Interreg CENTRAL EUROPE
European Union European Regional Development Fund
Transfarm4.0

MODULES OF ALTERNATIVE EDUCATION SYSTEMS ENCOURAGE MECHATRONICS FOR PRECISION FARMING

D.T3.2.4

Version 1
05 2022

Jan Sienkiewicz

PP12 ARR SA Bielsko-Biała

Screening of the high schools (D.T3.2.6) performed in the partners regions all together with the accompanying surveys will give partners the answer about general understanding of the Precision Farming term within students of the schools.

In order to explain a bit ore what PF is related to and that the term also include most modern IT related technologies like: Artificial Intelligence, GPS positioning systems, Big Data Management, Software Development or use of the robots and other Industry 4.0 related technologies.

Modern agriculture requires not only skilled personnel but also modern equipment which has to be serviced, maintained and used by highly skilled professionals. General understanding of the agriculture technologies still shows, that general knowledge or awareness does not pace technologies that are used.

The goal of the activity is to rise the awareness of the high school students about personal possibilities for the successful professional career in the field of agri production.

Performing the actions which will propose additional knowledge to the dedicated student groups via presentations in the field, on site dedicated trainings or of the school trainings will provide additional knowledge and awareness about new sectors for the future jobs.

The goal is to increase the number of the future workforce professionals supporting sector of agri production within the specialization in mechatronics and robotics. This will also show the ways of academic careers supporting the agri sector by the new technology and research projects in the future supplying PF sector with most modern technological developments.

1. Name of the event, implementing date and place

At the turn of 2021 and 2022, a series of trainings under the name of "Three dimentional education" were conducted in Poland and Slovakia. Trainings were held for students of secondary technical schools from Bielsko-Biala and Žilina. Trainings were conducted in Zylina on : 03.12. 2021, 07.12. 202108.12. 2021, 09.12. 2021, 10.12. 2021, 13.12. 2021, 14.12. 2021, 17.12. 2021, 20.12. 2021, 14.01.2022 and then in the month of February in FabLab in Bielsko-Biala on 1,2,3,8,9,10,11 and 18.

2. Number and types of participants/target groups

Trainings are offered by the ARRSA Bielsko-Biała conducted on an ongoing basis. FabLab Bielsko-Biala executes trainings for groups of high school and technical school students, as well as for students of the Bielsko-Biala University of Technology and Humanities. Through its cooperation network, training in mechatronics, robot operation and programming, spatial modelling skills and rapid prototyping are also conducted in the border area on the Czech and Slovak sides. A total of more than 70 people from secondary technical schools participated in the trainings.

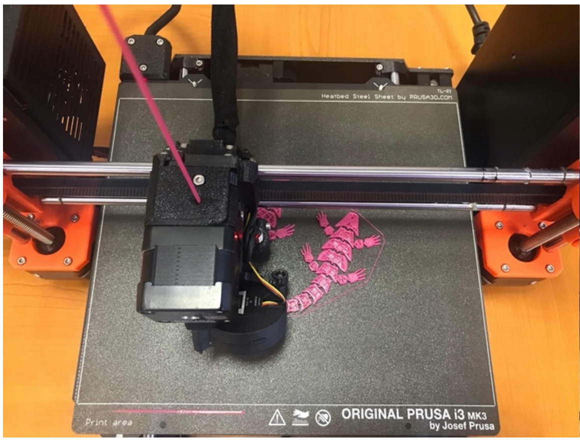
3. Topics tackled and links to deliverables, outputs

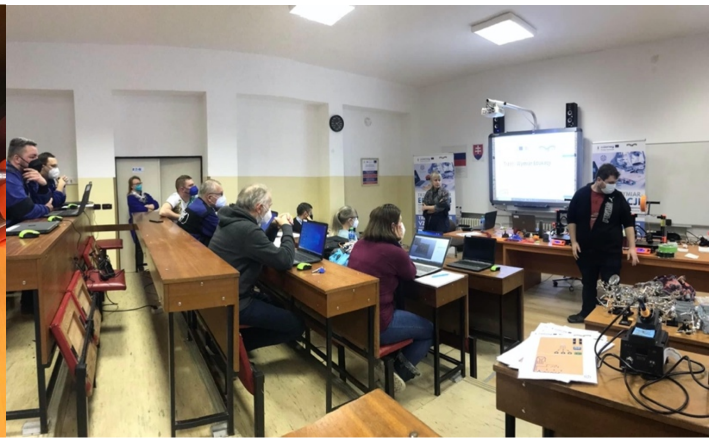
RDA Bielsko-Biala has been active in alternative education since the inception and establishment of FabLab Bielsko-Biala. FabLab Bielsko-Biala, now transformed into Digital Innovation Hub Digital Innovation HUB, has been operating since 2014, and its goal is to stimulate creativity, support innovation and assist in the implementation of projects, training in digital education and improving the competencies and skills of young people and students, as well as free educational and training programs to supplement the knowledge and skills of new chards of computer scientists and engineers. The main scope is the promotion of digital skills, knowledge in the use of 3D technology in manufacturing and development processes, the use of robots and the ability to program them, the design, programming and use of programmable electronic components in the design and development of technological lines and technologies, and virtual technologies (artificial intelligence, machine learning and big data).

4. Expected effects and follow up

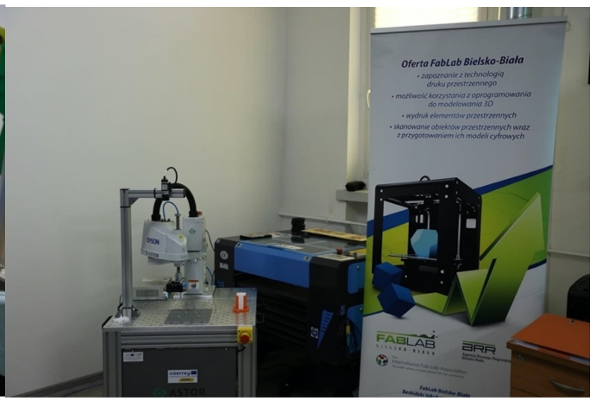
As part of the training preparation, training programs have been developed for future technical cadres to increase their knowledge and skills. The trainings provide additional specialized education outside the official education system for high school and technical school students and students of local scholars. The developed training modules will be applied in training in the future and will be expanded to include new elements of expertise, such as the use of drones, sensors and automation of autonomous control of mobile devices such as robots and other equipment used in production technologies (mowers, sprayers, surface scanners, etc.).

