes adjusted to her and she can be released from the cage. A strange queen placed in the cluster without this temporary protection usually will be killed at once by the workers. Queens usually are shipped in individual cages of about three cubic inches (50 cubic centimetres) with about half a dozen attendant bees and a ball of specially prepared sugar candy plugging one end of the cage. When the cage is placed in the hive, the bees from both sides eat the candy. By the time the candy is consumed and the bees reach each other, their odours have become indistinguishable, and the queen emerges from the cage into the colony and begins her egg-laying duties. **Beekeeping equipment.** Standard tools of the beekeeper are: the smoker to quell the bees; a veil to protect the face; gloves for the novice or the person sensitive to stings; a blunt steel blade called a hive tool, for separating the frames and other hive parts for examination; the uncapping knife, for opening the cells of honey; and the extractor, for centrifuging the honey from the cells. **Bee stings.** The worker bee sting is barbed, and in the act of stinging it is torn from the bee. It has a venom-filled poison sac and muscles attached that continue to work the sting deeper into the flesh for several minutes and increase the amount of venom injected. To prevent this, the sting should be scraped loose (rather than grasped and pulled out) at once. Bee stings are painful, and no one becomes immune to the pain. Immunity to the swelling is usually built up after a few stings, however. Normal reaction to a bee sting is immediate, intense pain at the site of the sting. This lasts for a minute or two and is followed by a reddening, which may spread an inch or more. Swelling may not become apparent until the following day. Occasionally, acute allergic reactions develop from a sting, usually with persons who have other allergic problems. Such a reaction becomes evident in less than an hour and may consist of extreme difficulty in breathing, heart irregularity, shock, splotched skin, and speech difficulty. Such persons should obtain the services of a medical doctor immediately. Source: https://www.britannica.com/topic/beekeeping		
EQUIPMENT:	**A hive**	**Tools for beekeping:** a hive tool; the uncapping knife **Safety and protection measures:** the smoker; a veil to protect the face; gloves	The extractor, for centrifuging the honey from the cells.
EQUIPMENT PRICE RANGE	75-150 EUR	35-65 EUR	850-1300 EUR
ECONOMIC FACTS AND DATA	As the world's second most important honey producer after China, the European Union (EU) offers a variety of apiculture products not just honey, but also pollen, propolis, royal jelly and beeswax. However, the EU is also a net importer of honey from third countries. Beekeeping is practised in all EU countries and is characterised by a diversity of production conditions, yields and beekeeping practices. EU members with the largest honey production (Romania, Spain, Hungary, Germany, Italy, Greece, France and Poland) are located mainly in the southern part of the European Union where climatic conditions are more favourable to beekeeping. World-wide amongst biggest producers, EU is also a net importer Despite being the world's second largest honey producer, the **EU** is a net **importer** of honey as domestic production only covers around 60% of consumption. The main supplier of honey imported into the EU is China, followed by Ukraine and countries in Latin America. Costs for beginning the beekeping. The price of the bee colony is around 70 €.The cost of wax plates (12-13) is 10 €Besides the expenses of needed equipment, there are costs of sugar and syrup for feeding the bees, medicines, and other expenses.		

	Therefore the one colony of bees with all equipment should cost around **325 €.** It is recommended to start beekeping from 3 colonies, therefor all the costs should be multiplied by 3 and added the cost of additional hive neded for unexpected cases, such as transfer or separation of the bee colony or accepting a new colony. In total, the beginning of beekeping should cost about 950 €. **Prices of products** The price of honey (1 liter) is from 4,5 to 10,00 EUR depending on the sort and quality. The price of beeswax is about 14-15 EUR /kg. The price of propolis (1 kg) is around 27,00 EUR-30,00 EUR.
REFERENCE PICTURES	
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=3-LfY3tNLug https://www.youtube.com/watch?v=hmgv1NuRFEU https://www.youtube.com/watch?v=Yb11qkmByTo http://www.honeybeecentre.com/learn-about-beekeeping#.Ww0r-cZRWUk

2.1.3. Growing of blueberries

INDUSTRY	Agriculture	TECHNOLOGY GROUP:	Gardenning	SPECIFIC TECHNOLOGY	2.1.3. Growing of blueberries
INTRODUCTION:	Blueberries are delicious and extremely high in antioxidants which is why it is regarded as a super food. Plants are easy to grow provided you use an acidic or 'ericaceous' compost. Blueberries bring a unique combination of delicious fruit and striking, year round ornamental beauty to the garden and landscape.				
RELATED KEY WORDS, ABBREVIATIONS:	Blueberries Soil preparation Planting Mulching Pruning Harvesting				
PROCESS DESCRIPTION:	**Site Selection and Preparation.** Select a sunny location with well-drained soil that is free of weeds and is well-worked. It's best to locate your blueberry plants in an area where irrigation is readily available as best results will be achieved by keeping the root zone moist throughout the growing season. Where the soil is not ideal or marginally-drained, raised beds are an excellent option. Blueberries also do well in patio containers and offer a great way for apartment and condo dwellers and those with little or no yard to enjoy blueberries. Blueberries prefer acidic soils. A fail-safe way to grow blueberries in almost any soil is to incorporate peat moss into the planting medium. For planting directly in the ground, work up a planting area approximately 75 cm in diameter and 30 cm deep for each plant. Remove 1/3 to 1/2 of the soil. Add an equal amount of pre-moistened peat moss and mix well. (One compressed bale will usually be sufficient for 4-5 plants.) For raised beds mix equal volumes peat moss with bark (not cedar or redwood), compost or planting mix. Talk to your local garden center. They're experts in your area and can best advise you on soil amendments. **Spacing.** Blueberries can be planted as close as 60-70 cm apart to form solid hedgerows or spaced up to 1,6 m apart and grown individually. If planted in rows, allow 2,4 to 3 m between the rows depending on equipment used for mowing or cultivating. **Planting. I**n most areas, it is ideal to plant in the fall or spring although in many regions you can plant year round. If you purchased containerized blueberry plants, remove from pot and lightly roughen up the outside surface of the root ball. Mound the plant's top soil about 1 cm higher than the existing ground and firm around root ball. Then mound soil up along sides of exposed root mass and water in well. **Mulching.** Blueberries do best with 5-10 cm of mulch over the roots to conserve moisture, prevent weeds and add organic matter. Bark O Mulch, acid compost, sawdust and grass clippings all work well. Repeat every other year. Do not use bark or sawdust from cedar or redwood trees. **Pruning.** It's a good idea to allow blueberries to get established before allowing them to bear fruit. If you start with smaller plants, simply remove most of the flower blooms as they appear. In future years, blueberry plants should be heavily pruned each year to avoid over-fruiting which results in small fruit or poor growth. In our three decades of experience at Fall Creek, we know that one of the biggest mistakes home gardeners make with their blueberries is lack of pruning. We assure you that aggressive, annual pruning will result in healthier, more vigorous plants and more prolific fruit production. Here are some simple tips: Remove low growth around the base. Remove the dead wood, leaving bright colored lateral branches. Cut out any short, discolored branches. Continue pruning until you have removed 1/3 to 1/2 of the wood out of your plants each year. Remember, this will promote growth and berry production so prune away!				

	Fertilizing. Once established, blueberries like acid fertilizers such as rhododendron or azalea formulations. (Ask your local garden center for recommendations.) Take care when fertilizing, since blueberries are very sensitive to over-fertilization. Follow label instructions. It's ideal to fertilize once in early spring and again in late spring. Be sure to always water thoroughly after fertilizing. For organic fertilizers, blood meal and cottonseed meal work well. Avoid using manures as they can damage the plants. A NOTE TO HOME GARDENERS: We regret that we don't have staff available to respond to home gardening questions on the phone or by email. If you have more questions, please contact your local garden center or extension agents. They're the experts in your area.	
EQUIPMENT:	**Garden tools: trowels, weeders, showels**	**Watering equipment: pumps, hoses, spraying tools**
EQUIPMENT PRICE RANGE	5,00 € - 25€	15,00 € - 350,00 €
ECONOMIC FACTS AND DATA	The prices of the blueberry plant range from 4,00 EUR to 12,00 EUR per plant depending on the sort and age. The price of peat for blueberries is about 6,5 EUR for 150 l. The market prices of berries range from 9,00 EUR to 14-15,00 EUR per kg depending on the season.	
REFERENCE PICTURES		
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=rVhvz7vyPHg https://www.youtube.com/watch?v=ipWf0c067xs https://www.youtube.com/watch?v=Mdyq1Dih4e4 https://www.almanac.com/plant/blueberries https://www.burpee.com/gardenadvicecenter/fruit/blueberries/how-to-grow-blueberry-plants/article10389.html	

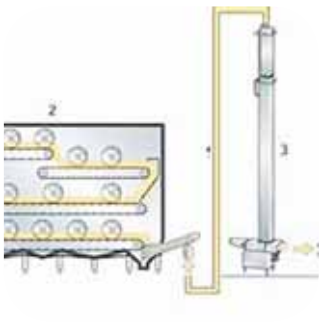
2.1.4. Greenhouse horticulture

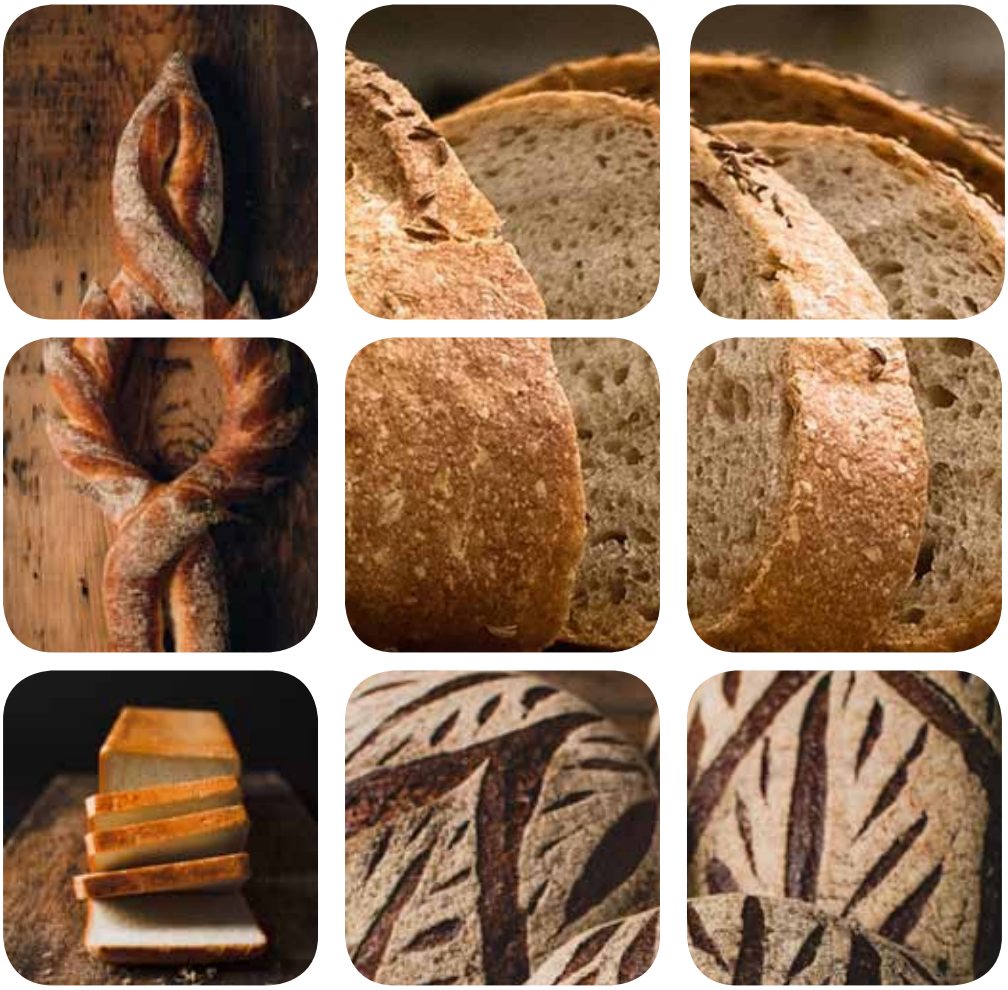
INDUSTRY:	**Agriculture**	**TECHNOLOGY GROUP:**	**Horticulture**	**SPECIFIC TECHNOLOGY**	2.1.4. Greenhouse horticulture
INTRODUCTION:	*Greenhouse horticulture* is the production of horticultural crops within, under or sheltered by structures to provide modified growing conditions and/or protection from pests, diseases and adverse weather. In its broadest definition, greenhouse horticulture includes the use of greenhouses and glasshouses, shade houses, screen houses and crop top structures.				
RELATED KEY WORDS, ABBREVIATIONS:	A greenhouse - a transparent or partially transparent material supported by a structure to enclose an area for propagating or growing plants.				
PROCESS DESCRIPTION:	When looking to develop or expand a greenhouse enterprise, it is important to make sure that the structures are suitable and meet the needs. The shape and design of the structure influences: • the amount of light transmitted • the amount of natural ventilation • the useable internal space • efficient use of structural materials • condensation run-off • heating requirements • the cost. When deciding on a greenhouse design for commercial production, key factors of the greenhouse need to be considered. It is not possible to provide a definitive priority list to suit everyone, but generally, the height of the structure is critical and will have significant bearing on managing the growing environment in a range of conditions. Ventilation is also at the top of the list and roof ventilation is superior to side wall ventilation. Active ventilation systems can also be considered. Heating is essential for controlled environment horticulture and naturally the computer control systems are critical. Covering materials, screens (thermal and insect) and evaporative cooling systems should also be carefully assessed.				
EQUIPMENT:	**Greenhouse structure and covering**		**Ventilation and heating installations**		**Evaporative cooling systems**
EQUIPMENT PRICE RANGE	2000,00€-250000,00€		1500,00€ - 150000,00€		1500,00€ - 150000,00€
ECONOMIC FACTS AND DATA	Greenhouse farming as professional family business can be developed in the land area from 0,5 ha. 0,15– 1,1 € – the price of 1kg of cucumbers. 12–14 kg – the yield of cucumbers from 1 m^2. It is 3 times lower than in the Netherlands. 80 t – average volume of pickled cucumbers per one season. 85thousands units – the number of cucumber seedlings planted in 1 ha. 100 m^3 – the volume of wood needed to equip 1 ha of greenhouse. 5–6 years – service duration of wooden greenhouse. 25 volumes – the average volume of plastic foil for covering of greenhouse per 1 year.				

REFERENCE PICTURES	
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=KBUGdGp7h4c https://www.youtube.com/watch?v=R9vZx-xRdEI https://www.youtube.com/watch?v=8Fl0RTQinno https://www.youtube.com/watch?v=B5Kcc_7PE2I https://www.youtube.com/watch?v=BuAmOvDtrME https://www.wur.nl/en/Research-Results/Research-Institutes/plant-research/Greenhouse-Horticulture.htm https://www.wur.nl/en/Research-Results/Research-Institutes/plant-research/Greenhouse-Horticulture/about-us.htm

2.1.5. Curd cheese products production

INDUSTRY:	Food processing	TECHNOLOGY GROUP:	Dairy products production	SPECIFIC TECHNOLOGY	2.1.5. Curd cheese products production
INTRODUCTION:	Curd making is at the heart of cheese production. It is where the final composition of your cheese – its moisture, pH, and physical characteristics - is determined. There is a wide variety of the curd cheese products which also includes different dessert products, such as glazed curd cheeses.				
RELATED KEY WORDS, ABBREVIATIONS:	Curd - a dairy product obtained by coagulating milk in a process called curdling.				
PROCESS DESCRIPTION:	The coagulation can be caused by adding **rennet** or any edible **acidic** substance such as **lemon juice** or **vinegar**, and then allowing it to sit. The increased acidity causes the milk proteins (**casein**) to tangle into solid masses, or *curds*. Milk that has been left to sour (**raw milk** alone or **pasteurized milk** with added **lactic acid bacteria**) will also naturally produce curds, and **sour milk cheeses** are produced this way. Producing cheese curds is one of the first steps in **cheesemaking**; the curds are pressed and drained to varying amounts for different styles of cheese and different secondary agents (molds for blue cheeses, etc.) are introduced before the desired aging finishes the cheese. The remaining liquid, which contains only **whey proteins**, is the **whey**. In cow's milk, 80 percent of the proteins are caseins. The production of glazed curd cheeses is executed by taking the curd into the bunker of the dosing machine, forming the curd cheeses, cutting off the curd cheeses and directing them to the glazing machine, glazing the cheeses and putting them on the conveyor of the cooler, cooling off the glazed cheeses, automatically wrapping up the glazed cheeses into biaxially orientated laminated polypropylene film, putting on the manufacture date and removing them with the help of removing transporter.				
EQUIPMENT:	**Curd production equipment: curd cheese vats.**		**Glazed curd cheese production line** composed of the following machines: – lift; curd dosing machine; filling and dosing machine; glazing machine; melting kettle for the production of glaze; cooler; transportation guidance system; wrapping up machine.		
EQUIPMENT PRICE RANGE	80000,00 – 200000,00 €		600000€- 1200000€		
ECONOMIC FACTS AND DATA	There are 5 biggest dairies in Lithuania that dominate in this sector: AB Pieno , AB Rokiškio sūris, AB pienas, AB Vilkyškių pieninė and UAB Marijampolės pieno konservai. These dairies process about 94 percent of the all milk in Lithuania. The annual turnover of the all dairies of Lithuania reach about 1 billion EUR. About half of the products are sold in the internal market, another half- exported. Dairies of Lithuania produce a wide range of products: fresh milk products, cheeses, butter, milk powder, condensed milk, lactose, whey powder etc. The main products are cheeses, whose export in 2016 made about 43 % of total export of dairy products. The price of glazed curd cheeses varies from 0,20 to 0,80 EUR.				

