

## 8.a Develop the virtual prototypes in the real environment also thanks to physical computing tools

**Functional Area: R&D**

**Pre-Requisites:**

Fundamentals of Algorithms formulation

Base of C programming

Fundamentals of mechanism

Fundamentals on actuators (electric motors, pneumatic actuators, etc)

Fundamentals on basic sensors (encoders, limit switches, etc..)

**Assessment criteria**

**Knowledge**

**LA8a.1. Plans, manages the assembling and executing operations of adjustment of mechatronics prototypes from virtual models.**

Starting from a given description of a product/process function (aim, functions drawings, etc..) the student will describe how to create a prototype focusing on the following steps:

- Parameters needed to prototype and replicate the main behaviour of the product/process I the real word
- Relations among the identified parameters
- Sketch of the mechanism needed to simulate the fundamental behaviour of the product/process machines
- Identification of a kind of sensors and actuators needed

Starting from a given description of a product/process which contains:

- The aim of the mechanism/machine
- the main function,
- the kinematics
- The equipped kind of sensors and actuators

The student will describe and will formulate:

- the algorithm which connect all the functions described

- Knowledge of application of kinematics laws
- Knowledge on actuators categories (electrical, pneumatics, automatic, etc,)
- Knowledge on sensors categories (optical, automatic, resistive, etc,)
- Knowledge on microcontrollers (components, functions, characteristics, etc.)
- Knowledge on embedded microcontrollers boards (Arduino, ST Nucleo, etc..)
- Knowledge of low-level programming for prototypes controlling

**Skills**

- Identify the fundamental functions/parameters (components, movements needed, connections, etc..) needed to replicate the main behavior of the product/process I the real word
- Simplify the product/process in its fundamental parameters/functions

<ul style="list-style-type: none"> <li>• Selection of a microcontroller and/or embedded system</li> <li>• Low level code (C) needed to control the prototype</li> </ul> <p>Starting from:</p> <ul style="list-style-type: none"> <li>• a given description of a product/process function (aim, functions drawings, etc..) the student</li> <li>• A selection of simple actuators (DC motors, pneumatic pistons, etc..)</li> <li>• A selection of simple sensors (encoders, limit switches, switches, etc..)</li> <li>• Simple connection elements (modular profiles, 3d printed, etc)</li> <li>• Partial low-level code which has to be completed</li> </ul> <p>The student will create a prototype assembling the provided components (actuators, sensors, connectors, etc) according to the function to simulate. After that the student will connect the prototype to an embedded system. The student has to complete the provided code, compile and upload it on the embedded system in order to control the prototype. The prototype will be equipped with a simple user interface (start/stop buttons, knobs, etc..). The evaluation will be formulated according to the written description provided by the student and the testing of the behaviour of the created prototype.</p>	<p>needed to prototype and simulate the product/process in the real word.</p> <ul style="list-style-type: none"> <li>• Formulate the kinematic model of the prototype</li> <li>• Identify the control logic connect and connect the fundamental parameters</li> <li>• Identify the fundamental mechanical, electrical and electronics components needed to prototype and simulate the product/process in the real word.</li> <li>• Create the mechanical and electrical connections among actuators, sensors and end effectors and connect them to a microcontroller (or other control platforms)</li> <li>• Program the microcontroller in order to simulate the behavior of the product/process</li> <li>• Ability to understand if the physical behavior corresponds to the desired one.</li> <li>• Manual skills to create the physical prototype</li> </ul>
	<p><b>Transferable skills</b></p>
	<ul style="list-style-type: none"> <li>• Ability to explain the behavior of a system simplifying its behavior to the fundamental functions</li> </ul>