5. Annexes: e.g. agenda of the event, pictures, media coverage web- links etc



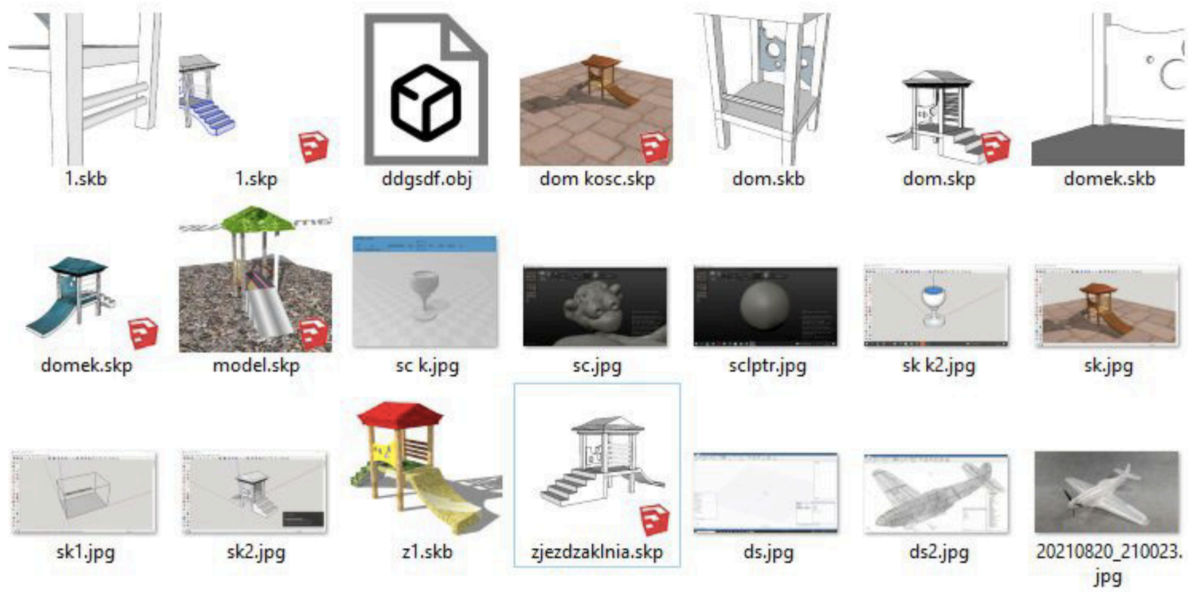






Training module I

A framework program of training and workshops on Spatial modelling for polish and slovak students, as part of the training "The third dimension of education"



Contents of the training plan:

- Description of modelling techniques and modelling software.
- The stages of conducting the training.
- Description of the topic and tasks presented to participants.
- Description of the competencies transferred to the participants.
- Description of the theoretical and practical part.

1. Description of modelling techniques and modelling software.

3D modelling, is a digital representation of any object or surface, using 3D modelling software. In the most basic case, a 3D model can be created from simple shapes such as cubes, rectangles and triangles. These shapes are then modified into complex, polygonal designs. Applications 3D modelling facilitates the communication of ideas, and is used to create interactive designs of objects or surfaces that represent the actual design.

Depending on the application, it is also possible to check the structural feasibility of a design. For xample, a part of a physical object can be created quickly, we can analyze the physical properties, and then update the model as needed.

Whether offline or in the browser, 3D modelling software allows designers and companies to model products and present them internally or to customers, before creating the final product. Not surprisingly, 3D modelling can be both time- and cost-efficient.

Basic concepts:

Vertex: A single point and the smallest element of a 3D model.

Edge: A straight line connecting two vertices that helps define the shape of a 3D model.

Polygon: Any shape formed by connecting straight lines. There are several types of polygons/multiangles (equilateral, rectangular, regular, irregular, cyclic, convex, concave) depending on the number of sides and the size of the angles.

Face: The most basic part of the polygon/mesh polygon mesh. It helps to fill in the the space between the edges. When the flat surfaces in a model are "covered," they form a so-called face.

Mesh: Otherwise known as a mesh, it is a collection of polygons (polygon) that are connected in their faces, edges and vertices. A 3D object consists of one or more meshes.

3D environment.

Every 3D modelling program operates in a 3D environment, which is visualized by computers using vectors and planes.

Vectors/Vector: A geometric object that has length and width dimensions. It is usually represented by an arrow.

Plane/Plane: A two-dimensional surface that extends into the distance.

Main types

There are three main types of 3D modelling used in CAD software.

Solid

Interestingly, this 3D modelling technique is used to create solids. Its purpose is to The purpose is to ensure that all 3D objects are geometrically correct. Solid modelling is a complex process because it requires simulation of the model's exterior and interior.

Solid modelling is helpful in creating, animating, designing and visualizing functional models. The designer is able to see what the design looks like and how it works from the the very beginning.

Surface

Surface modelling, is a mathematical method of displaying or presenting solid 3D objects. It focuses on the exterior aspect of a 3D model, allowing the user to view the 3D model from different angles on solid surfaces.

Surface modelling is easier than solid modelling, although it is more complex than a mesh. It is mainly used in architectural illustrations and animations in video games.

Wireframe
Wireframe modelling is based on generating a 3D model by following the edges of the object. These 3D models consist entirely of points, arcs, circles, curves and lines.
The object is not recognized as a solid, but as points and their connections, and the boundary of the object is registered. Compared to surface and solid modelling, meshing is the least complex method of representation of 3D objects. Typically, the basic elements in modelling in skeletal structure are triangles. The more triangles, the more realism is obtained.