REFERENCE PICTURES	        
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=HOtC2Fexqdk https://www.youtube.com/watch?v=-G0UIu84nnY https://www.youtube.com/watch?v=dQ6LZ6MgSek https://www.youtube.com/watch?v=dYWKOntNoqI https://www.youtube.com/watch?v=YjRiDhyIjvo https://www.youtube.com/watch?v=eOhO0bhLndw http://www.suris.lt/ http://www.szes-la.cz/stat/projekty/erasmus/vystupy/cz_08_list02_quark.pdf http://dairyprocessinghandbook.com/chapter/cheese



2.1.6. Lithuanian Dark Rye Bread baking

INDUSTRY	Food processing	TECHNOLOGY GROUP:	Bakery	SPECIFIC TECHNOLOGY	2.1.6. Lithuanian Dark Rye Bread baking
INTRODUCTION:	One of the oldest and most fundamental Lithuanian food products was and is rye bread. Rye bread is eaten every day for breakfast, lunch and dinner. Two kinds of bread are traditional, plain fermented and scalded. Plain fermented bread has been baked from earliest times, while scalded bread has only been baked since the start of the 20th century. Plain bread ferments overnight but needs to be kneaded for a long time, while scalded bread fermentation takes almost 3 days.				
RELATED KEY WORDS, ABBREVIATIONS:	Fermentation - a metabolic process that consumes sugar in the absence of oxygen.				
PROCESS DESCRIPTION:	There can be distinguished home-made and industrial baking of dark rye bread. In case of traditional home-made baking, the starter is used to leaven black rye bread. Starter is usually a leftover of dough from the last bread baking. Just before baking, the saved piece of dough is dissolved in warm water and is added to the newly mixed dough. Should there be no starter a new starter is prepared before mixing new dough by mixing all starter ingredients, keeping in a warm spot to ensure maximum fermentation. This starter should be ready in 24 hours. Starter gives bread an agreeable, pleasant sour taste. Every starter has its own particular taste. Some homemakers add sour milk in place of water. To make dough, the water is heated to 40-45C, poured half of the flour, starter and mixed well. Sough is sprinkled with flour and set in a warm spot to ferment. During fermentation the volume of dough will almost triple. Fermentation is complete after about 14 hours. Then dough is beaten, added remaining flour, salted and kneaded well. Then the top of dough is smoothed, dampened with wet hands, covered and set in warm spot to rise for about 3 hours. The baking pans are prepared by lining them with maple or cabbage leaves or dust with flour. Oblong loaves are formed, smoothened tops with damp hands. Bread is baked in preheated oven at 200C, for about 2-3 hours. Bread is done when it gives off a solid sound. The industrial baking of dark rye bread is also prepared in a traditional Lithuanian way, without using any preservatives and food additives. There are used the same core ingredients - rye meal and flour, water, sugar, fermented rye malt, yeast, iodized salt, caraway seeds. The above described processes of preparation of dough is executed in the industrial vats, the loaves can be formed by hands of machines and the bread is baked by using industrial ovens, afterwards can be sliced and pre-packed.				
EQUIPMENT:	**Vats and mixers for the preparation and fermentation of dough**		**Oven (for hand-made traditional baking)**		**Industrial ovens and packing lines**
EQUIPMENT PRICE RANGE	Home -made baking: 50,00 €-150,00€ Industrial: 80000,00 – 200000,00 €		5000-20000,00 €		300000,00€ - 1500000,00€

ECONOMIC FACTS AND DATA

In the food industry of Lithuania bread production is the second branch after the dairy industry.

The biggest industrial bakeries in Lithuania include "Vilniaus duona", "Fazer Lietuva" and "Klaipėdos duona".

In the last years the consumption of bread products, especially dark bread is decreasing.

However, there can be noticed increase of demand of other bread products, including the light bread.

There is increasing market possibilities for the small bakeries supplying fresh and home made bread.

Average cost-effectiveness of the bread bakery is about 15 - 20 percent. Cost-effectiveness of the wheat bread, cake and confectionery bakery can reach up to 40 percent.

Dark formed bread

	Starter		**Raw materials 1 kg/EUR**	**Price of raw materials**
1	Flour	0,15	0,29	0,04
2	Caraway seeds	0,03	1,16	0,03
3	Water	0,35		0
	Dough		**Raw materials 1 kg/EUR**	**Price of raw materials**
1	Mix "Promyk"	2	1,45	2,9
2	Water	1,1		0
3	Liquid malt	0,1	1,16	0,12
4	Starter	0,5		0,08
5	Salt	0,01	0,14	0,00
6	Yeast	0,06	0,68	0,04
7	Starter pate "Ritesa"	0,015	3,18	0,05
8	Sugar	0,06	0,52	0,03
	Total	**3,845**		**3,22**
	Price of 1 kg , EUR	**0,84**		

1. Liquid dough
2. Temperature of dough t°C about 24 - 26°C
3. Dough fermentation lasts 30 - 40 minutes
4. The dough can be formed (split) mechanically – requires more flour, or manually by putting the dough into forms.
5. Final fermentation at 34 - 36°C, lasts 40 - 60 min
6. Baking at 260°C (with steam), baking at 210°C about 30 - 40 min

REFERENCE PICTURES	
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=iUuKstAWof4 https://www.youtube.com/watch?v=Bl85pCb2UEU https://www.youtube.com/watch?v=3UjUWfwWAC4 https://www.youtube.com/watch?v=swn8W0iyoko https://www.thespruceeats.com/top-lithuanian-bread-recipes-1136748 https://www.thespruceeats.com/lithuanian-dark-rye-bread-recipe-rugine-duona-1136744 http://www.lnkc.lt/eknygos/eka/food/bread.html

2.1.7. Processing of herbs

INDUSTRY	Food industry	TECHNOLOGY GROUP:	Processing of herbs, herbal tea production	SPECIFIC TECHNOLOGY	2.1.7. Processing of herbs

INTRODUCTION:

Herbal tea is a healthy and tasty drink which increasingly gains the popularity amongst the consumers worldwide. It presents healthy alternative to the traditional coffeine containing hot drinks wht makes it attractive choice for the people who choose healthy and environmentally friendly and sustainable life-style. Besides, herbal tea is also considered as a medicine helping to treat many diseases and facilitating recovering from them. The herb industry is also one of the key suppliers for perfume industry which uses oils that are obtained from herbs to make perfumes. The pharmaceutical industry also derives significant raw product from herbs, and the food industry obtains flavourings of all types from herbs. Even the mint that flavours our tooth paste comes from herbs. There are many alternative therapies that attribute medicinal properties to plants – aromatherapy, flower therapy, herbal medicine, to name but a few.

Cultivation and especially processing of the herbs is a complex, challenging and very interesting technological process. Processing of herbal tea can be executed not only at the industrial level, but also on the small scale in the home conditions.

RELATED KEY WORDS, ABBREVIATIONS:

Herbal tea, drying and dehydrating, cutting, threshing, mixing, blending.

PROCESS DESCRIPTION:

Cultivation of medicinal herbs and plants. Mass-production of herbs and plants comes first from mechanization in cultivation and is an important phase for the preparation of the green product. In this step it is highly important to ensure that that all the natural properties of the product are preserved and enhanced and that, at the same time all the useless and noxious parts are eliminated.

Drying and Dehydrating. Drying or Dehydrating high quality freshly picked herbs and medicinal plants is also a critical technological process. In order to preserve the natural properties it is important to ensure a short time at low temperatures of drying. To attain it there are used stainless steel bulk barns with drying systems and silica gel dryers equiped with the with stainless steel loading trays and PLC system to memoprize and control different cycles of drying for different herbs.

Cutting, threshing, classification. A dried product is processed by cutting, threshing, screen separation and airblow classification. These processes can be executed separately or can be integrated in one production line. During these processes heavy elements are separated from light (seeds from husks), long from short (leaves from stems), little from big (teacut from teabagcut).

Mixing, blending is executed with belt mixers that accurately blend different products (herbal teas) or make uniform batches of the same product. Such technologies also allow to reduce considerably the volume of the product, preserving only the active compounds and eliminating all undesired parts such as dirt, sand, dust and stones. A metal detector can also be installed to prevent iron particles going into the product.

Packing of the product is executed by automatic packing machines, that execute the dosing of herbal tea, packing into teabags or loose tea packings, putting into labeled boxes.

EQUIPMENT:	Drying and Dehydrating	Cutting, threshing, classification	Mixing, blending	Packing of the product
	Dryer containers Stainless steel bulk barns with drying systems and silica gel dryers equiped with the with stainless steel loading trays and PLC system	Production line for cutting, threshing and classification Mills for dried plant mass Jagged roller mills Centrifugal mills Vibrational sieves and conveyors Sieves and conveyors Pneumatic separators	Belt mixers	Packaging machines for packing into tea bags Packaging machines for bulk packaging
EQUIPMENT PRICE RANGE	20000 – 600000 EUR	50000-3000000 EUR	100000-300000 EUR	500000 – 1500000 EUR

ECONOMIC FACTS AND DATA	The world production of herbs is now estimated at more than 0.5 million tons per year and consists mainly of dried herbal raw materials produced for pharmaceutical purposes. The turnover of medicinal and aromatic plants includes approximately 2000 species. The European market is one of the most important consumers of this production. In Europe, due to the climate and soil conditions Mediterranean as well as Central and East European countries are the best localizations for growing herbs. Total area occupied by the species of plants is approximately 70,000 hectares. The largest suppliers of herbal material are France, Poland, Spain, Germany and Austria. European herbal industry processes approximately 200 species, mainly from field crops. Gathering from natural habitats is marginal today, as obtaining a uniform mass product from this source is difficult. Source: https://pdfs.semanticscholar.org/154f/7c2abdc8ab1186b7e1ddcbd68597d0cf7a3c.pdf
REFERENCE PICTURES	
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=KU2_wMYBXrk https://www.youtube.com/watch?v=uuI_RDiZPi4 https://www.youtube.com/watch?v=uVXGVV_rLIA https://www.youtube.com/watch?v=GUQ24wgYvfw https://www.ricola.com/en/experience/processing http://www.wildnesswithinliving.com/blog/2016/3/28/the-process-of-processing-herbs

2.1.8. Smart food production

INDUSTRY	Food industry	TECHNOLOGY GROUP:	Food processing	SPECIFIC TECHNOLOGY	2.1.8. Smart food production

INTRODUCTION:

Smart foods are those that have been developed through the invention of new or improved processes, for example, as a result of man-made materials/ingredients or human intervention; in other words, not naturally occurring changes.

Smart foods may:

- have a function, other than that of providing energy and nutrients;
- perform a particular function never achieved by conventional foods;
- have had significant investment of intellectual property;
- have been developed for specialised applications, but some eventually become available for general use.

The British Nutrition Foundation (BNF) and the Design and Technology Association (DATA) classify smart foods as:

- foods with novel molecular structures, e.g. modified starches, fat replacers and sweeteners
- functional foods, e.g. cholesterol - lowering spreads, probiotic yogurts, fortified eggs
- meat analogues, e.g. textured vegetable protein (TVP), myco-protein and tofu
- encapsulation technology, e.g. encapsulated flavours in confectionery
- modern biotechnology, e.g. soya bean, tomato plant, particular enzymes

Source: http://www.foodafactoflife.org.uk/attachments/26596934-b2e7-4c1c0b32122b.pdf

Natural food scarcity amid the exponentially growing population of the planet questions the future of agriculture and challenges food manufacturers, engineers and bioscientists to discover new sustainable solutions.

Metalworks, the R&D branch of the media agency Maxus predicts that in the next decades technology will redefine the food and drinks industry as well as our attitude to nutrition. Among the biggest challenges of the humanity, the researchers name growing of biotech/engineered food with modified characteristics and smart food-waste management. Other trends to watch will include creation of new food experiences, new types of interaction with the "Internet of food", as well as innovative concepts of ready-to-consume and 3D-printed foods. None of these challenges and trends are new as such, most of them were analyzed and predicted by the Popsop team back in 2013.

Nevertheless, here are the highlights from the Metalworks food trends report, as follows:

1. Lab-grown foods and smart tools for personalized healthy nutrition are already a reality and they will be further developing. First engineered beef was cultivated from muscle cells of livestock in a London lab in 2013. As an alternative to real meat, two California-based innovative companies Beyond Meat and Hampton Creek produce plant-based substitutes of meat with the same nutritional value. Their produce is available in local supermarkets.

2. As conscious food consumption grows, numerous food-related platforms, apps and tools will appear massively. Some are designed to minimize food waste, such as LeftoverSwap, others inform consumers on GMO content, such as Fooducate. There are also electronic devices like Tellspec that analyzes the chemical composition of food and detects harmful ingredients such as nitrates or potential allergens.

3. Bars and restaurants will use technology to provide customers with data-based fast services or immersive emotional experiences beyond the taste of food and drinks. A handful of restaurants in Asia already uses robotic wait and cooking staff to save on wages. A San Francisco-based chain of smart restaurants Momentum uses a robo-cook that makes 360 deli burgers per hour.

4. The 'Internet of Things'—app-connected smart devices—will find their places in the kitchen too. Samsung has already presented a WiFi-connected refrigerator; GE has partnered with an outsourcing incubator Quirky to fund the development of a smart jar that informs a user when the milk will go bad. Some start-ups also experiment with the 'Internet of Food', creating smart frying pans, such as Pantelligent, or Bluetooth-enabled thermometers to measure the temperature of the cooked food, such as iGrill mini for grilled meat.

5. Food 3D-printers and nanopackaging may revolutionize the way the dishes are cooked and how the ingredients are stored. This year, Hershey's created a chocolate machine CocoJet that 'printed' dark, milk or white chocolate.

The use of nanopackaging will give a longer shelf life to products without any preservatives, which results in less food waste, healthier nutritional options and lower costs for both manufacturers and consumers.

Source: http://popsop.com/2015/05/how-technology-changes-the-future-of-food-5-trends-to-watch/

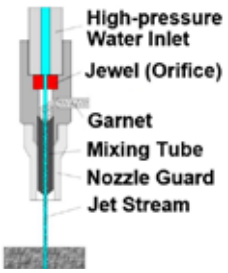
RELATED KEY WORDS, ABBREVIATIONS:	Smart foods Modified starches Low-fat products Sweeteners Encapsulation technology Biotechnology
PROCESS DESCRIPTION:	The transition of food production from domestic to industrial contexts has resulted in new problems in terms of product consistency and quality. Although variation of quality would be tolerated on a domestic level, consumers expect consistently high standards in the food products that they purchase. In addition, health concerns and advances in scientific understanding have presented new possibilities in ingredient technology. Novel molecular structures may focus on (for example): · modified starches, e.g. pre-gelatinised starch; · fat replacers, e.g. olestra; · sweeteners, e.g. aspartame. Modified Starches Starch consists of two types of glucose polymers: amylose and amylopectin. They occur together in starch granules, with approximately 20-25% usually being amylose. However, 'waxy' varieties of starch, e.g. maize, have very little amylose. When gelatinised starch solutions are allowed to stand for a few hours, they begin to show changes in their rheological properties. For example, dilute solutions lose viscosity, and concentrated gels become rubbery and exude water. Both types of change are due to a phenomenon called retrogradation, which involves the amylose molecules. This is because, within the gelatinised solution, amylose acts to bind together the expanded granular structure of amylopectin molecules. Understanding this natural phenomenon has led to the production of modified starches, which can be altered to provide consistent results, tailored to the needs of the product. Starch may be modified by physical means (e.g. heating and shearing) or chemical treatment (e.g. oxidation, derivatisation). Demand for low-fat products has been driven by consumer interest in health, in general, but particularly by a concern about energy intake and, in some cases, fat. In the UK, 45% of men and 33% of women are overweight; 17% and 21%, respectively, are obese. Fat replacers can be a useful tool in reducing fat intake and can help reduce total energy intake. Examples of fat replacers are: Carbohydrate and protein-based · Modified glucose polymers · Modified starches, e.g. maize, potato and rice · Native proteins, e.g. gelatine, maize protein, whey-protein concentrate Lipid-based · Fatty acid esters of sugar or sugar alcohols · Medium-chain triacylglycerols · Emulsifiers, e.g. polyglycerol esters, lecithin. Sweeteners are classed as either intense or bulk. Intense sweeteners, e.g. saccharin and aspartame, are many times sweeter than sugar and so are only used in tiny amounts. This makes them suitable for use in products such as diet drinks, which are very low in energy. Bulk sweeteners, e.g. sorbitol, have a similar sweetness to sugar so are used in similar amounts. They are used in sugar-free confectionery. Encapsulation technology is applied in many industries, including food, medicines, fragrance and scratch-n-sniff products. Within food technology, encapsulation is used to: • act as a vehicle for the addition of yeast in brewing or lactic acid starter cultures in dairy fermentation · enhance the appearance or flavour of food through natural and artificial flavours and colours • fortify food products with additional nutrients, e.g. functional foods • aid preservation · ensure consistency.