Category:How different types of modelling work
Solid
A 3D designer starts by preparing a mesh model of the solid object to be created. The mesh model is then converted to a 3D view and the following are added surfaces to create the 3D model. Logical operations include join, difference and intersection, which are used to create complex designs, combined with basic shapes. Pick and place creates the desired modification by working directly on edges, vertices and surfaces. Parametric modelling controls the geometric shape of the model, by manipulating parameters.
It is worth noting that not all solid modelling programs can achieve the the above results.
Surface and Sculpting
Surface modelling begins by defining the shapes and curves of the of the model's exterior. Unlike in solid modelling, objects may not be correct physically and geometrically (without defined thickness or mass properties). This is helpful because the designer will be able to easily manipulate the object with fewer constraints. Because of its flexibility, it is relatively easy to work with imported objects. Removing and replacing the surface of an imported object, is easy.
Sculpting
Sculpting is often referred to as sculpting. Creating a model using tools for sculpting involves pulling, pushing, smoothing and compressing the surface of a solid object solid. Complex calculations are used to create detailed meshes, that look more like actual models. The process often begins with a basic model or shape. Then sculpting tools are used to manipulate the surfaces. The first layer created during sculpting, defines the basic features of the model. Once the basic shape, the geometry can then be subdivided to add finer details. Fine textures are added to layers with many details, with further subdivisions. Textures and painting can also be applied to make the model look more realistic.
There are many built-in textures in 3D modelling software, and some programs even allow you to import your own.
Key principles
Deformations in CAD allow a 3D designer to modify the surface of a of the model. For example, when designing complex models that will require some experimentation before getting the actual design, one can use deformation tools to create a large number of polygons. In this process, designer can work in a way that preserves the original model. W deformation, the topology of the model is not changed.
Manipulation, is the process of transforming an already designed model, in order to adapt it it to suit your needs. The transformation tools in CAD programs are the most commonly used manipulation tools.
Binary operations: a polygon modelling operation performed to create a new mesh from two other meshes. Two or more meshes, can be connected or intersecting intersecting.
Measurement: This is the calculation of grid values. You can measure: volume, area, cross section cross-section, and fit.
Applications
3D modelling has applications in many fields including those you don't expected. Entertainment: 3D modelling is used to create characters that are used in movies and television shows. Digital modelling software such as ZBrush, Sculptris and SelfCAD, are popular options. Fashion: Designers use 3D modelling to see the complications in clothes before they they are physically created. There is 3D modelling software for fashion design, including Fusion 360, Clo and Romans CAD, which uses a combination of techniques such as sculpting, box modelling and surface modelling.
Architecture: 3D modelling is used to visualize buildings yet to be yet to be built, often using surface modelling. AutoCAD, SketchUp and ArchiCAD are a few popular programs.
Publishing: The possibilities for designing book covers and images using 3D modelling are endless.

The gaming industry: 3D modelling is used to create characters and scenes in games. Combining 3D modelling with animation makes games more realistic. Surface modelling techniques are those most commonly used in this industry.
Manufacturing: 3D modelling is used to (re)produce parts and improve designs, both in engineering and conceptualization.
Medical: 3D modelling is used to design prosthetics, parts to repair damaged organs, even dentists are using 3D modelling to repair damaged teeth.

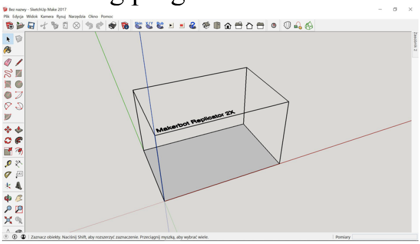
Types of files

File formats store all the information about 3D models. Among the most popular file types supported by CAD programs include:
STL: A popular 3D file format widely used in 3D printing, rapid prototyping and computer-aided manufacturing (CAM). The STL file format was developed to facilitate the transfer of files from 3D modelling software, to 3D printers.
FBX: A proprietary file format that supports model geometry, texture, color and other appearance-related properties. It is mainly used when working with movies and video games videos. It was developed by Autodesk as an interchangeable format for its programs CAD.
3DS: Another proprietary file format from Autodesk that stores geometry, animations and basic model appearance information. The 3DS format is mainly used in academic, engineering, architectural and manufacturing domains.
OBJ: This 3D file format is mainly used in 3D printing. It stores 3D objects that contain polygonal surfaces, texture maps, 3D coordinates 3D and other information about the objects.
STEP : STEP stands for "Standard for the Exchange of Product Data." It was built primarily to create a mechanism for describing product data, without relying on other systems.

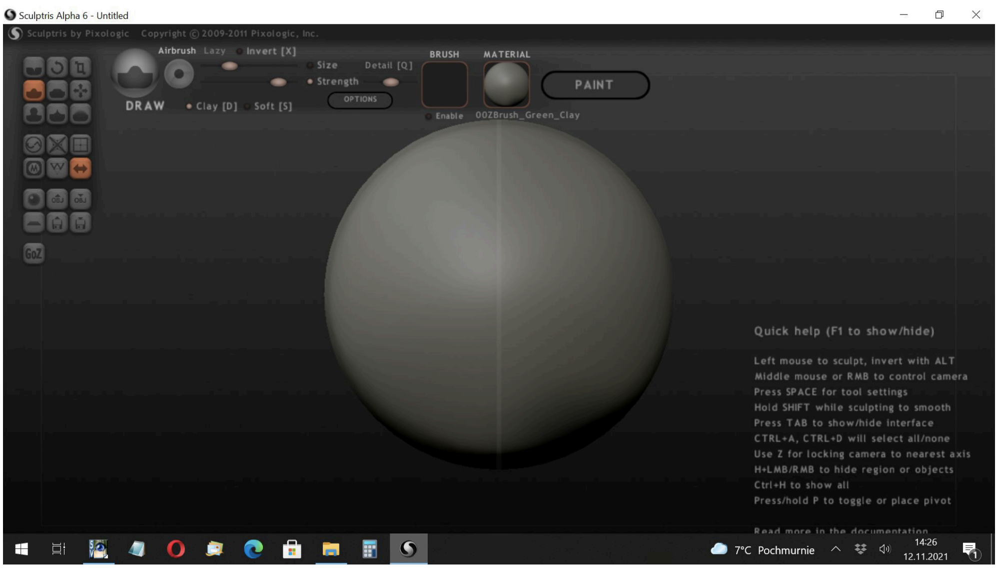
Glossary

3D object : Anything that can be represented in 3D space. Geometric objects are good examples of 3D objects, whether they are surfaces, curves, nulls or polygons.
3D Rendering: The final stage of 3D modelling, which includes finalizing the model. It includes special effects, modifying colors, adding textures and lighting.
3D modelling: The process of creating a 3D model by shaping and forming blocks Boolean: A mathematical system used to express the relationship between things. It is used in 3D modelling to add, subtract and perform other operations.
Boolean operations: A technique that uses two objects to create another object. The objects must overlap.
CAD: An acronym for computer-aided design. It is a system that allows designers to use calculations to design models.
CAM: Computer-aided manufacturing, is the creation of physical products from objects designed by computer.
Edges: Formed from two connected vertices, edges are used to transform 3D models.
Geometry: This point data creates the actual 3D model.
Lighting: Multidirectional and uniform light that illuminates the 3D model. V-Ray and Corona, are examples of programs used for lighting.
Materials: Includes colors and textures assigned to 3D models to give them a more realistic appearance. It has different types of properties depending on the mode being used rendering.
Meshes: A 3D model made of triangular polygons. Polygons consist of edges, faces and vertices, which determine what the shape of the object looks like.
NURMS modelling: A technique that uses a mesh of low polygons to transform the shape of a smooth surface. It is typically used to smooth out meshes in programs such as AutoCAD and 3ds Max.
Polygon modelling: 3D modelling of objects using polygons to perform surface estimation. In polygon modelling, vertices are processed, edges and surfaces.
Rapid prototyping: The entire process of creating a 3D model using techniques 3D modelling and printing it with a 3D printer.
Render: Creating an image using data stored in a computer.
Rig: The process of facilitating animation by adding controls to a model.

Modelling programs:

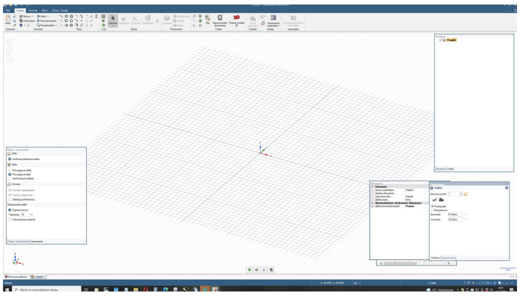


Skechup Make. Powerful but accessible 3D modelling software SketchUp is an alternative to expensive 3D modelling software such as 3DSMax and Cinema4D, which allows you to, among other things, publish your completed work on Google Earth(3D visualizations of buildings and objects on a map).
There is a sort of lack of technical jargon in SketchUp. In the course of using using the program we benefit from a number of helpful hints and guides that help, for example, to grasp the "draw" when drawing rectangles, circles and other shapes. Sketchup intelligently predicts where you want the endpoints to go, and closes them, saving a lot of time.
SketchUp Make, despite its truncated version compared to the commercial version does not lack functionality. Despite its ease of use and includes all the usual collections of drawing and filling tools you would expect, easily accessible on the toolbar at the top of the screen. We can also use the "Tips instructor" that appears on the right side of the screen, in a relevant drop-down tab.
Other options are available through the menu system: for example, you can place additional palettes in the work area to save time searching through the menus. Of particular note noteworthy is the "Materials" palette , which contains more than 100 different ready-made samples, such as vegetation, metal and glass. The Shadow Settings palette is also noteworthy, as it allows you to apply realistic shadows with simple sliders. Integration with Google Earth and maps. The real fun, however, lies in exporting SketchUp drawings to Google Earth. You can send images of your 3D designs via email or upload them to a free
space in Google's Google Web Warehouse . You can also geo-tag them in one step using Google Maps, as it is integrated with Sketchup. After adding geo-tagging to your model, you'll get a snapshot that includes 3D terrain data and color aerial photos. However, there are some problems with the SketchUp program. This is most apparent when trying to create spherical surfaces. Pushing and pulling straight lines is much easier.
SketchUp provides a straightforward approach to designing and modelling 3D graphics and is ideal for non-experts in CAD technology.



Sculptris - a very easy-to-use tool for creating 3D models. At first, the program provides us with a solid in the form of a sphere and a set of tools that allow us to model any shape from it. Available tools include

creasing, twisting, scaling, drawing, flattening, ripping, pinching, smoothing, etc. With each of these tools, there are options for setting the tool's range, its strength and accuracy. In addition, there is an option to reduce the previous action. The function Symmetry, on the other hand, allows all tools to operate symmetrically with respect to an axis passing in front of the figure and dividing the sphere into two hemispheres (a permanently visible line marked with a lighter color).
The resulting solid can be colored using the default schemes (single and multicolored, glossy and matte) or use hand coloring. This the latter allows you to freely paint each part of the figure with a brush of a specific color. In addition, as a texture we can set any color by importing the selected image.
Also, we can change the color of the background we are working on, also by specifying an image from the hard disk. The resulting solid can be saved at any time to the .sc1 format (Sculptris' own extension) and played back by the Sculptris program. Sculptris program) and recreate it to continue sculpting/painting.
The operation of Sculptris is very simple, the operation of most functions can be guessed from the icons, however, due to the lack of a Polish language version, basic knowledge of English. To make the use of the application even simpler, on the screen all the time we see a short instruction telling us what we can do and how to do it. At any time we can turn it off/on by clicking the F1 key.