	Why encapsulate? Encapsulation technology can: • achieve a controlled release of a core material, e.g. sustained release of the core material over a period of time at a constant rate · mask the taste of a capsule's core · reduce the reactivity of core material, e.g. to oxygen and water · ease the handling of the core, e.g. by prevent lumping, converting a liquid to a solid and by being easy to mix · dilute the core material, when used in small amounts, but achieve a uniform dispersion How are the core materials released? Core materials within capsules may be released through the shell by: • mechanical compressive force · dissolving in liquid (e.g. flavour capsules in a powder being diluted) · melting during baking · breaking and opening due to the shear in a blender · diffusing at a slow rate due to water or temperature increase. What is modern biotechnology? Traditional breeding methods involve many generations of livestock or crops, which takes considerable amounts of time for desirable traits to be achieved, e.g. cross breeding pigs to produce pork with less fat. Newer modern biotechnology techniques allow scientists to identify individual genes that control particular characteristics. The selected gene can be transferred to another plant or animal to bring about a desired change more rapidly. This technique is quicker than traditional methods and is more exact. Its primary advantage is the ability to introduce or remove selected genetic material to an existing species. However, the benefit must be carefully assessed and will be subject to rigorous safety assessment. Conventional breeding can also be used with modern biotechnology to improve varieties and will still be used where possible. Genes, DNA and traits All plant and animal cells contain genes, which determine their individual characteristics, e.g. the colour of a plant's leaves. Genes are composed of specific lengths of deoxyribonucleic acid (DNA). DNA is made up from two strands intertwined in a spiral - this is known as the double helix. Each strand is made up from four nucleotide bases; the amounts of these bases vary. The bases are put together in different sequences to create a unique code. Each code carries a particular instruction which the cells follow to reproduce individual traits, e.g. height and colour. Understanding the nature of DNA has led the way to modern biotechnology, sometimes referred to as genetic modification. Modern biotechnology allows specific sequences of DNA to be manipulated to modify the characteristics in plants and animals. Source: http://www.foodafactoflife.org.uk/attachments/26596934-b2e7-4c1c0b32122b.pdf	
EQUIPMENT:	High-pressure homogenization equipment for processing everages, sauces and other fluid products; separators for pruducing ESL extended shelf-life) milk by reducing the bacterial count prior to asteurization; freeze dryers helping to prolong the shelf-life of food by drying deep-frozen food in a vacuum to vaporize the ice; refrigeration technologies providing innovative freezing and chilling technology throughout the production, transport and storage of food.	Modified atmosphere packaging for powdered bulk products by extending their shelf-life to several years .
EQUIPMENT PRICE RANGE	-	-
ECONOMIC FACTS AND DATA		

REFERENCE PICTURES	
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=ezNYkz9a0XI https://www.youtube.com/watch?v=ja0UOi8VlvQ https://www.youtube.com/watch?v=4xFH2CZ5pAI https://www.youtube.com/watch?v=hw321SwC6kA http://www.fao.org/docrep/014/i2454e/i2454e00.pdf

2.2. Metal Processing and Machinery

2.2.1. Turning, Milling, Drilling, Laser cutting, Waterjet cutting

INDUSTRY	Metal processing	TECHNOLOGY GROUP:	Metal cutting	SPECIFIC TECHNOLOGY	2.2.1. Turning, Milling, Drilling, Laser cutting, Waterjet cutting
INTRODUCTION:	Metal cutting proces is an industrial proces in which metal parts are shaped by removal of unwanted material. In traditional chip-forming processes, such as turning, drilling, and milling metal is removed as a plastically deformed chip of appreciable dimensions. Metal cutting is one of the most widely used method for metal parts forming allowing to get parts with defined dimensions and shapes and required surface roughness. Sheet metal cutting most widely is used by help of lasers or water.				
RELATED KEY WORDS, ABBREVIATIONS:	CNC – computer numerical control. Tool bit – a non-rotary cutting tool. Milling cutter – a rotary cutting tool. Cutting fluid – fluid for cooling and lubrication during the metal cutting. Lasers – a narrow single color beam of light. Abrasive jet – jet of fine abrasive particles, usually about 0.025 mm in diameter. Tool bit  Milling cutter  Drill  Cutting fluid  Abrasive jet 				

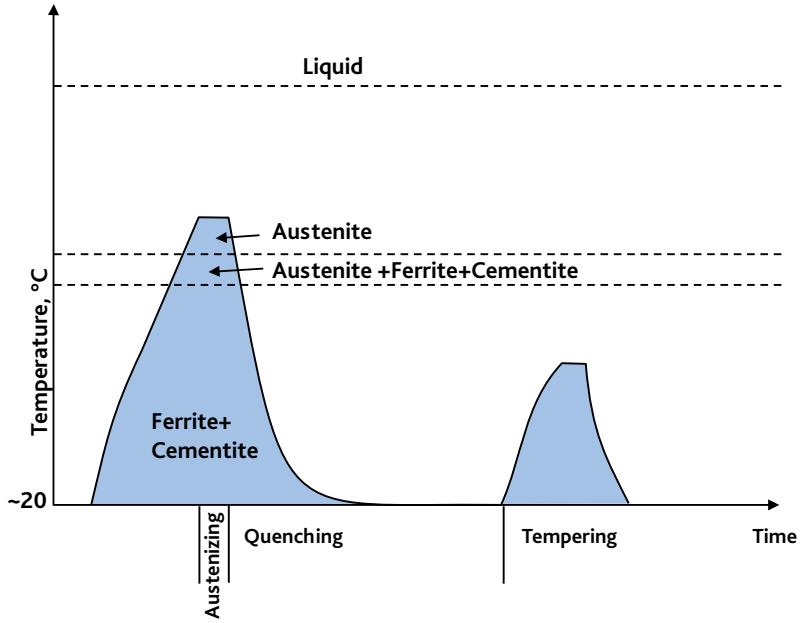
PROCESS DESCRIPTION:	**Turning** is a machining process in which a non-rotary tool bit describes a helix toolpath by moving more or less linearly while the workpiece rotates. Turning can be done manually, in a traditional form of lathe, which frequently requires continuous supervision by the operator, or by using an automated lathe, which does not. Today the most common type of such automation is CNC. https://www.youtube.com/watch?v=8EsAxOnzEms **Milling** is a cutting process that uses a milling cutter to remove material from the surface of a workpiece. The milling cutter is a rotary cutting tool, often with multiple cutting points. As opposed to drilling, where the tool is advanced along its rotation axis, the cutter in milling is usually moved perpendicular to its axis. https://www.youtube.com/watch?v=Ef59DogwLrI **Drilling** is a cutting process that uses a drill bit to cut a hole of circular cross-section in solid materials. The drill bit is usually a rotary cutting tool. The bit is pressed against the workpiece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the workpiece, cutting off chips from the hole as it is drilled. https://www.youtube.com/watch?v=KYfAjakKO5w **Laser cutting** is a technology that uses a laser to cut materials, and is typically used for industrial manufacturing applications. Laser cutting works by directing the output of a high-power laser most commonly through optics. The laser optics and CNC are used to direct the material or the laser beam generated. The focused laser beam is directed at the material, which then either melts, burns, vaporizes away, or is blown away by a jet of gas, leaving an edge with a high-quality surface finish. https://www.youtube.com/watch?v=PlF_oXvbu4s **Waterjet cutting** is a technology that uses a very high-pressure jet of a mixture of water and abrasive substance for metal cutting. https://www.youtube.com/watch?v=XfGkLsUm92Q https://www.youtube.com/watch?v=lMSGHJ8GJ1A		
EQUIPMENT:	**Turning machine**	**Drilling/Milling machine**	**Laser metal cutting machine**
EQUIPMENT PRICE RANGE	1000 – 40 000 EUR … > 100 000 EUR	600 – 20 000 EUR … > 100 000 EUR	8000 EUR … > 100 000 EUR
ECONOMIC FACTS AND DATA	Metal price depends on metal type, sizes and quality. Low-carbon steel. Sheet metal and standard profiles – 1.5 … 2.5 EUR/kg. Stainless steel. Sheet metal – 3.5 … 6.5 EUR/kg. Aluminium alloys. Sheet metal and standard profiles: > 3.5 EUR/kg. Laser and water cutting: different sizes (for example sheets 4000x2000x20 mm). Instrument price depends on design and application. Turning: tool holders – 300 … 500 EUR/ps, inserts – 10 … 20 EUR/ps. Milling: tool holders – 300 … 3000 EUR/ps, inserts – 10 … 20 EUR/ps. Drilling: solid carbide drills – 40 … 300 EUR/ps. Metal cutting service price depends on tchnology and equipment. Turning (CNC) – 35 … 50 EUR/h. Milling (hand/CNC) – 25 … 35 EUR/h. Drilling – 15 … 20 EUR/h. Laser cutting – 25 … 35 EUR/h.		

REFERENCE PICTURES

2.2.2. Heating and cooling

INDUSTRY	Metal production and processing	TECHNOLOGY GROUP:	Heat treatment	SPECIFIC TECHNOLOGY	2.2.2. Heating and cooling
INTRODUCTION:	As long ago as Greek and Roman times it was known that the sharpness of a sword could be improved by rapidly cooling it after heating it up to forging temperature. The reasoning for that was not known though. The term heat treatment in most people's mind associates with hardening **-** making material harder, increasing its strength. It is not so much known, however, that the processes for making the material purposely softer are also covered with this term. Moreover, heat treatment is not constrained with metals only; even some glass grades are heat treatable. For example, car windows are made from heat-treated glass (called tempered glass) because if it really breaks then only to safe tiny pieces.				
RELATED KEY WORDS, ABBREVIATIONS:	Hardening, heating, cooling, quenching, stress relief, heat treatment cycle, tempering, annealing, process anneal.				
PROCESS DESCRIPTION:	The term heat treatment is used to describe the controlled heating and cooling of materials for the purpose of altering their structures and properties. The same material can be made weak and ductile for ease in manufacture, and then retreated to provide high strength and good fracture resistance. Whether you want to make a ductile machine shaft or a hard file **-** anything is possible! Because both physical and mechanical properties can be altered by heat treatment, and these changes can be induced with no concurrent change in product shape, heat treatment is one of the most important and widely used manufacturing processes. More than 90% of heat treatment is performed on steel and ferrous metals. Other heat treated alloys are Al-, Cu-, Ti- or brass alloys. Heat treatment is not always for increasing strength or hardness. Sometimes is necessary to make the materials purposely softer – reveal internal stresses, make material more or again plastic for bending, stretching, etc. Such heat treatment is called processing heat treatment as it prepares the material for fabrication. Steel, composed primary of iron (mostly over 95%) and carbon, is clearly the most important of the engineering materials. It is thermally treatable because iron can exist in different crystal structures: in room temperature it exist as ferrite but in higher temperatures as austenite. In steels, ferrite can contain only a fraction of carbon, which forces the creation of two-phase mixture. The rest of carbon is in another phase called cementite. Heating to austenite forming temperature is called austenizing. Austenite can accommodate around 10 times more carbon and two-phase structure transforms to one phase structure. If such structure was slowly cooled, it would change again to room two-phase structure. By fast cooling (quenching) carbon has no time to transform to two phases yet cannot stay in high temperature only existing austenite. Another phase called martensite will be formed. Basically, martensite is a ferrite where all excessive carbon atoms are entrapped inside. This increases the hardness considerably. Increased hardness means increased strength and wear resistance but the toughness is very low https://www.youtube.com/watch?v=fLvZkZxiXnE. Such material is not practically usable. In order to have better toughness values we have to do heat treatment cycle called tempering. Hardening is always followed by tempering and tempering is not done without hardening! By changing the tempering temperature we can balance between hardness/strength and toughness. There is always a mutual sacrifice: either we have high hardness and tensile strength but low toughness or vice versa. Low tempering temperature is for former and high tempering temperature for later case. For example, a file has to maintain its filing properties for a long time and its impact resistance is not so important. In order to achieve that, its tempering temperature must be from lower end. A chisel is working in impact conditions. By making low temperature tempering only, its cutting edge would be sharp for long time but would break under dynamic loads. The tempering temperature should be higher. Another good example is cutting dried spruce branches with an heat treated axe. If the hardness is too low (high temperature tempering) the cutting edge will be plastically deformed and obtains "S" shape in contact area. If the hardness is too high (low tempering temperature) the cutting edge would crack.				

The most classical heat treatment is heating in air containing furnace and cooling in water.



Heat treatment of nonferrous materials is very different phenomena. The principal difference lies in the mechanisms by which hardening and strengthening are achieved. The process itself might be similar that first stage is heating to elevated temperature, holding and followed by quick cooling. However, after heating and quenching the hardness decreases and formability increases on the contrary. The hardness along with strength starts to increase after certain period. This period is so-called incubation period when the material is easily formable. It has high technological importance. As the hardness increases with time, the process is often called aging. Aging time can be shortened by heating to moderate temperatures.

EQUIPMENT:	**Simple batch type furnace**	**Vacuum furnace**	**Continous heat treatment line**
EQUIPMENT PRICE RANGE	800 – 1500 €	~ 800000 €	> 800000 €
ECONOMIC FACTS AND DATA	Heat treatment costs only a fraction of product final price but extends many times its life		
REFERENCE PICTURES			

Figure 1. Load removal from a furnace hold in austenizing temperature. Heat treatment temperature can be evaluated by parts glow

Figure 2. Cylindrical part removal form protective case for quenching

Figure 4. Car wind1ow heat treated glass

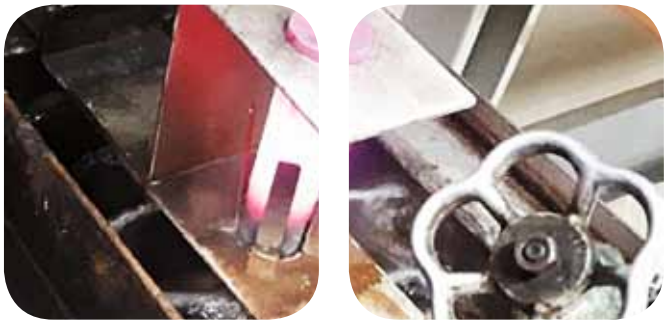


Figure 3. Quenching the same cylindrical part by cooling its one end with flowing water. Cooled end can be distinguished by colour

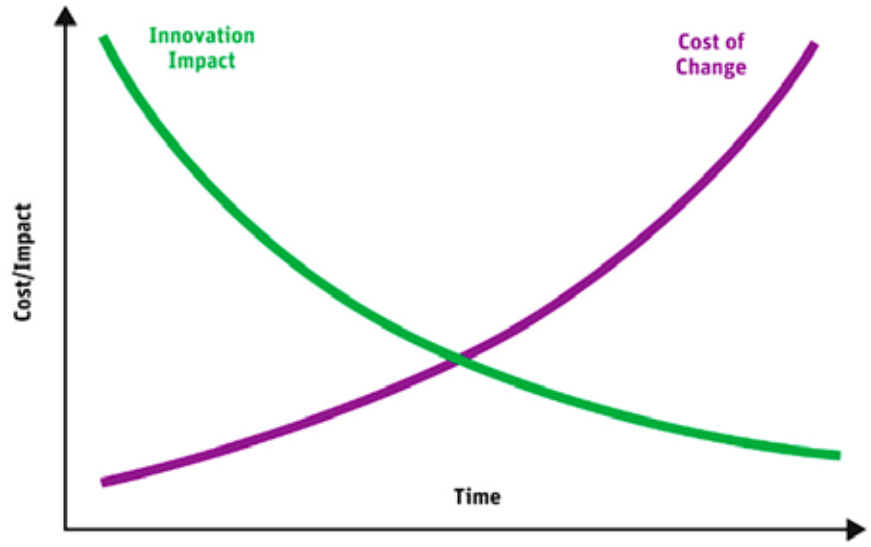
Figure 5. Hardening influence to the mechanical properties. 1 – soft and ductile part without hardening, easily bendable; 2 – hardened part without tempering, really fragile and breaks already applying minor force; 3 – hardened and high temperature tempered, bendable only by applying bigger force; 4 – hardened and tempered with optimum tempering, bendable only slightly and when by applying big force