DesignSpark Mechanical. It is a SpaceClaim-based free program for professional 3D design. It was developed to make any designer, not necessarily a trained engineer, like to creating objects, prototypes, etc. in 3D. Why you should use DesignSpark Mechanical:
DesignSpark Mechanical is equipped with time-saving features, so the user can design just as easily, quickly and creatively than was ever possible before.
With DesignSpark Mechanical, the user will be able to:
Create detailed dimensioned spatial models
Combine their designs with off-the-shelf components from the RS Components library and the library of 3D Allied Electronics
Easily create geometry with intuitive and handy 3D modelling commands And most importantly, this tool is completely free. And importantly:this is no time promotion.
DesignSpark Mechanical is available in Polish language.

2 Stages of training delivery:

I. Start of the course:
II. Design course
1 Introduction to 3D modelling: ; discussion of selected 3D creation software: Sketchup, DesignSpark, Sculptris, Meshmixer; - basic concepts, file formats, importing, exporting, converting; discussion of 3D design applications
2. getting started with 3D creation program – Sketchup (discussion of the interface and basic settings of the program, advantages, disadvantages, possibilities, basic tools, edges and surfaces, Z-axis - entering the 3rd dimension, creating simple solids: principles of creation, starting to create a project: a slide for a children's playground, putting into practice the learned functions, creating simple solids, push-pull tool, offset tool, follow-me tool, transformations, scaling, moving and transforming objects, creating groups and components, plug-ins and plug-ins, checking a solid for printability, exporting solids to stl format, assigning textures and colors to objects, working with 3D views and project preview views,

using the learned functions in practice, starting a project: a cup, principles of using the "folow me" tool - practical exercises,

3.Introduction to virtual sculpting: the Sculptris program (getting acquainted with the Sculptris program, getting acquainted with the principle of creating objects and ways of their transformation, interface of the program, types of tools for shaping/transforming surfaces, inclusion of tool menu options, using keyboard shortcuts, enabling/disabling symmetry options, adding a new sphere to shape a solid, simplifying the created graphic /reducing the mesh/, scaling, import/export, example modelling: mascot head

4. Getting started with the 3D creation program – DesignSpark (discussion of the interface and basic settings of the program, advantages, disadvantages, possibilities, navigating through the menu, explaining the differences in the approach to work in relation to the previously learned Sketchup program, edges and surfaces, importing images, moving meshes, creating simple solids: creation principles, the push-pull tool, offset tool, follow me tool, transformations, scaling, moving and transforming objects, creating groups and components, creating solids with complex shapes, trimming, combining and partitioning objects, checking solids for printability, exporting solids to stl format, setting colors and transparency for objects, working with 3D views and design previews, principles of using the "folow me" tool - practical exercises, recreating a project together using DesignSpark tools and options
Summary/end of the class
- Recall of program names and their functionality
- Recording on portable memory sticks

4. Description of competencies transferred to participants

- Getting acquainted with the basic concepts covering the sphere of 3D design.
- Mastering the basic functions of the programs discussed in the course
- To expand the ability to work with a computer and use it to create virtual reality.
- Developing imagination - including spatial imagination.
- Encouraging young people to use the computer creatively as an alternative to the world of games.
- "From digital design to real projects"-demonstration of objects digitally designed and printed for their use
- Encouraging participants to explore knowledge and practical use in the projects created.
- To indicate the enormous potential of this field of design-including as an an interesting option for choosing a professional path in the future.
- Directing participants where they can independently look for additional knowledge in the field of in the field of design (sites containing materials for on line learning, tutorials, instructional videos, etc.).

5.Description of the theoretical and practical part.

Both parts form a compact whole and intertwine during the course. Coherent transfer of information and instant use of it in practice provides a more interesting source of cognition for young people thanks to which the process of learning new things is more effective.
The theoretical concepts discussed are visualized in real time on a screen using a computer and an image projector.
The various functions of the programs discussed are also supported on the fly with images and example operation and then repeated independently by students at their computer workstations.
With more complicated topics, the instructor demonstrates at least twice how the function works/operates, as well as giving direct guidance to students having trouble mastering a given issue. During the four-hour class, three ten-minute breaks are provided to help maintain concentration during the class. During the breaks it is possible to have additional individual consultations on the project.

Training Module II

Workshop of scanning and operation of 3D scanner

Place of implementation:
FabLab Bielsko-Biala or school.
Equipment needed:
Prusa Research 3D printers - Prusa MK3S and Prusa Mini.
Computer with software
Description:
Practical workshop of 2 hours on 3D scanning. Participants will learn the principles of operation, handling and application of 3D scanning equipment, as well as have the opportunity to process and process digital scans. Each participant will be able to independently perform the scanning process of any object, allowing them to gain practical knowledge and skills in the scanning process. Two handheld 3D scanners will be made available to the students. Each has an application that guides them through the process of scanning, analyzing and processing the scans made, and saving the finished 3D models for later use. The process of scanning small objects and people will be demonstrated, then students will be able to test the scanners themselves by taking their own measurements and scans. There will be two handheld scanners from 3D companies System Sense on USB and Structure Sensor in the form of an iPad overlay.

3D scanner System Sense and Structure Sensor

The use of an advanced 3D scanner used for professional applications will also be demonstrated in the form of a demonstration. The presentation will consist of a discussion of the principle of operation and the

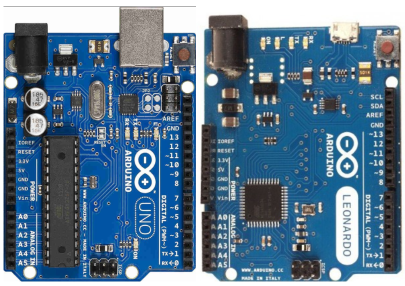
performance of sample scans using the scanner and included accessories. The scanning process will be carried out using a rotary table to facilitate full scanning of the object. Participants will learn the various stages of scanning. Calibration will be carried out, using a standard placed on a movable stand within reach of the scanner, called the process of calculating the rotation of the table's axis. The scanning process will be carried out, and the resulting data, called a point cloud, will be cleaned of imperfections using simplification and enhancement tools. The next processing step to obtain the final model will be to transform the point cloud into a grid of triangles to facilitate later editing. At this stage, any remaining imperfections in the form of holes and discontinuities can be patched according to certain parameters to make the model a closed solid. Once completed, the model should be saved to one of the available formats. If the process was done correctly the resulting output will be a model that can be printed on a 3D printer or imported into a CAD program for further processing called reverse or reverse engineering.