2.2.3. Engineering Design

INDUSTRY	Machinery	TECHNOLOGY GROUP:	Engineering Design	SPECIFIC TECHNOLOGY	2.2.3. Engineering Design
INTRODUCTION:	The general objective of Engineering Design (as compared to Design) is to "make" mechanical systems perform as we expect. Good engineering design gives you objects, that are functional, reliable, safe and cost effective. If some product or thing around you often breaks, quickly wears off, badly rusts or fails in some other way or cannot due the job in normal use – this is usually due to bad engineering design.				
RELATED KEY WORDS, ABBREVIATIONS:	Machine design, GrabCad, CAD, how things work, amazing robots, engineering design				
PROCESS DESCRIPTION:	The engineering design process is a series of steps that guides engineering teams as they solve problems. All possible aspects, that the product quality depends on, must be considered in detail. Engineering design process is mostly a teamwork. https://www.youtube.com/watch?v=bipTWWHya8A&index=23&list=PLyGJI5XXNa5SxyMYuFUWP4d0nx5DC6sgP Good engineering design is based on the understanding how things work and, more imporatantly, what may go wrong if not addressed properly. Engineering design heavily relies on engineering knowledge and experience. https://www.youtube.com/watch?v=EXP58ykBhEg Fascinating engineering designs https://www.youtube.com/watch?v=F9_m2xvwxpk Fascinating engineering designs https://www.youtube.com/watch?v=ZjzXWr1rhdQ Car engine design and operation principles explained https://www.youtube.com/watch?v=N7lWM_yDxU0 Door lock design and operation principles explained https://www.youtube.com/watch?v=WX8NG0275R4 Door handle design and operation principles explained https://www.youtube.com/watch?v=3MUL65-vZHY Watch movement design and operation principles explained https://www.youtube.com/watch?v=HMROEMSc-Kk Innovative technological solutions for car parking Engineering design is always a problemsolving. The first step of it is understanding the basic problem being addressed and its solution requirements. For example, shall the device be operated by motor or manually, used indoors or outdoors, what performance is expected, etc. Any engineering problem can be solved in many ways. Next important step is data collection and solution ideas brainstorming. "**If you have just one idea for the solution, it is probably a bad one. If you have 100 ideas, there is probably one good among them**". After that the collected ideas must be evaluated with all known advantages and disadvantages considered. The most promessing one must be predicted for future development to the more detailed level. The best conceptual solution is then refined based on engineering calculations and testing in iterative manner. The whole engineering design process is iterative, meaning that the steps above are repeated as many times as needed, making improvements as the amount of engineering data increases or by learning from failures.				
EQUIPMENT:	**Meccano systems, LEGO systems, robot building kits, materials, workshop tools**		**Simple basic 3D CAD software**		**3D printer + testing equipment**
EQUIPMENT PRICE RANGE	a 100.- € + …				6000.- + 6000.-

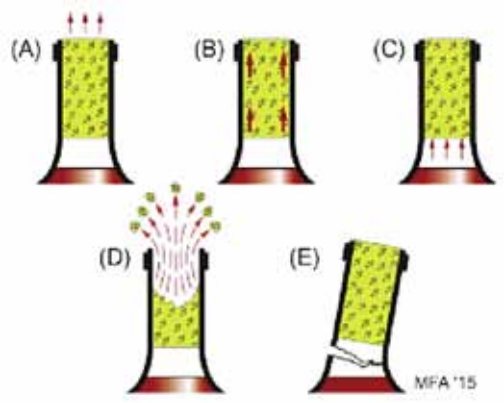
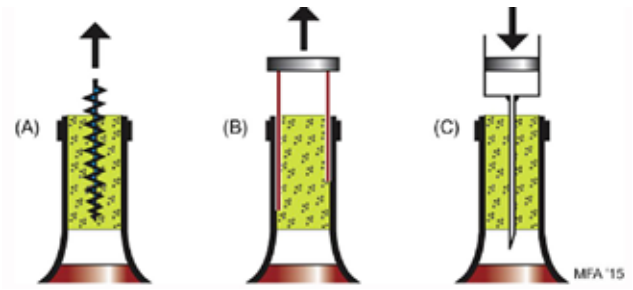
ECONOMIC FACTS AND DATA

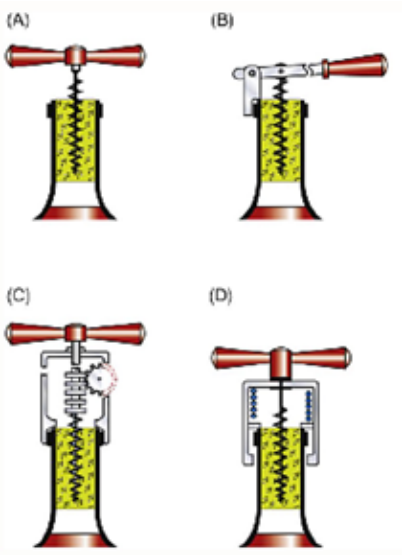
https://www.ansys-blog.com/engineering-simulation-the-10x-multiplier-to-top-line-growth/



	Concept Design	Detailed Design	Prototyping	Evaluation	Production Ramp-Up
Cost/Resolution	1X	10X	100X		1000X
Innovation Impact	1000X	100X	10X		1X

It is vital in engineering design to realise the importance of the **procedure' first phases**, where the basic solution ideas are generated with minimum cost. It would be much more difficult and costly, if this wasn't done properly and we have to change things at the later stages of engineering design procedure.

REFERENCE PICTURES	https://reader.paperc.com/books/Materials-Selection-in-Mechanical-Design/605626/Contents An example below of neering design procedure from need to final solution in order to illustrate the variety of engineering design options in all stages of product development.  Market need = engineering problem: " The liquid in corked bottle must be effectively accessed".  Five possible conceptual ideas, how it could be done, each having certain advantages and disadvantages. (A): axial pull; (B): shear assisted pull; (C): pressure push from inside; (D): cork destruction; (E): bottle neck removal.  There are technologies and tools available on the market in order to use the first three ideas. The last two ideas are considered obsolete due to prevailing disadvantages.



Four possible methods in order to use the first technology: axial pull.

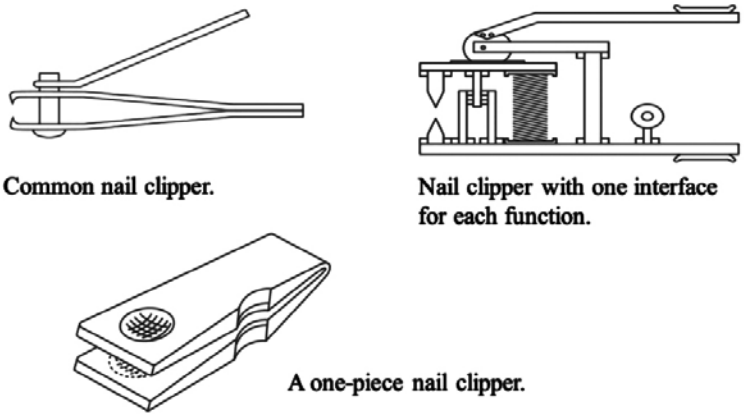
(A): direct pull; (B): lever assisted pull; (C) gear assisted pull; (D) spring assisted pull

Final engineering design solution for method (B): lever assisted pull

Final engineering design solution for method (C): gear assisted pull

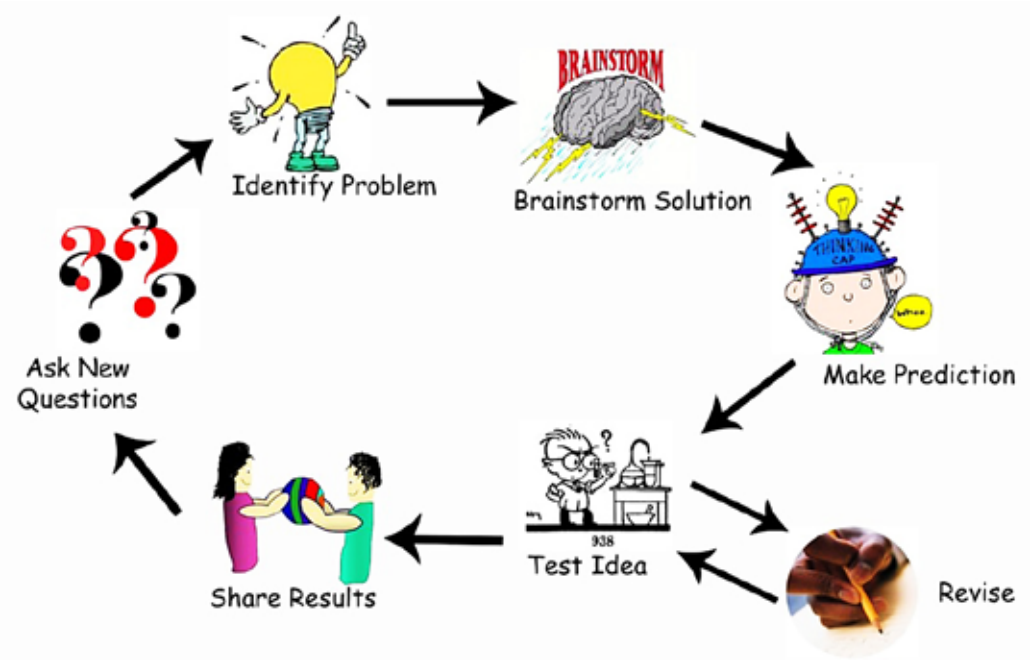
Final engineering design solution for method (D): spring assisted pull

http://www.omerohome.com/product/handcrafted-italian-spring-assisted-corkscrew-cow-horn



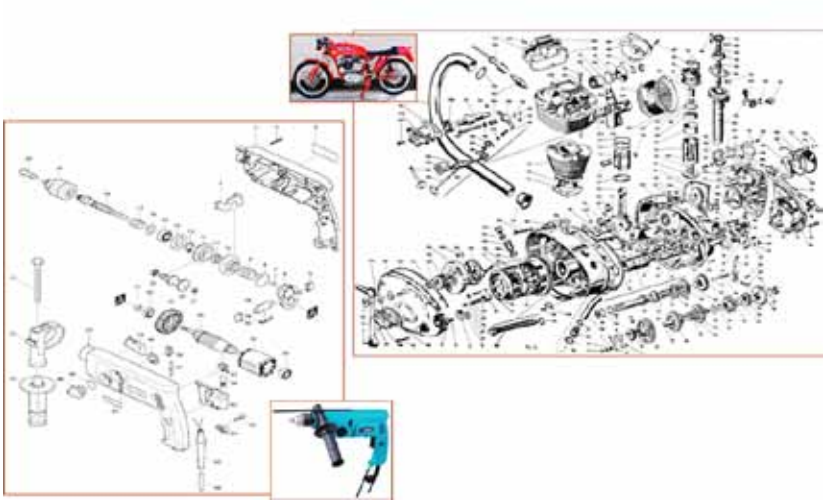
Different engineering solutions for nail clipper design

https://www.slideshare.net/illuminationgroup/ch-11-ullman-the-mechanical-design-process-4th-edition-75691873



http://compscienceedu.blogspot.com.ee/2013/07/engineering-design-process.html
Adequate engineering design process

Mechanical structure and its components



A design engineer' task IS NOT:

to design the world best machine or structure.

A design engineer' task IS:

to design the machine or structure according to agreed specification:

- that is safe and reliable.
- that is easy to manufacture, maintain and utilise.
- in required deadlines.
- in given budget.

KISS = *Keep It Simple, Smart* = the best design engineering strategy

Broken laptop hinge (sign of bad engineering design) due to unadequate strength and durability

http://www.scooterresource.com
Broken scooter wheel (sign of bad engineering design) due to poor material choice or poor loads assessment.

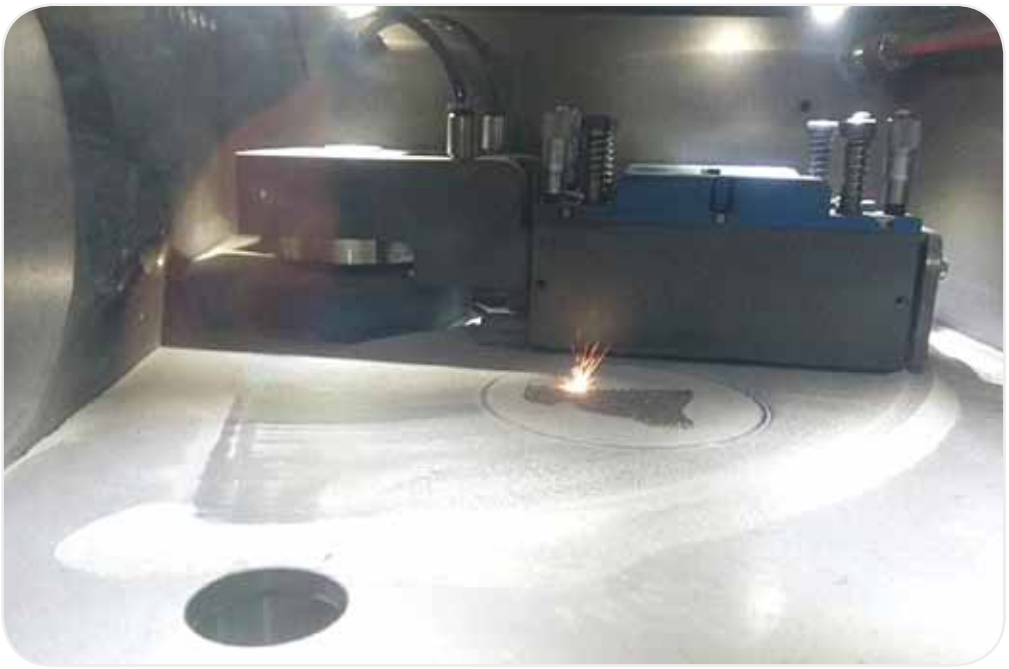
https://en.wikipedia.org/wiki/Tacoma_Narrows_Bridge_(1940)

Collapse of Tacoma Narrows Bridge due to bad engineering design and poor engineering skills in order to provide reliable design.

Corroded door (sign of bad engineering design) due to unadequate assessment of environmental conditions or wrong surface treatment

2.2.4. Rapid Prototyping

INDUSTRY:	Machinery	TECHNOLOGY GROUP:	Additive Manufacturing and Rapid Prototyping	SPECIFIC TECHNOLOGY	2.2.4. Rapid Prototyping
INTRODUCTION:	3D Printing is the form of a formalized term additive manufacturing and use in the rapid prototyping process. The 3D printing process is used to rapidly creating a system or part representation before final release or commercialization. It highlights the fact to producing something quickly and the output is a prototype or basis model from which further models and ultimately the final product will be derived. Initially, polymer (plastic) materials are utilized in 3D printing such as ABS, Starch (powder) and Resin. But recently the material domain has extended and now different metals and composites are used to form a shape (part). The additive manufacturing technology (3D printing) is relatively new in terms of material development, feature sizes and faster throughput. Moreover, this technology leads to the cleaner production concept as it contributes to the reduction of production process wastes because of its layer by layer addition of material to produce a product rather removal of material as in conventional machining process.					
RELATED KEY WORDS, ABBREVIATIONS:	AM – Additive Manufacturing, RP – Rapid Prototyping, 3D – three dimensional, CAD/CAM (Computer Aided Design & Manufacturing), CAD (solid modelling) software, STL file format, SLA – Stereo Lithography, FDM – Fused deposition modelling, SLS – Selective laser sintering				
PROCESS DESCRIPTION:	The 3D printing technique mainly works on the principle of SLA, FDM and SLS to produce a part or feature, consist of following steps: 1. **CAD Model** – A software solid model of part that fully describes the external geometry. 2. **Conversion to STL file** – Convert the CAD model into STL file format to use in 3D printer equipment. 3. **STL file transfer and Manipulation** – STL file must be transferred into 3D printer and do necessary adjustment in size, position and orientation for building. 4. **3D Printer (equipment) Setup** – Properly setting up of parameters for building process such as material constraints, energy source, layer thickness, timings, etc. 5. **Building (forming)** – It is an automated process, only monitoring is needed to ensure no errors. 6. **Removal** – Once the printer has completed the building step, the part must be removed. 7. **Post Processing** – It may include the cleaning up of part, etc. before it is ready to use. 3D printing mainly applied for creating prototypes, physical proof of concept, mock-ups, educational opportunities (health care also) and many more. https://www.youtube.com/watch?v=8z-iebHRxJk (3D printed home) https://www.youtube.com/watch?v=nk_8IcBVkRA (3D printed Beautiful Deer model) https://www.youtube.com/watch?v=fVg1rIT-J34 (3D printed coolest creations) https://www.youtube.com/watch?time_continue=119&v=31i6jFgeGY8 (3D Printed Illidan Stormrage – World of Warcraft) https://www.youtube.com/watch?v=5rrpQnnGC6E (Metal 3D Printing)				
EQUIPMENT:	**3D Printer (FDM – plastic filament)**		**3D Printer (SLA)**		**3D Printer (SLS and SHS)**
EQUIPMENT PRICE RANGE	Depends on size (600 – 7000 EUR)		1500 – 6000 EUR		15000 – 500000 EUR or more

ECONOMIC FACTS AND DATA	3D printing is one of the advanced manufacturing technology and considered to be a future manufacturing in the digital world. R&D in this technology progressing in incredible way along with 4th industrial revolution. The technology of 3D printing starts with the small scale prototypes, size and speed limitation but today one can buy 3D-printed shoes, 3D printed jewellery, 3D printed pens, and even 3D printed vehicles spare parts. Automotive industry, airplane manufacturer use 3D printed parts in their industrial production. Even healthcare and life science industries influenced by 3D printing applications. It also getting hype at school level and among secondary school students. In the global market the economic impact is projected up to the hundreds of billion euros by the year 2025. Many start-ups companies open their businesses by providing 3D printing services and they are also executed in Baltic States. Economic benefits of 3D Printing may include: It allows new complex shape to be created, Business opportunity (shops) where anyone can get their design printed, prototypes can be fabricated easily without significant investment, Reduction of wastages in terms of materials (plastic and metal) leftover [Madame Eureka 2012]. **3D Metal Printing at TTÜ** http://bit.ly/2oqer2A 

REFERENCE PICTURES

Processing

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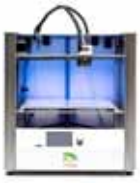

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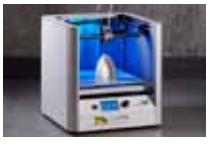

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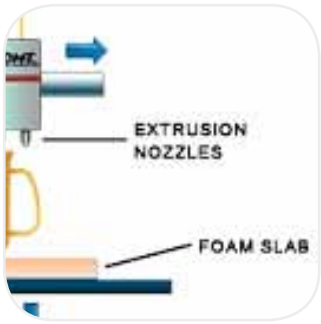
3D Printed Strati Car




EXTRUSION
NOZZLES
FOAM SLAB

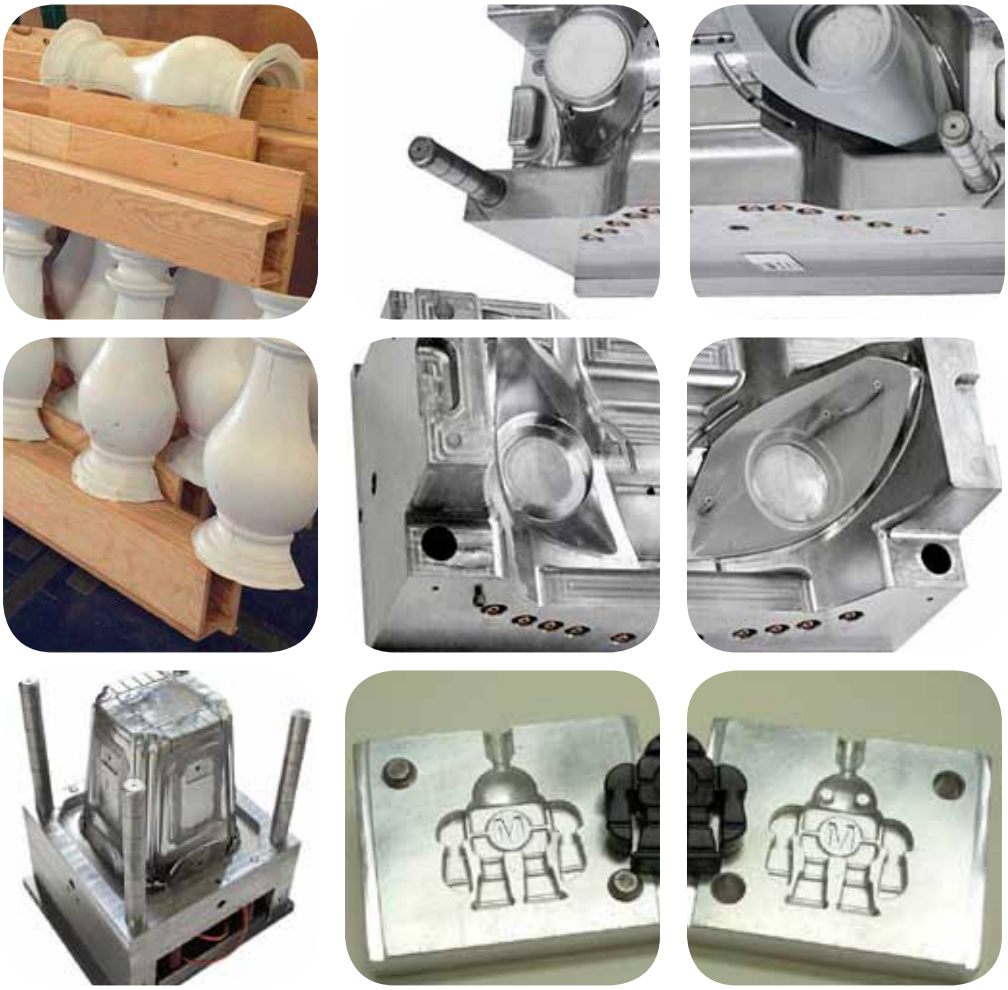








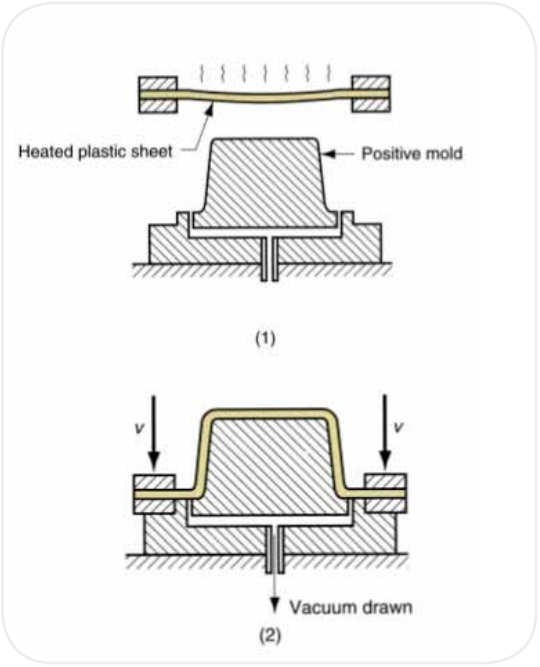




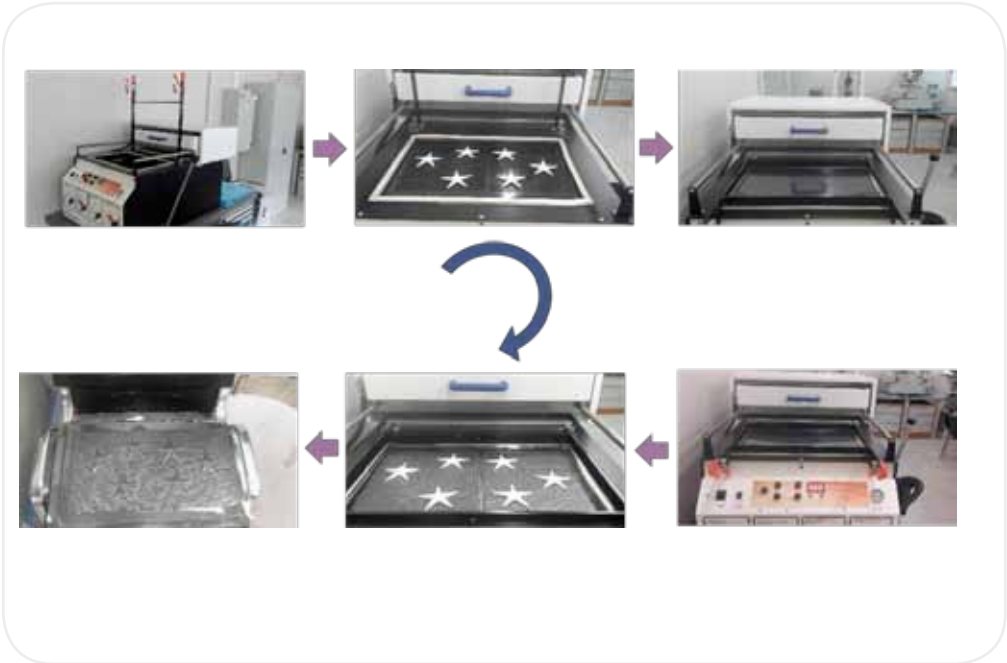
2.2.5. Injection Moulding and Vacuum Forming (Plastic)

INDUSTRY	Machinery	TECHNOLOGY GROUP:	Manufacturing Processes (Shaping or Moulding Process)	SPECIFIC TECHNOLOGY	2.2.5. Injection Moulding and Vacuum Forming (Plastic)
INTRODUCTION:	The growing importance and applications of plastics during the last several years have increased at much faster rate than metals. It leads to the commercial and technological importance of the shaping processes such as injection moulding and vacuum forming. The reasons behind the importance of plastic-shaping processes are not only technological but commercial also as everyone come across and uses plastics moulded products in the daily life. These shaping techniques increase the variety of part geometries, cut-down the energy and handling efforts. Due to their broad applications it is worth to know how those processes are carried out and can be further improved.				
RELATED KEY WORDS, ABBREVIATIONS:	Heat, mechanical force, solidification, part geometry, metallic mould, thermoforming, thermoplastics, deformation, VF – Vacuum Forming.				
PROCESS DESCRIPTION:	The main process steps are: *product design*, *mould design* and *production process* Injection Moulding: 1. Feeding of plastic granular or powder into the injection moulding machine barrel via hopper. 2. Barrel consist of a screw and heaters that mix and melt the plastic into molten form. 3. The screw also acts as a ram rapidly moves forward to inject molten plastic into the mould. 4. Mould clamping forces are applied for a while to setting-up the shape of moulded part. 5. Cooling and removing of the moulded part. Vacuum Forming: 1. Inserting of mould into the vacuum forming machine. 2. Placing and clamping of plastic sheet. 3. Heating of plastic sheet through heater. 4. Stretching of mould towards semi-melted (soften) plastic sheet via lever. 5. Creating of vacuum via vacuum pump to draw the sheet onto the mould and forming the part. 6. Release, cooling and removing of the part. https://www.youtube.com/watch?v=ypxWHOtRG3g (Vacuum Forming Machine Process demo) https://www.youtube.com/watch?v=-tAhCtlF3uo (Vacuum Forming by using the home appliances) https://www.youtube.com/watch?v=b1U9W4iNDiQ (Injection Moulding Process Animation) https://www.youtube.com/watch?v=y1Zhpdx-XtA (LEGO production by injection moulding) https://www.youtube.com/watch?v=Ens_f2eSXYU (Injection moulding with 3D printed mould)				
EQUIPMENT:	**Vacuum Forming Machine (Desktop)**		**Vacuum Forming Machine (Commercial)**		**Injection Moulding Machine**
EQUIPMENT PRICE RANGE	2500 – 7000 EUR		5000 – 60000 EUR		8000 – 90000 EUR or more

ECONOMIC FACTS AND DATA	All around the world, billions of goods are produced every year through those processes with huge turn-over to plastic industry. Applications of vacuum forming are wide spread in the consumer goods packaging such as confectionary (chocolate and candy) packaging, and food packaging. It is also used in manufacturing of refrigerator interior, baths tub and shower tray, car interior, and children toys etc. Injection moulding process is more suitable for high volume production and use in manufacturing of bottles, packaging, automotive parts and components, some musical instrument, small chair and tables, etc.
REFERENCE PICTURES	



VF Process



VF Equipment


McDonald's

2.2.6. Automated Assembling

INDUSTRY	Machinery	TECHNOLOGY GROUP:	Assembling	SPECIFIC TECHNOLOGY	2.2.6. Automated Assembling
INTRODUCTION:	Automated assembly is a process where part feeding, detection, verification, orientation, mating, fixing and testing is done fully automatically. Sometimes human testing or packaging is run parallelly to ensure processe quality.				
RELATED KEY WORDS, ABBREVIATIONS:	DFMA - Design for Manufactory and Assembly, DFAA: Design for Automated Assembly , SMT - Surface-mount Technology, VPM: Virtual Product Model , MV - Machine Vision, Robot Welding				
PROCESS DESCRIPTION:	The Automated Assembly process mainly consist of following steps: 1. **Feed the parts** – depending on part size and shape different feed methods are used. 2. **Detect the parts presence in the pickup position** – confirm, that part is in the position. 3. **Check the part** – Confirm, that part is genuine and suitable for assembly. 4. **Orientate the part** – If needed, part is turned around or pick-up system is informed to turn part around after pick-up. 5. **Pick the part** – Grab the part and remove it from the feeder. 6. **Mate the part in its position** – Put part on its position in the assembly. 7. **Fasten the part** – one by one or all details together are fixed to the assembly. 8. **Check the assembly** – Insure that assembly is well-assembled and all parts are putted in correct positions. 9. **Packaging** – if product or sub-assembly is transported to the other location. Automated assembly is mainly applied for mass production but flexible production lines allow us to assembly also smaller series. https://www.youtube.com/watch?v=2_R8oYQh4Uo (mobile phone screen protector application) https://www.youtube.com/watch?v=GDNAy6qYIi4 (Fully automated motor assembly line) https://www.youtube.com/watch?v=8_lfxPI5ObM (assembling TESLA automobile) https://www.youtube.com/watch?v=pGqPjYALB50 (BMW X2 production) https://www.youtube.com/watch?v=BepAMlrJwXI (Pick and place introduction)				
EQUIPMENT:	**Assembly station for small parts**		**Assembly line for biger parts**		**Full factory with human assistance**
EQUIPMENT PRICE RANGE	Depends on size: 10 000 – 1 000 000 EUR		Depends on size: 100 000 – 10 000 000 EUR		Depends on size: up to 1 000 000 000 EUR
ECONOMIC FACTS AND DATA	Automated assembly gives us perfect, exact and fast set of repeated actions to complete part handling, mating and inspection for production final process - assembly. By using automated assembly the process speed and quality is increasing remarkably and cost of assembly process is usually lower and predictible. Human workpower is the weakest link because of health and mood variations. In case of automated assembly line the reliability and continous working is quaranteed by wellorganized service plan. Pick and Place device for Printed Circuit Board assembly (fine electronics), details are putted in their positions but fastening (welding) took place in the different device.  Surface Mounting Device (SMD) with pick and place system.				

REFERENCE PICTURES

2.2.7. Digital twin

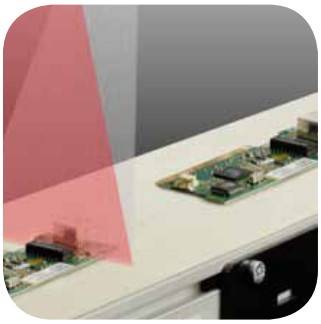
INDUSTRY	Machinery	TECHNOLOGY GROUP:	Digitalisation. VR/AR, Simulations	SPECIFIC TECHNOLOGY	2.2.7. Digital twin
INTRODUCTION:	The concept of Digital Twin (DT) is creating and maintaining a digital representation of the real world of the factory and supporting its management and reconfiguration by the means of optimization and simulation tools, which are fed with real and updated factory data. This concept is not new as it was first used by NASA research in 1957, when the satellite Vanguard was sent into orbit. More than half a century later, recent advances in ICT are offering new opportunities to fully exploit the potential of the DT in the manufacturing field.				
RELATED KEY WORDS, ABBREVIATIONS:	VR – Virtual Reality DT – Digital Twin AR – Augmented reality				
PROCESS DESCRIPTION:	Digitalisation of existing manufacturing equipment and products in 3D CAD software. Transfer of digital models to the game engine platvorm Unity3D and enabling interactions in Virtual Reality. 1. System arcihtecture creation (draft) 2. 3D models preparation 3. Interaction enabling - scripting 4. Integration **Some videos and tutorials:** https://unity3d.com/learn/tutorials/s/interactive-tutorials https://unity3d.com/learn/tutorials/s/roll-ball-tutorial https://youtu.be/f8PRUE0ERO8				
EQUIPMENT:	**Unity3D software**		**HTC Vive VR set**		**High-end PC**
EQUIPMENT PRICE RANGE	0-100 eur per month		700-900 eur		1000-2000 eur
ECONOMIC FACTS AND DATA	Game engine base version is free. Main cost is hardware.				