Training module III

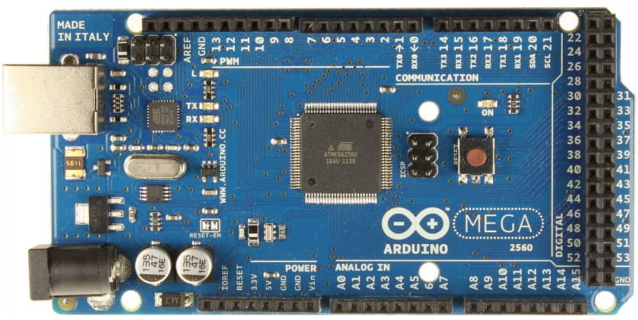
Arduino microcontroller programming workshop

Place of implementation:
FabLab Bielsko-Biala or school
Equipment needed:
Computer with Prusa Slicer software
Materials needed:
Arduino starter kit including Arduino Uno board, sensors cables and other electronic components. For a full list of components, see Appendix 1
Description:
The theoretical and practical workshop of 4 hours on microcontroller programming and design of electronic circuits using the Arduino platform will consist of learning the basics of electronics, programming and construction and measurement of electronic circuits. Programming and electronics are inseparable parts of our lives, so knowing and understanding how they work, can allow participants to develop and choose their future career direction or interests. It is for such purposes that the Arduino project was created, which is a combination of runner boards with microcontrollers and a programming environment. They have been adapted as much as possible for simple and effective learning for people starting out with microcontrollers. Arduino is used by hobbyists, but also by professional people, as it is ideal for fast and reliable prototyping of electronic circuits of future projects. During the training, participants will learn exactly what Arduino is, what its capabilities and limitations are, and examples of use presented. For the duration of the workshop, participants will receive individual kits consisting of an Arduino board, electronic components, Arduino peripherals and connecting cables. Access to the technical specifications of the circuits needed to perform the tasks will also be provided.

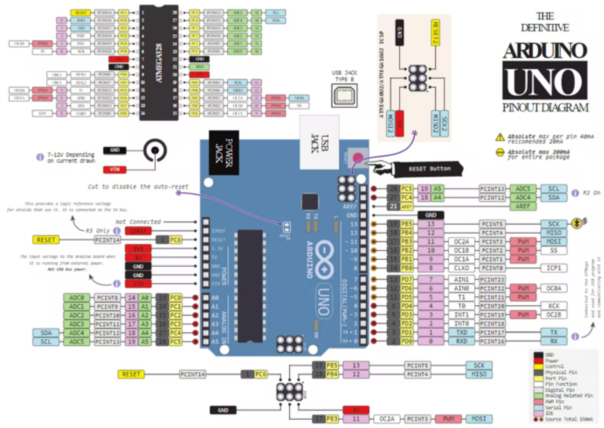
There are many models and versions of Arduino runtime boards available on the market. They differ in size, number of available input/output pins, microcontroller used or computing capabilities. The most popular versions are Uno, Nano, Mega, Mini and Leonardo.



Arduino Uno left and Leonardo right



Each board has digital I/O ports, analog connectors, a 5V and 3.3V power section and communication buses. The operating voltage, and therefore the logic on which the board operates, is 5V, which is more common, and 3.3V and is a result of the microcontroller used. For circuits operating on 5V logic, communication with sensors operating on 3.3V is not a problem, but in the opposite situation too much voltage can cause partial or complete damage to the microcontroller or even the Arduino board. The ideal version for beginners is the Uno board with the following parameters :
14 digital inputs/outputs allow you to, among other things, control LEDs, relays and read button states,
6 PWM outputs allow, for example, to control motors and adjust the brightness of LEDs,
6 inputs of built-in analog-to-digital converter with 10-bit resolution supports, among others, sensors with analog output, UART, I2C and SPI communication interfaces, installation of dedicated overlays so-called Arduino Shield, maximum current capacity of a single lead is 40 mA, the Atmega328 chip is clocked at 16 MHz, has 32 kB of Flash program memory, 1 kB of EEPROM and 2 kB of SRAM,
to power the Arduino, you can use any 7 V to 12 V power supply with a DC 5.5 x 2.1 mm connector or a USB cable
Some of the connectors have more than one functionality, and with the diagrams for each board, the user can decide which pin is best and what capabilities it has.



Each participant will receive a so-called Arduino starter kit, which is necessary for the implementation of the workshop, and after the workshop it will be up to the participant how to use it. The kit was composed in such a way as to enable the creation of as many circuits as possible and the realization of further, even more complicated ideas.
The training itself is divided into:

1. presenting the safety rules for working with electronic circuits,
2. getting acquainted with the different types of Arduino boards available on the market,
3. discussing the schematic and the elements of which the various boards are composed,
4. explaining the principles of the circuit's inputs/outputs and their use,
5. presenting the programming environment with an explanation of the most important functions needed to program the circuit,
6. connecting the Arduino to the computer and uploading a sample program in order to verify the correctness of the operation and settings of the program and the board
7. getting acquainted with the programming language used in the environment, participants will learn the syntax of the language and the functions needed to create a program,

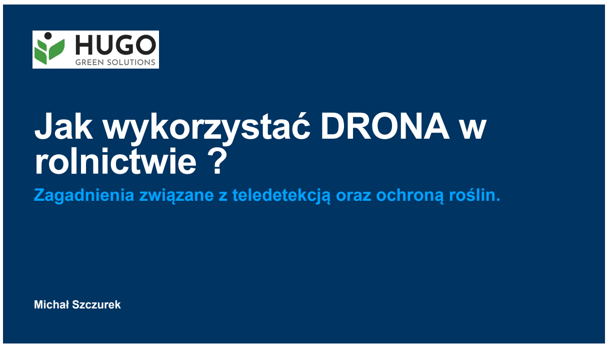
Participants, together with the instructor, will build electronic circuits and code, upload and verify the correctness of the program and the circuit itself,
After completing all the sample tasks, participants will receive individual projects that they will be able to perform under the supervision of the instructor, this will allow to check to what extent they have assimilated the knowledge and encourage further development of their skills.