REFERENCE PICTURES

http://ivar.ttu.ee/



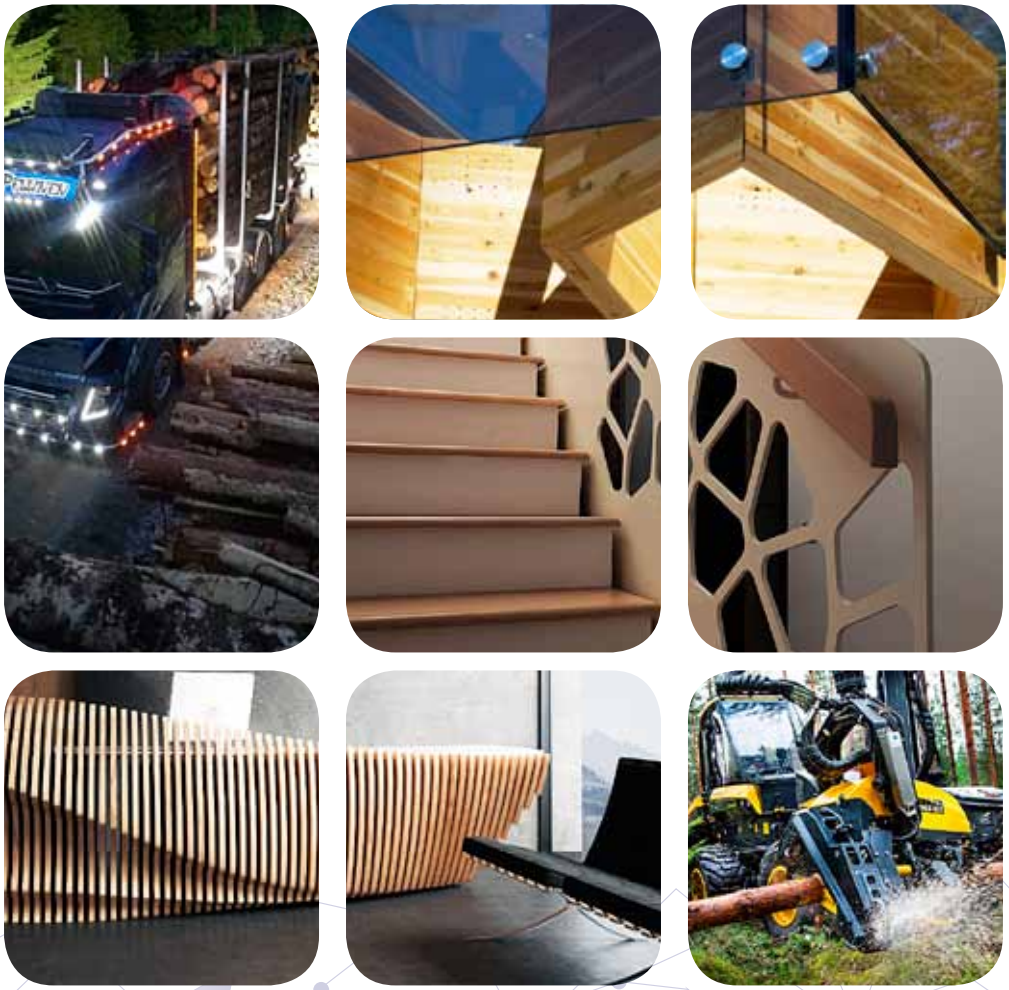










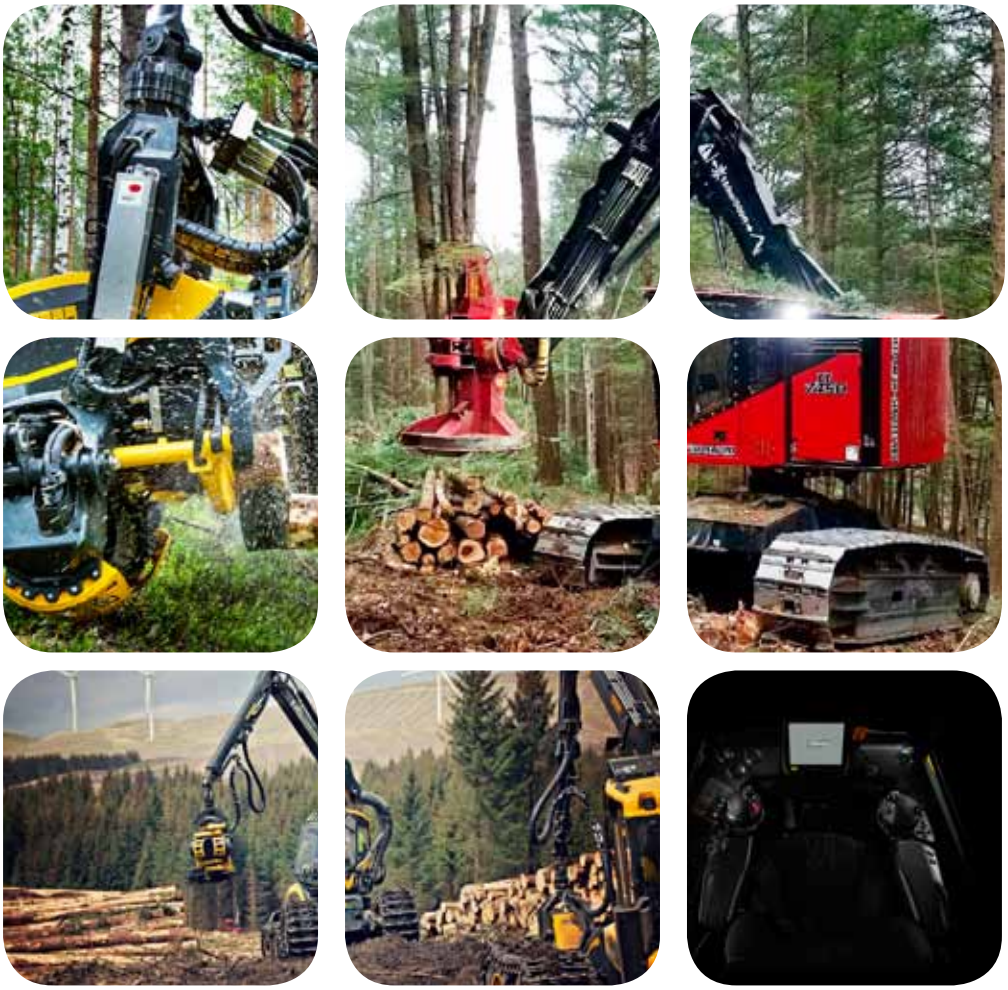


2.3. Wood working and Forestry

2.3.1. Reforestoration

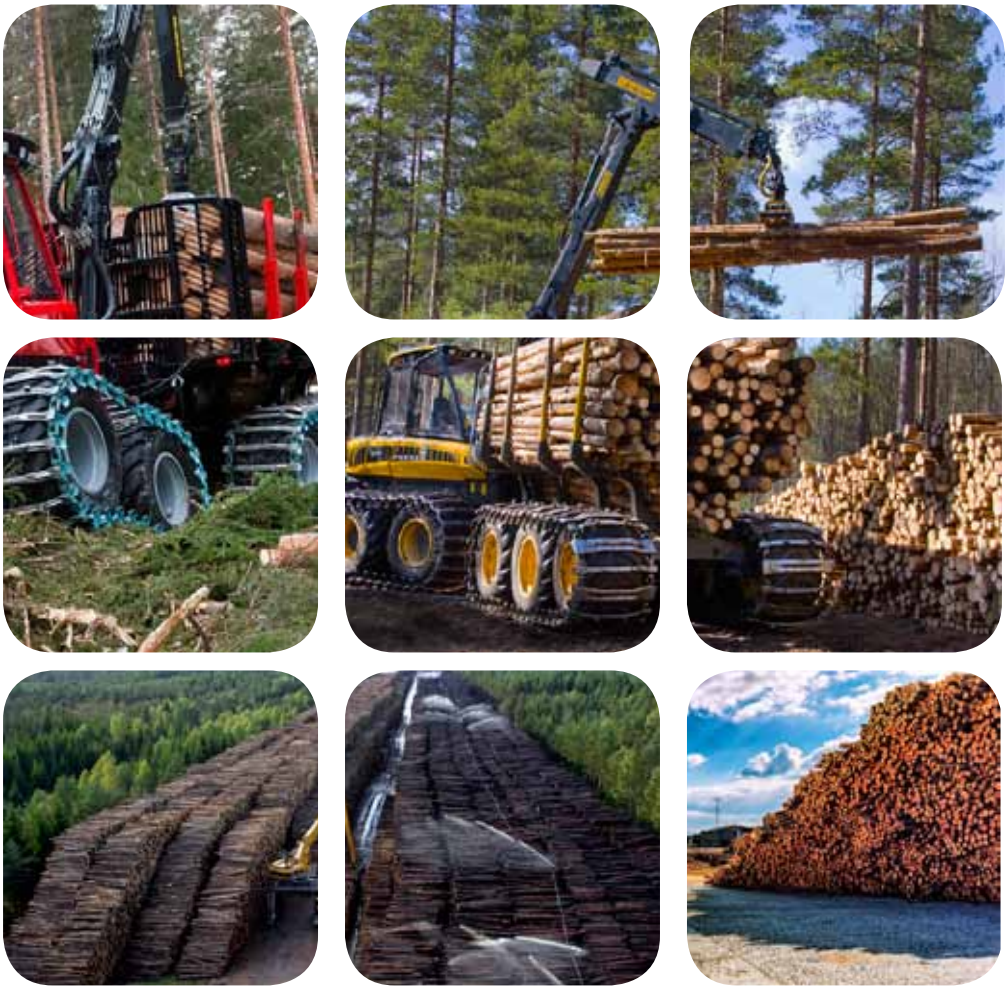
INDUSTRY	Forestry	TECHNOLOGY GROUP:	Arboriculture	SPECIFIC TECHNOLOGY	2.3.1. Reforestoration
INTRODUCTION:	Forest regeneration decisions are made by the forest planner prior to the development of the felling area and by resurveying the felling area after development, and assessing whether there has been a change. The forest typology is assessed and a decision is taken to restore the forest (natural / mechanical).				
RELATED KEY WORDS, ABBREVIATIONS:	Skidder - a heavy duty vehicle used in the forestry process to pull out trees out of the forest, called "rails", in which logs are transported from cutting to loading; GPS - Global Positioning System; Typology - local classification of forest ecosystems.				
PROCESS DESCRIPTION:	Forest soil preparation is carried out mechanically by removing the ground vegetation so as to ensure that the tree plants grow better in the ground. Mechanical processing takes place in two ways - with the help of a heavy cutter, also known as a disk plow. The cutter is powered by a special forestry tractor - a skidder. Alternatively, with the help of a digger, you can create micro elevations - high (wet soil). Additional technology also reads the landing GPS data for planners. The maintenance of young forest is divided into agrotechnical care, it is up to 3 years old and composition care for 15-20 years of age. The essence of agrotechnical care is lawn mowing, allowing the plants to grow above the grass. Separate a row around the plants, seamlessly. The service price is around 100,- eur/ha. A person manages about 0.6 ha a day. Very hard physical work. Composition care takes care of the most useful felling composition when reaching the cutting age. Depending on the height of trees, there is a standard for one tree density (number of trees) of 1 ha. On average, the number of trees should be reduced by half the number of trees to be planted. In the process of rarefaction it is evaluated, which trees to leave. The price of the service is about 100,- eur/ha. Very hard physical work. In the coming years, high-speed cared care with special equipment could be introduced. There is not yet in Latvia. Pruning In the 7th year, trees are mechanically pruned to produce wood without branches. It is difficult to predict demand for 50-70 years, the pruning of trees is limited to 500 trees per ha. Protection against damage. Different chemical materials are used for protection of trees (in Latvia State Forests) against insects, mutton, gnats and trout. Ferramon traps - Chives for insects.				
EQUIPMENT:	**Skidder**		**Disk Plow**		**Tree planting bar**
EQUIPMENT PRICE RANGE	80 000 – 160 000 euro		5000 – 50 000 euro		150,- euro
ECONOMIC FACTS AND DATA	The price of the reforestoration service is approximately 600,- eur/ha, depending on forestry typology. Tree planting is mainly done by hand using Tree planting bar. Service price 98,- eur/ha. One person per day set an average of 0,3-0,5 ha of forest. This is a hard, hard work. When planting spruce between rows should leave 2 meters, between plants of 1.6 mercy. In rare cases, a special excavator with a planting head is used instead of a cup (not in Latvia). Forest soil preparation service costs 110,- euro/ha with Skidder and 450,- euro/ha with excavator.				

REFERENCE PICTURES	
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	http://www.lvm.lv/mezsaimniecibas-cikls https://www.youtube.com/watch?v=ik5ZVethbjc https://www.youtube.com/watch?v=SR6VlEkYP_g meža plānotājs, infrastruktūras uzturēšana https://www.youtube.com/watch?v=73050YM4CnY karjera mežā https://www.youtube.com/watch?v=yvGoZfWKPG8 skiders https://www.youtube.com/watch?v=X5lKxn5ALm4 https://www.youtube.com/watch?v=5QSP1KT6gFA meža stādīšana https://www.youtube.com/watch?v=DacgQh1wKyQ meža stādīšana ar ekskavatora galvu https://www.youtube.com/watch?v=OlQeWBLYmOg jaunaudžu kopšana https://www.youtube.com/watch?v=hNIOtUByp2s jaunaudžu kopšana https://www.youtube.com/watch?v=izr-P8yKfUc meža frēze

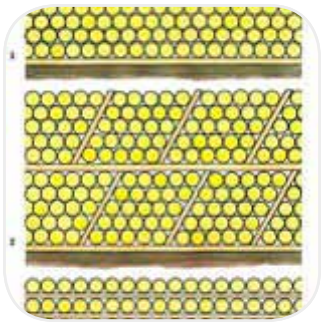


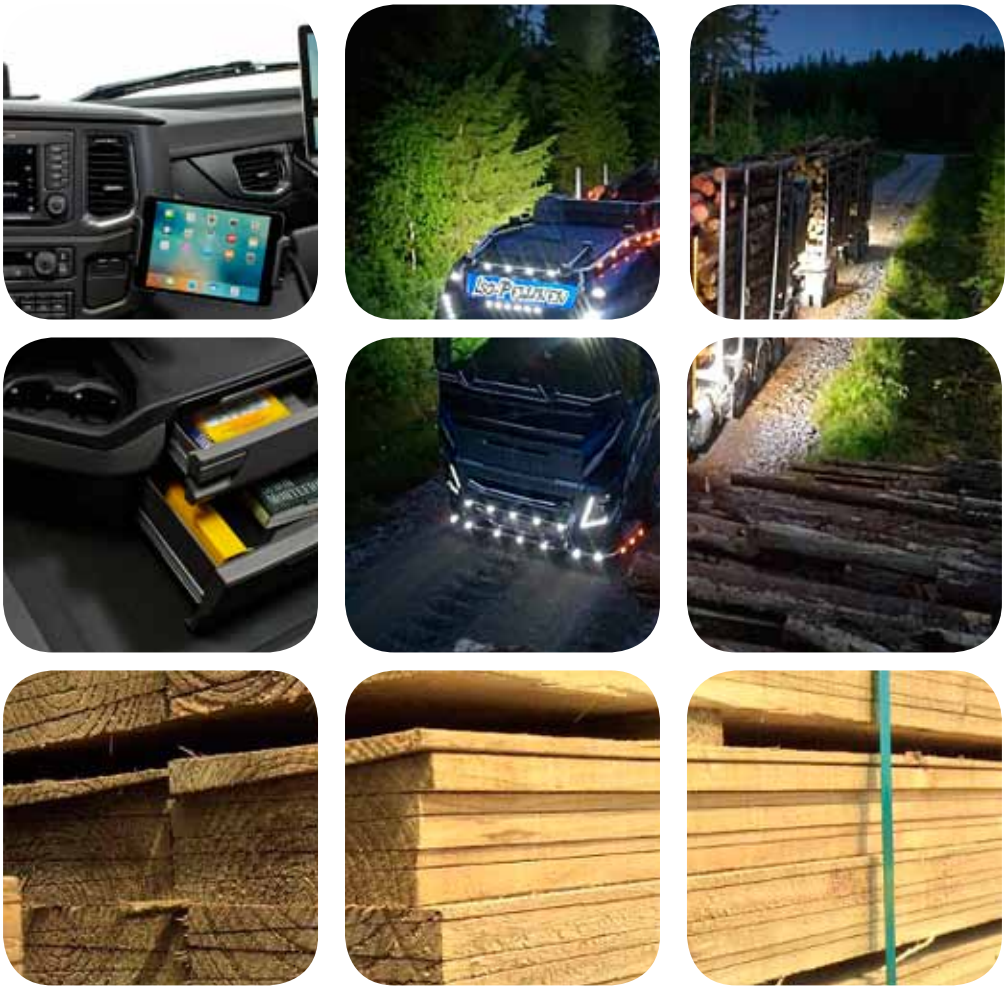
2.3.2. Trees cutting

INDUSTRY	Forestry	TECHNOLOGY GROUP:	Logging	SPECIFIC TECHNOLOGY	2.3.2. Trees cutting
INTRODUCTION:	The beginning of tree felling is planning, which is led by the logging master and the sales department, which has been preparing and giving a job to the Work Manager for the area, boundaries, assortment of felling area already a year ago.				
RELATED KEY WORDS, ABBREVIATIONS:	A **harvester** is a type of heavy forestry vehicle employed in cut-to-length logging operations for felling, delimbing and bucking trees. A forest harvester is typically employed together with a forwarder that hauls the logs to a roadside landing. **Felling head** - typical harvester head consists of: chain saw, curved delimbing knives, feed rollers, diameter sensors, measuring wheel.				
PROCESS DESCRIPTION:	Trees are sawn, pruned and grazed using a high-powered forest machine - Harvester. When starting the felling works, the Harvester operator receives the file FILE.APT, which indicates the assortment specifications: species, length, diameter and quality requirements. The operator enters the felling area, drives the jacket with a joystick and grasps the tree with a cutting head. Introduces the tree species to your computer. The rest is done by the forest machine automatically: cut, cut and girth the tree according to the entered APT file. The operator's task is to follow the assortment quality requirements and to manually stop the process if a non-standard situation is followed - wood twist, truppe or dry matter and other cases.				
EQUIPMENT:	**Harvester**			**Felling head**	
EQUIPMENT PRICE RANGE	300.000,-			100.000,-	
ECONOMIC FACTS AND DATA	The price of harvester averages 300,000, - eur, cutting head costs 100,000, - eur, service price is calculated from felling area, 6-8 eur / m^3. The machine is operated 24 hours a day, with three operators working on it. During the day, cut and gobble from 150-250 m^3 of different assortment of wood. Operators earn from 1 to 1.5 euros per m^3, depending on the amount of work, the average salary can range from 1000 to 2000 euro per month net, on hand. Usually starting a career as a Forwarding Operator, after 3-4 years, switch to Harvester Management.				
REFERENCE PICTURES					
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=saYrIcV3zkk https://www.youtube.com/watch?v=F6KmJYgqW_g https://www.youtube.com/watch?v=1ZOmJqlq508 https://www.youtube.com/watch?v=cwwkO7m4bpY https://www.youtube.com/watch?v=4vU4x541r20 https://en.wikipedia.org/wiki/Harvester#Agriculture_and_forestry https://lv.wikipedia.org/wiki/D%C5%BEoistiks				



2.3.3. Assortment stacking

INDUSTRY	Forestry	TECHNOLOGY GROUP:	Logging	SPECIFIC TECHNOLOGY	2.3.3. Assortment stacking
INTRODUCTION:	The selection of the assortment begins with the felling planning, the logging master determines the stacking area (4m^3 = 1 meter) and the optimal location. On the other hand, based on the task, Harvester's operator slips logs or branches into a technological corridor, or twigs, to later turn them into chipping, or to make them easier to collect.				
RELATED KEY WORDS, ABBREVIATIONS:	Forwarder - a forestry vehicle that transports logs and moves on the road; Manipulator; stack of long timber (trunks, half bumps and long assortment); Cracking - Taking timber in different types of stairways and slopes. Stacking timber in different types of stairways and slopes.				
PROCESS DESCRIPTION:	The assortment is delivered and stacked after the delivery of the forest assortment with the assistance of a forwarder. The Forwarder's operator drives with the technique and, with the help of a manipulator, puts the assortment on the pillars and takes it to the place of loading and unloads. The stacking of the assortment is carried out in accordance with the work order in assortment (7-9 main assortment types). The forwarder's operator marks the group of assortments (assortment, customer) with leaflets. Both Harvester and Forvarder's computer records the amount of development and sends data to planners. Forwarder data is used to track the stock of wood assortment in shavings. Felling residues are not developed in all cases. If the conditions are favorable, the removal does not exceed 700-400 meters, the branches are individually stacked, arranging tree felling, so that the branches form piles. The remnant of the felling area is measured in mWh (megawatt hours), evaluating quality, humidity, etc. factors.				
EQUIPMENT:	**Forwarder**				
EQUIPMENT PRICE RANGE	150.000,-				
ECONOMIC FACTS AND DATA	Forwarder's price is an average of 150,000, -eur. Service price 4-6 EUR / m^3, operator's profit from development is from 0.7 to 1 EUR per m^3. For one forwarder there are 2-3 people. During the day, 100 to 150 m^3 are exported.				
REFERENCE PICTURES	     				
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=saYrIcV3zkk https://www.youtube.com/watch?v=F6KmJYgqW_g https://www.youtube.com/watch?v=1ZOmJqlq508 https://www.youtube.com/watch?v=cwwkO7m4bpY https://www.youtube.com/watch?v=4vU4x541r20 https://en.wikipedia.org/wiki/Harvester#Agriculture_and_forestry https://lv.wikipedia.org/wiki/D%C5%BEoistiks				



2.3.4. Timber logistics

INDUSTRY	Forestry	TECHNOLOGY GROUP:	Logging	SPECIFIC TECHNOLOGY	2.3.4. Timber logistics
INTRODUCTION:	The main technological processes are assortment loading, assortment transportation and assortment unloading at the customer.				
RELATED KEY WORDS, ABBREVIATIONS:	Forwarder - a forestry vehicle that transports logs and moves on the road; Manipulator; Stacking timber in different types of stairways and slopes. Dryland forest edaphic row, which combines the types of forest growing conditions in well aerated mineral plants; Tumbled mung agglomeration of wood.				
PROCESS DESCRIPTION:	**Transportation**. Forwarder data is the basis for the logistics department to know and plan the assortment balances and their transportation to the customer. The logistics department plans routes for timber workers and sends a job assignment via e-mail. The chef's operator finds the relevant assortment, loads in compliance with the safety requirements, assesses the amount of wood and sends the data to the department, prints the bill of lading and sends the assortment of wood to the client according to the received route. Unload and return the bill of lading to the client in accordance with the instructions. **Timber assesment.** Different standard methods are used to measure the wood assortment, based on the species, diameter and length of the wood. There are several methods for assessing the assortment, for example, a group method that is more commonly used for firewood, pulpwood, bulk or individual, each tree separately. Independent certified valuation companies (SIA LVF) are used to evaluate the assortment, in large companies (RSEZ Ltd. Verems, AS Gaujas Koks, etc.). The equipment is used for measuring - a measuring line, which determines the wood quantity in cubic meters and the quality requirements of another customer (screw, twist, height of branches, frequency, diameter of billets, crumbles, stains, chips, etc.) every 10 cm by scanning wood diameter. Particular attention is paid to insects, which often deny the quality of wood.				
EQUIPMENT:	**Log carrier vehicle**			**Timber assesment authomatic line.**	
EQUIPMENT PRICE RANGE	200.000,-			1.500.000,-	
ECONOMIC FACTS AND DATA	The price of the car is approximately 200,000, - the service price is 5 eur / m^3, the operator receives approximately 1200, - eur per hand, the net salary per month				

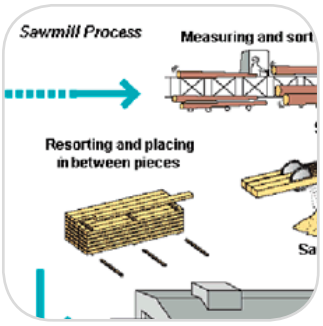
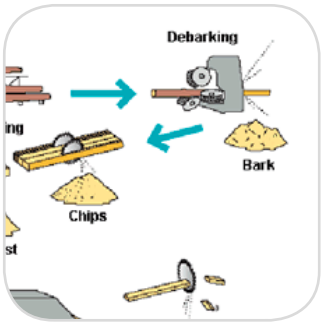
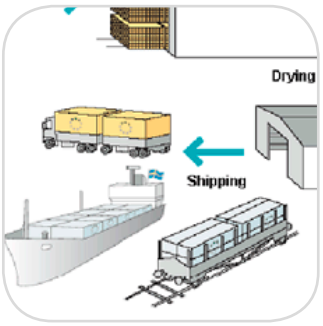
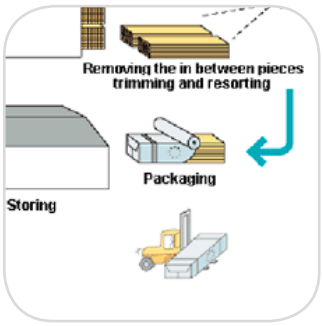
The most popular assortment types by tree species in order of priority

Pine tree	Class A saw log	Saw log	Small saw log	Pulpwood	Fire-wood
Fir-tree		Saw log	Small saw log		
Birch	elite (Class A) plywood	Class B plywood	Tara wood	Pulpwood	Fire-wood
Aspen Black alder Other leaf trees		Saw log	Tara wood		Fire-wood

REFERENCE PICTURES	
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=oh-E80ExiVw https://www.youtube.com/watch?v=2m1eCNz6ax0 https://www.youtube.com/watch?v=xCP-zTs_0Gc https://www.youtube.com/watch?v=ph_eFF60ouQ

2.3.5. Lumber

INDUSTRY	Woodworking	TECHNOLOGY GROUP:	Lumber production	SPECIFIC TECHNOLOGY	2.3.5. Lumber
INTRODUCTION:	Sawn timber is produced from the relevant timber assortment (wood species, log length, diamter and quality requirements, for example, the number of branches per meter, etc.), which are prepared by felling the forests and evaluated accordingly in the company. Next, the round logs are placed on a ramp, where they fall on rectangular beams or planks when they reach the corresponding saws. The adjacent product of this process is peel, sawdust, and perennials.				
RELATED KEY WORDS, ABBREVIATIONS:	Ramp - Outsides -; Brushes - Timber, of a thickness and width of 100 mm or more, are made of logs or glued boards, they are used in house building, furniture industry, packaging industry, etc. ; Multi-saw - a saw that is specially designed to cut parallel to the length of the tree; Band saw - it's a long saw blade that consists of a continuous metal band of a tooth stretched between two or more wheels to cut the material.				
PROCESS DESCRIPTION:	Sawing is carried out in a saw mill with circular saws (large saws) or Band saws (horizontal or vertical). The moisture content of the sawn material is 30 %, when the lumber material changes, it dries, shrinks, deforms and cracks. Under the influence of the environment, the material so to say - "breathes", becomes wetter or swells and deforms. Basically, the deformation takes place on wooden fibers that are circular, trying to straighten. This lumbering property limits the use of wood as a material for the manufacture of precise parts and also in high-quality interiors. A special problem can be the branches that can render it to fall (especially to the spruce), or bend. Branch place is hard and does not work, it can be torn off. Consequently, the lumber is dried and glued to reduce the strength of the internal wood and the tendency to deform, and to avoid the branches. Long-standing saw timber is "dead" (about 5 years) and deforms much less. After obtaining lumber, they must be dried to a certain humidity, depending on their further application, for the joinery 8-12%, for construction 18%. The humidity is determined by a special meter. Sawn timber is dried in special drying rooms - in hangars. In domestic conditions, it can dry under natural conditions in a barn or under sheds (2-3 months).				
EQUIPMENT:	**Multisaw**	**Band saw**	**Drying equipment**	**Moisture meter**	
EQUIPMENT PRICE RANGE	6.000 - 100.000 EUR	4.000 - 80.000 EUR	50 m^3 aprox. 100.000 EUR	200 - 1000 EUR	
ECONOMIC FACTS AND DATA	Service price to staff team: 10-20 EUR/m^3 Lumber costs: 50-150-1000 EUR/m^3 From 1m^3 of logs is produced 0.4-0.55m^3 of lumber Salary: 460-560 per month Production equipment line approximate price – high volume 1.000.000-5.000.000 EUR Bandsaws saws made in Latvia - http://www.tehnika.lv/lat/prod.htm Impregnation of sawn timber depending on the processing specification starting from 17 € / m^3 Drying of sawn timber from 15 € / m^3 Lumber planing services starting from 10 € / m^3				

REFERENCE PICTURES	        
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=b8Xl451QvBE https://www.youtube.com/watch?v=EDIumr3MM0Y https://www.youtube.com/watch?v=WZxUBYVVAps https://www.youtube.com/watch?v=l5Gru0IyX6s https://www.youtube.com/watch?v=l9px0heI-aI https://ru.wikipedia.org/wiki/%D0%91%D1%80%D1%83%D1%81_(%D0%BF%D0%B8%D0%BB%D0%BE%D0%BC%D0%B0%D1%82%D0%B5%D1%80%D0%B8%D0%B0%D0%BB) https://en.wikipedia.org/wiki/Saw https://en.wikipedia.org/wiki/Bandsaw

2.3.6. Profile materials

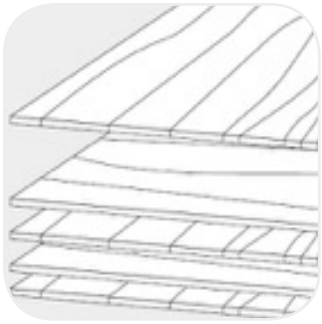
INDUSTRY	Woodworking	TECHNOLOGY GROUP:	Lumber Processing	SPECIFIC TECHNOLOGY	2.3.6. Profile materials
INTRODUCTION:	In order to further use the obtained lumber for the production of the finished product, for example, made furniture, building elements - stairs, shelves or decked floors, they must be processed. First of all, select and cut the size.				
RELATED KEY WORDS, ABBREVIATIONS:	Grooves-joints, grooves; Slats - timber used to enclose the gap between floor and wall; Chariot - used for turning timber into various incisions;				
PROCESS DESCRIPTION:	Production of profiled materials. Dry boards are treated from all sides by milling the joints grooves. The profiled materials are floorboards, terraced boards, cladding boards, flooring trims. The profiled material is produced on a four-sided planer, whereby a rotating knife produces a smooth, pleasant surface in the required size. In the event that the material requires rounded edges or specific shapes, the so-called profile, it is obtained with the appropriate shape of the milling machine - the rotary knives of the required shape (the hammers can make any type of milling cutter) such as baroque skirting, window laths or door shaping elements . Also, joining sites, such as floor or cladding boards, are molded. In turn, the turning parts are produced on the turning edges, where a rotating piece of wood is used to produce a cutter or forge to obtain the required shape and size, for example, stair racks or a simple broom shaft. In order to give the product a pleasant look, at the end, the material is sanded using home-made, sandpaper, which is applied to rotogravure or rotary instruments.				
EQUIPMENT:	**Planer**	**Milling machine**	**Lathe**	**Jigsaw**	**Grinder**
EQUIPMENT PRICE RANGE	300 - 10 000 EUR	1000 - 50 000 EUR	2000 - 20 000 EUR	500 - 20 000 EUR	200 - 5 000 EUR
ECONOMIC FACTS AND DATA					
REFERENCE PICTURES	    				
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=scnG-4PE-_4 https://www.youtube.com/watch?v=bdcrAs9YcH8 https://www.youtube.com/watch?v=b0Tkwt-0OR8 https://en.wikipedia.org/wiki/Groove https://en.wikipedia.org/wiki/Baseboard https://lv.wikipedia.org/wiki/Kokgriešana				

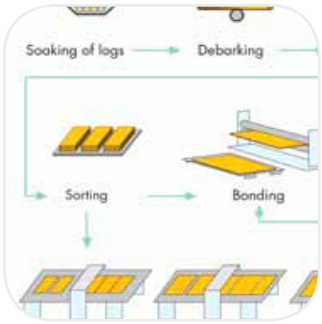
2.3.7. Slab materials

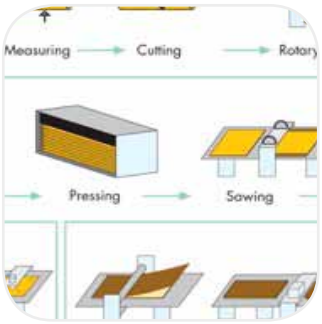
INDUSTRY	Woodworking	TECHNOLOGY GROUP:	Slab materials production	SPECIFIC TECHNOLOGY	2.3.7. Slab materials
INTRODUCTION:	There is a distinction between different types of board materials that are manufactured from lumber-related products or wood that can not be used in lumber production or pure wood. The slab materials have better durability, they do not deform and do not change their size and are relatively resistant to climatic conditions.				
RELATED KEY WORDS, ABBREVIATIONS:	Faction – KSP - particle board, OSB - oriented particle board; Plywood board - A thin veneer sheet made of plywood				
PROCESS DESCRIPTION:	Particle board production is mainly made up of coniferous and deciduous logs that can not be used in the production of lumber and also from the production of sawmill residues in sawdust, cuttings or chips, splitting the material up to a certain fraction. Further, the chips are dried and glued to obtain material of different sizes. A slab consisting of finely chopped wood particles (chips and wood dust divided by fractions - exterior fine fractions, middle layer of coarse fractional wood particles), compressed together with glue. This yields particle board (CSP) or Oriented Particleboard (OSB). The latter are more resistant to higher loads. Plywood is mainly used for the production of birch logs or plywood, and as a by-product chips are formed. From the beginning, the log is soaked, then the plywood is peeled off (the plywood is treated with hydrothermic treatment and then the plywood tape is then dumped.) It is then dried continuously in sliding dryers, after which the veneer is glued by applying a glue and pressed in a hot press. The resulting plywood top coats are laminated with different materials , colors and textures as needed.				
EQUIPMENT:	**Chipping production machine**	**Drying machine**	**Gluing machine**	**Pressing machine**	
EQUIPMENT PRICE RANGE	10 000 - 50 000 EUR	50 000 - 200 000 EUR	50 000 - 200 000 EUR	10 000 - 100 000 EUR	
ECONOMIC FACTS AND DATA	Service price not available Product price varies of qualaity and thickness and other dimensisons of materials 2-10 EUR/m^2; 300-500 EUR/m^3				
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=mE1s5CZEGR4 https://www.youtube.com/watch?v=XzIVuQQRY3s https://www.youtube.com/watch?v=LVPAzWnMlag&index=7&list=RDvwLz6M_N3HM https://www.youtube.com/watch?v=eF5LVBW1vl8 https://www.youtube.com/watch?v=STjdDSpEu6w&t=318s https://www.youtube.com/watch?v=b0E7crKp5cU https://en.wikipedia.org/wiki/Particle_board https://en.wikipedia.org/wiki/Oriented_strand_board				