The segment for reproducing sample programs will consist of descriptions of the tasks to be performed, electronic wiring diagrams that participants will have to reproduce on individual training kits, and explanations of the programs they will create on their own in the programming environment.

Example wiring diagram of an RGB LED to an Arduino Uno board
The individual tasks will allow to acquire electronic and programming knowledge in a simple way. Examples of topics that participants will deal with:
handling digital, analog and PWM input/output signals and communication protocols such as I2C, UART, SPI, control of LEDs with precise definition of what color they should light up and precise control of on and off time, smooth brightening and extinguishing of the LED with the use of PWM output, measuring the resistance of an element using voltage measurement at the analog input, RGB LED control for any color using three base colors, operation of buttons and switches to control the program operation, connecting an LCD display and displaying any text on it, creating a simple sequence of sounds using a buzzer, measurement of distance using an ultrasonic sensor, measuring ambient temperature and light level with displaying the values on the LCD screen.
The next stage will be the independent realization of one's own ideas using available electronic components of the kit and those on the equipment of FabLab Bielsko-Biala. Participants will be provided with a link with all the examples, libraries and schematics that will facilitate further learning and developing their skills in microcontroller programming.
The knowledge gained will be only the beginning of learning about the possibilities of programming and the Arduino platform, which should encourage participants to further develop on their own. Being able to access devices, electronic components, technology and knowledge is essential for students in determining their interests and possible career paths. This is the main goal of the workshops and lectures in question. This will give participants the opportunity to build the foundation of their knowledge and work experience.

Educational Modules preppared with cooperation of University of Agriculture in Kraków, spinn-off company Hugo Green Solutions

Training I Drones in Agriculture



Definicja pojęcia DRON

Dron to inaczej Statek Powietrzny który nie wymaga do lotu załogi obecnej na pokładzie oraz nie ma możliwości zabierania pasażerów, pilotowany zdalnie lub wykonujący lot autonomicznie

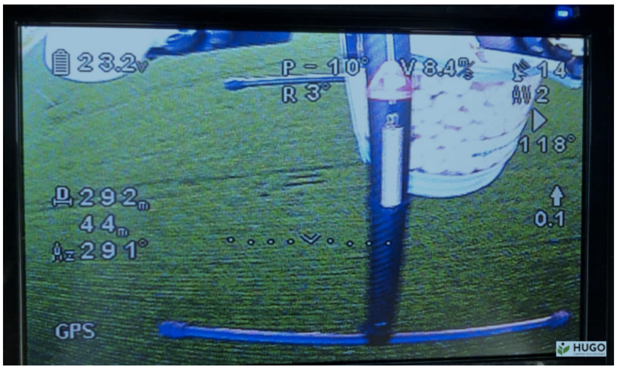
- BSP Bezzałogowy Statek Powietrzny
- UAV Unmanned Aerial Vehicle
- RPAS Remotly Piloted Aircraft System

HUGO

Rodzaje dronów dostępne na rynku

- Wielo wirnikowe
- Płatowce

HUGO



Drony w rolnictwie

- Szacowania szkód w uprawach
- Monitorowanie upraw
- Ochrona roślin

HUGO

Produkty końcowe

- Gotowe mapy RGB
- Mapy uwzględniające różne wskaźniki (prezentacja Pix4D)
- Oprysk roślin
- Aplikacja preparatów ochrony roślin

HUGO

Training II

Innovation Technologies in Agriculture

Wykorzystanie bezzałogowych statków powietrznych oraz zdjęć satelitarnych do uzyskania danych teledetekcyjnych dotyczących stanu upraw

Upowszechnienie odbiorników GPS – Global Positioning System ułatwiło pozyskiwanie danych obrazowych na potrzeby rolnictwa czy leśnictwa. Obecnie na świecie korzysta się z czterech rodzajów nawigacji satelitarnej:

- **GPS** – Global Positioning System - system amerykański o zasięgu globalnym początkowo utworzony dla armii amerykańskiej, który posiada 31 satelitów,
- **GLONASS** – Global Navigation Satellite System - jest rosyjskim odpowiednikiem GPS, działa podobnie jak on i również posiada 31 satelitów,
- **GALILEO** uruchomiony w 2016 r., posiada obecnie 22 satelity, a docelowo ma posiadać 30 satelitów, pełną funkcjonalność ma osiągnąć w 2020 roku,
- **Beidou** – chiński system nawigacji obejmuje swoim zasięgiem tylko obszar Azji, aktualnie posiada 4 satelity, jego kolejna wersja Beidou 2 ma posiadać ma posiadać docelowo 5 satelitów geostacjonarnych i 30 na orbitach średniej wysokości, a swoją pełną funkcjonalność osiągnie w 2020 roku.

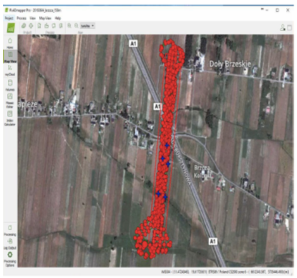
HUGO GREEN SOLUTIONS

Wykorzystanie bezzałogowych statków powietrznych oraz zdjęć satelitarnych do uzyskania danych teledetekcyjnych dotyczących stanu upraw

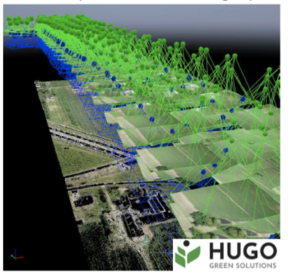
GPS współpracują z różnego rodzaju czujnikami np. czujnikami optycznymi takimi jak **kamery multispektralne**, dzięki którym otrzymuje się dane rastrowe obrazowe służące np. do określenia indeksów wegetacji w **rolnictwie, leśnictwie czy ochronie środowiska.**