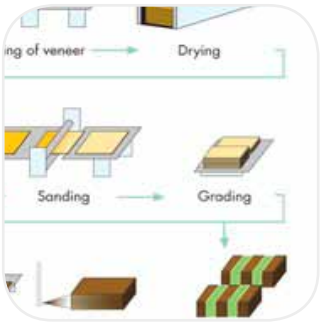
REFERENCE PICTURES









2.3.8. Furniture production

INDUSTRY	Woodworking	TECHNOLOGY GROUP:	Slab materials production / CNC procesment	SPECIFIC TECHNOLOGY	2.3.8. Furniture production
INTRODUCTION:	The resulting plate material is widely used in construction as a constructive element, for example, laying a floor covering, or a finishing material for walls and cut, or widely used in the manufacture of furniture, making tables, shelves, cabinets, etc. Furniture production combines use of Precious woods				
RELATED KEY WORDS, ABBREVIATIONS:	Spindle - Rotary heads; Natural or Precious woods - dried lumber; Reclaimed wood – old wooden parts refinished for durniture, MDF is a slab made of wood by-products of both hardwood and hardwood, glued together with wax and resin at high temperatures and pressures; these boards are more durable and denser than plywood; CNC - a tool runs by a computer; CAD – computer design programs; CAM - production process monitoring and control programs; 3D – three - dimensional object;				
PROCESS DESCRIPTION:	Furniture production is divided into dried lumber, also known as Natural wood and Slab materials. For the production of wooden furniture, dry joinery lumber is used for pine, fir or hardwood (part, oak, birch). Laminated particle board and MDF slabs, less plywood, are used for the production of slab furniture. Wooden furniture is made from dry lumber, sawn in strips and glued shades, then cut them, cut in precise sizes and varnishes. The board furniture is made from laminated particle board, cutting it in precise sizes. The cutting of slabs takes place on a cutting board, but if the required shape is not straight line then milling. As a rule, flatbed milling machines are automated, which makes it easier to produce several identical required copies. Automated equipment necessary to operate a computer and special Software, in a variety of controllers controlling the rotating head (flies), which strengthened various tools gaining the necessary forms. Sophisticated devices are also able to automatically replace the tool by performing several operations and significantly reducing the production cycle of one component. An automated device head can also be a laser cutting or engraving, water jet, knife, and the like. **CNC production** is the process by which the material is used for the processing of computer-controlled process which is widely used in metal processing, wood processing and other automated production processes. Its main elements are the co-ordinating table, the processing head, and the computer with the corresponding processing Software. The necessary material appears on the coin table and attached. By coordinates table caliper moves the processing head with necessary tools and guided by a computer program into the desired coordinate point (X.Y.Z.) with the cutting instrument parameters. To run such a port, you need the necessary part of the output file FILE.STL. Such files files to develop special programs for vector graphics, where each point, line or shape has its own coordinates (3D) three-dimensional. These Softwares are called CAD programs (AutoCAD, CorelDRAW, Illustrator, etc.), they are relatively expensive license, but there is also a simple free alternative (Google Sketch-up). When the output file is available in the required format, which is a requirement of all individual facilities (there is a possibility the file or files to convert, but not always it happens accurately, without loss of data), the following may be necessary parts processing or production process modeling. This stage also happens automatised with CAM Software, making it possible to modify, set or change the various treatment processes, coordinates, processing settings or the order. Woodworking has a wide range of different CAM software, most often provided by the machine manufacturer. Both processes are interconnected, so they are called CAD / CAM production.				
EQUIPMENT:	**CNC milling table**		**CAD Programmes**		**Hand tools**
EQUIPMENT PRICE RANGE	5000,-		Free – 10 000,-		100 – 5000,-
ECONOMIC FACTS AND DATA					

OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=huuDTZYvtos https://www.youtube.com/watch?v=3LdtpAQtXkI https://www.youtube.com/watch?v=HBMu_T8GjYw https://www.youtube.com/watch?v=qoh0K3zzBrg https://en.wikipedia.org/wiki/Milling_(machining) https://en.wikipedia.org/wiki/Medium-density_fibreboard https://en.wikipedia.org/wiki/Flooring#Wood_flooring https://en.wikipedia.org/wiki/Numerical_control https://en.wikipedia.org/wiki/Computer-aided_design https://en.wikipedia.org/wiki/Computer-aided_manufacturing https://lv.wikipedia.org/wiki/3D_model%C4%93%C5%A1ana
REFERENCE PICTURES	

2.3.9. Construction

INDUSTRY	Woodworking	TECHNOLOGY GROUP:	Construction	SPECIFIC TECHNOLOGY	2.3.9. Construction
INTRODUCTION:	Wood is traditional and ecological materials are widely used in construction industry, from ancient times. As technology evolves, the use of wood is made easier by achieving faster, more high-value, more cost-effective construction.				
RELATED KEY WORDS, ABBREVIATIONS:	Calibrated - planed; Brushes - Timber, with a thickness and width of 100 mm or more, are made of logs or glued boards; they are used in house building, furniture industry, packaging industry, etc .;				
PROCESS DESCRIPTION:	**Log houses** are wooden houses, which are made from logs, which are selected in the woods straight, rough and the same diameter. Log houses are made from gravel or twisted logs, following the logging and joining of logs. There are a number of traditional types of tree joints, with the advent of new technologies, joining solutions improve. If the rolled logs are used, then a bulky lathe is required, which, with a special knife, will make the log round. With the help of a special cutter, the grooves of the log joints will be created. If a non-walled tree is used, then the logs are peeled with a horse or a special hand tool, cut by electric or chainsaw, a graphe with a curved axe or grooved with hand tools. **Stationary buildings** are wooden houses, in which the tree is used mainly for construction (frame) construction and insulation of layers. Wooden panels are made from dried lumber, which are calibrated, grooved in length and glued together, combining heat insulation, various vapor compensating films and board materials. **Multi-storey modular homes**. In the world, wood is becoming increasingly recognized as a building material, especially popular in Scandinavia. The wooden houses have a particularly pleasant aura, air, which means that the tree is used as building material for the construction of multi-storey houses (currently the tallest building with 26 floors in Norway). The technology is similar to standing buildings, many storey houses consist of separate modules, which will strengthen each other building several storeys. **Glued beams** are glued together and used to glued high-conductivity busbars (beams), providing great overlaps by building sports halls, manufacturing complexes SIA Verems, Latvia or cultural objects such as concert halls.				
EQUIPMENT:					
EQUIPMENT PRICE RANGE					
ECONOMIC FACTS AND DATA					
OTHER REFERENCES (LINKS TO VIDEO MATERIALS)	https://www.youtube.com/watch?v=FU9_v58YL0A https://www.youtube.com/watch?v=PzwJLkz6WY0 https://www.youtube.com/watch?v=Fsezel6YyJo https://www.youtube.com/watch?v=KImuIeMrlKc https://www.youtube.com/watch?v=ndTOoO1wl_M https://ru.wikipedia.org/wiki/%D0%91%D1%80%D1%83%D1%81_(%D0%BF%D0%B8%D0%BB%D0%BE%D0%BC%D0%B0%D1%82%D0%B5%D1%80%D0%B8%D0%B0%D0%BB)				

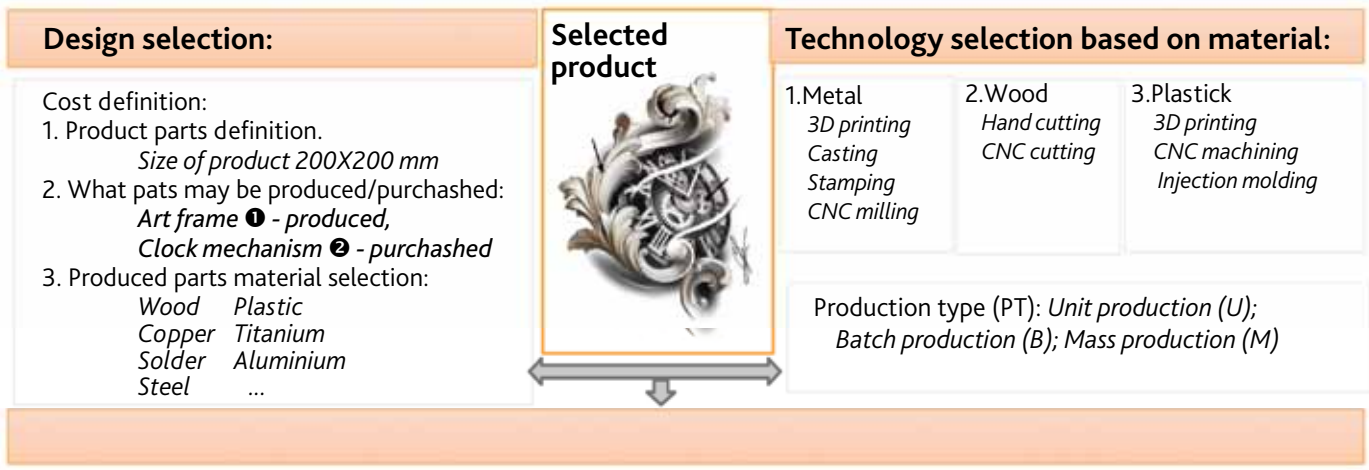
REFERENCE PICTURES

3. Practical work for Reflection Phase

Career counsellors organize practical work for school students using product cost calculations in technology cards, information gathered during visits to companies, as well as other information available on the Internet. The assignments can be related to business sustainability in the selected industry.

Example of a practical assignment:

Calculate how many hectares of forest should be logged on average per month to pay off the acquisition of new forest machines – harvesters, taking into account that the average cost for the logging service at the Latvian State Forest auctions is EUR 6 per cubic meter of wood. The prices and technical specifications of harvesters can be found on the web or by contacting dealers (johndeere.com or ponse.com , or others). Three people are working on a single machine with an average net salary of 1500–2000 euro per month (salary calculator to find out the employer taxes – www.vid.gov.lv). On average, one hectare of forest is 800 cubic meters of wood (Latvian State Forests) and 400 in private forests. Depreciation of the machine is 5 years; maintenance costs (fuel, oil, running costs) are 0.1 euro per 1 cubic meter of wood.



Metal										
Material	Machining type	PT	Qnt	1 part material cost (1pcs/€)	Preparation time (hours)	Preparation cost (h/€)	Processing time (hours)	Processing cost (h/€)	Comments	1 pcs direct cost (€)
Copper	3D	U	1	200	3	20	4	50	Programming cost 60 €	460
Copper	Casting	B	6	23	1	0.5	0.5	10	Mould cost 1000 €	190
Copper	CNC machining	B	5	40	3,25	20	1	40	Programming cost 60 € + machine setup 5 EUR	141
Titanium	3D	U	1	200	3	20	4	50	Programming cost 60 €	460
	Casting	B								200
Stainless steel	CNC machining	B	5	10	3,25	20	1	40	Programming cost 60 € + machine setup 5 EUR	111
Stainless steel	3D	U	1	10	3	20	4	50	Programming cost 60 €	270
…										
Wood										
Wood	Hand made	U	1				25	20		500
Wood	CNC machining	B			3				Programming cost 60 €	110
…										
Plastic										
Plastic	3D	U	1	5	3	20			Programming cost 60 €	42
Plastic	Stamping	M							Stamp cost 10000	5
…										

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AGF Pluss SIA

ArtStudio IK

Daba Laba SIA

Gaujas Koks SIA

Rēzeknes gaļas kombināts SIA

Latgales Dārzeņu loģistika SIA

Latgales Galdnieks IK

Latgales Piens AS

Latvijas valsts meži AS

Leax Rēzekne SIA

Light Guide Optics Int. SIA

Nodarbinātības Valsts aģentūra

Rēzeknes autobusu parks AS

SM SIA

Upeslāči IK

Viļānu selekcijas un izmēģinājumu stacija

Verems RSEZ SIA

Zieglera Mašīnbūve SIA

Zeize SIA

Amoor OÜ

Balbiino AS

Baltic Connexions OÜ

Barrus AS

Bellfire OÜ

BLRT Grupp AS

Estonian Cell AS

Ensto Ensek AS

E-profiil AS

Fazer Food OÜ

HKScan Estonia AS

Kalev AS

Norma AS

Pagaripoisid OÜ

Põltsamaa Felix AS

Puiduhake.com OÜ

Saku Õlletehase AS

Stora Enso Eesti AS

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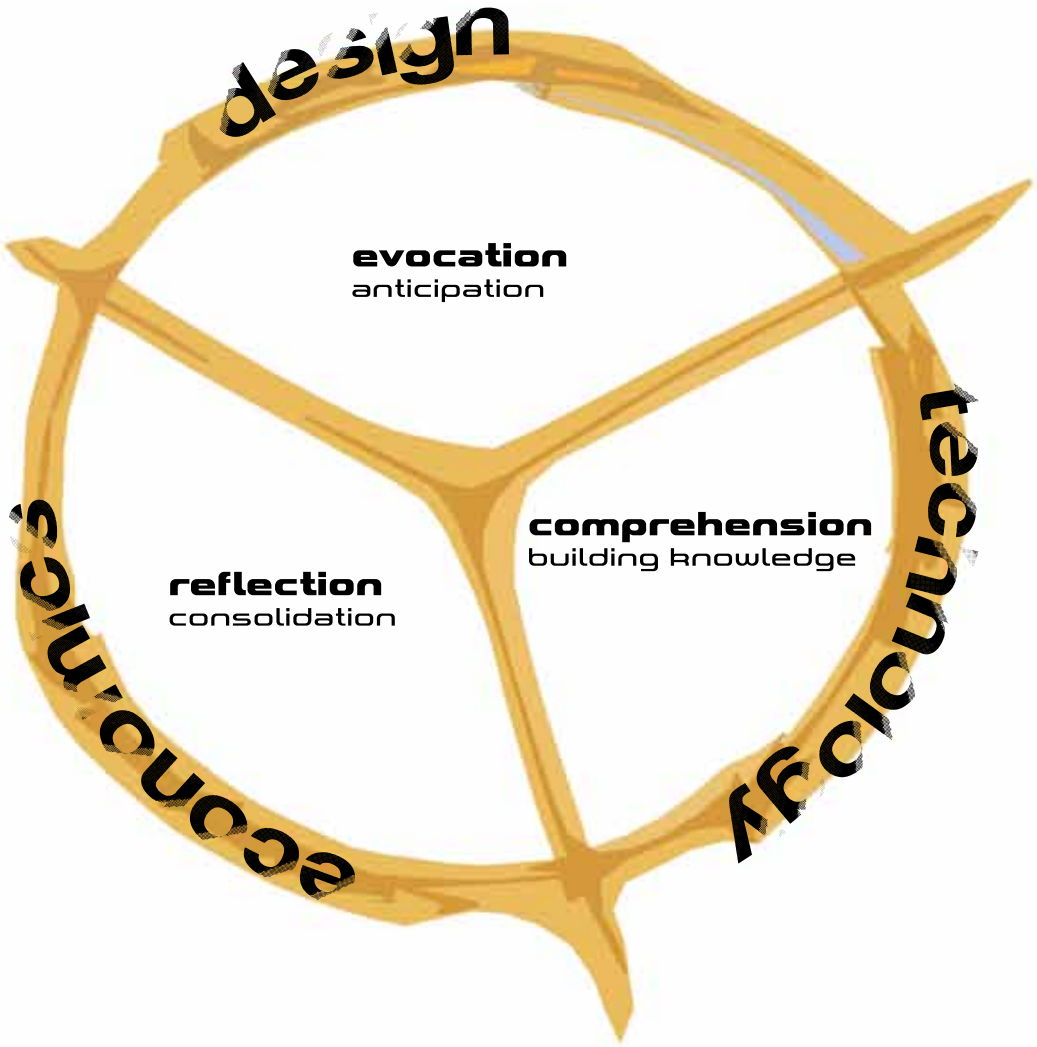
design
evocation
anticipation
technology
comprehension
building knowledge
reflection
consolidation
economics

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