HUGO GREEN SOLUTIONS

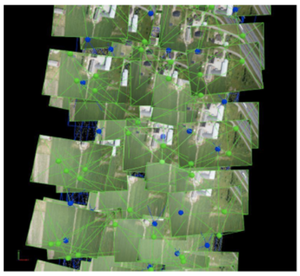
Mapa, sieć punktów pozyskiwania zdjęć z kamery na samolocie bezzałogowym



Sieć zdjęć uzyskanych w wyniku przelotu nad badanym polem uprawnym uzyskana z kamery na samolocie bezzałogowym



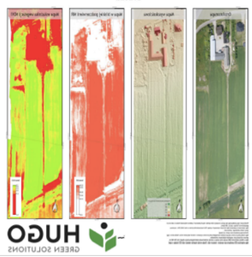
Sieć zdjęć uzyskanych w wyniku przelotu nad analizowanym polem uprawnym widok z góry uzyskana z kamery na samolocie bezzałogowym



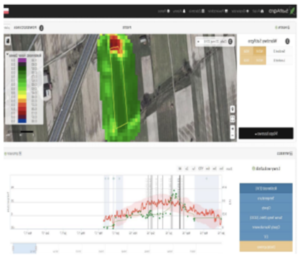
Wizualizacja 3D analizowanego pola uprawnego uzyskana z kamery na samolocie bezzałogowym

Wizualizacja analizowanego pola uprawnego w zakresie różnych widm światła widzialnego miejscowość Brzoza

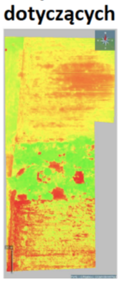
Brzoza



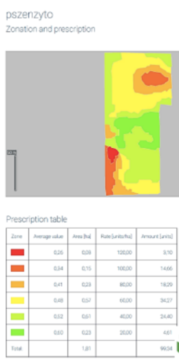
Wysokiej rozdzielczości obrazy uzyskiwany z satelit (https://satagro.pl/)



Wykorzystanie bezzałogowych statków powietrznych oraz zdjęć satelitarnych do uzyskania danych teledetekcyjnych dotyczących stanu upraw



Mapa terenu - wygenerowany wskaźnik NDVI przy użyciu oprogramowania Pix4Dfields



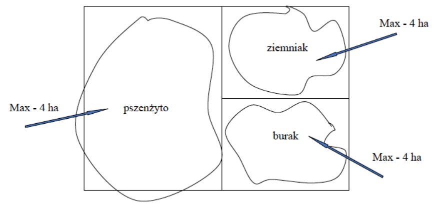
Mapa nawożenia azotem (tzw. dawka korekcyjna) w kg·ha^{-1}, wygenerowana na podstawie wskaźnika wegetacji NDVI przy użyciu oprogramowania Pix4Dfields

Pobieranie, przechowywanie i przygotowywanie próbek gleby

Aktualnie coraz częściej do praktyki rolniczej wprowadzane są innowacyjne technologie nawożenia, których celem jest optymalizacja dawek nawożenia adekwatnych do warunków glebowych, terminów stosowania i rodzajów upraw. A jednym z podstawowych elementów pozwalającym prawidłowo ustalić potrzeby nawozowe roślin jest znajomość właściwości gleby wraz z ich przestrzennym rozkładem w skali pola. W pobranym materiale glebowym jesteśmy w stanie wykonać analizę zawartości przyswajalnych form składników pokarmowych, zarówno składników z grupy makroelementów, jak i mikroelementów. Oprócz oznaczeń zawartości składników pokarmowych w glebie wykonuje się oznaczenie pH gleby. Kluczem do otrzymania jak najdokładniejszych wyników jest właściwy sposób pobierania prób glebowych oraz odpowiedni moment ich poboru (Powałka 2017). Podczas pobierania prób korzysta się z wytycznych określonych normą PN-R-04031:1997.

Pobieranie, przechowywanie i przygotowywanie próbek gleby

POBIERANIE PRÓBEK GLEBY



Pobieranie, przechowywanie i przygotowywanie próbek gleby

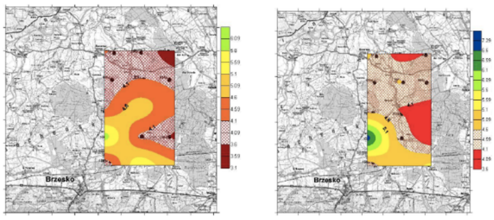
Pobór próbek gleby w terenie

Przestrzenny rozkład pH gleb w gminie Borzęcin w KCl

Pobieranie, przechowywanie i przygotowywanie próbek gleby, generowanie map nawożenia gleby

Pobór próbek gleby w terenie (Surfer 10.0)

Metody cyfrowe wizualizacji zasobności gleby, stanu odżywienia roślin oraz potrzeb nawozowych



Przestrzenny rozkład pH w 1 mol KCl gleb w gminie Borzęcin (poziom 0-10 cm z lewej i 40-50 cm z prawej)

Metody cyfrowe wizualizacji zasobności gleby, stanu odżywienia roślin oraz potrzeb nawozowych

CLAAS Crop Sensor ISARIA – detekcja stanu upraw (https://www.claas.roltexkrasnystaw.pl/maszyny-nowe/claas/easy-2018/rolnictwo-precyzyjne/crop-sensor-ISARIA)

Metody cyfrowe wizualizacji zasobności gleby, stanu odżywienia roślin oraz potrzeb nawozowych

CLAAS Crop Sensor ISARIA – detekcja stanu upraw (https://www.claas.roltexkrasnystaw.pl/maszyny-nowe/claas/easy-2018/rolnictwo-precyzyjne/crop-sensor-ISARIA)

Metody cyfrowe wizualizacji zasobności gleby, stanu odżywienia roślin oraz potrzeb nawozowych

Yara-N-Sensor – zróżnicowane dawkowanie nawozu (https://www.researchgate.net/figure/Sensore-Yara-N-sensor-usato-per-stimare-il-contenuto-di-azoto-in-foglie-di-rapa-in-base_fig4_298793969)