# The Smart Factory Lab

That Smart Factory lab is a cornerstone in the newly established Innovation lab at the Mads Clausen Institute at Alsion in Sønderborg. The Innovation Lab is a physical environment corresponding to the stages of the innovation process. This allows participants from companies and students to move from a theoretical approach to practical and applied innovation principles. The Innovation Lab is dynamic and may change according to the innovation challenges and changing conditions. The physical outline of the lab is represented in Figure 1. The lab is a 150 m^2 room and is split up into four sections, corresponding to the stages of the innovation process: creativity, design/prototyping, production/operations, and
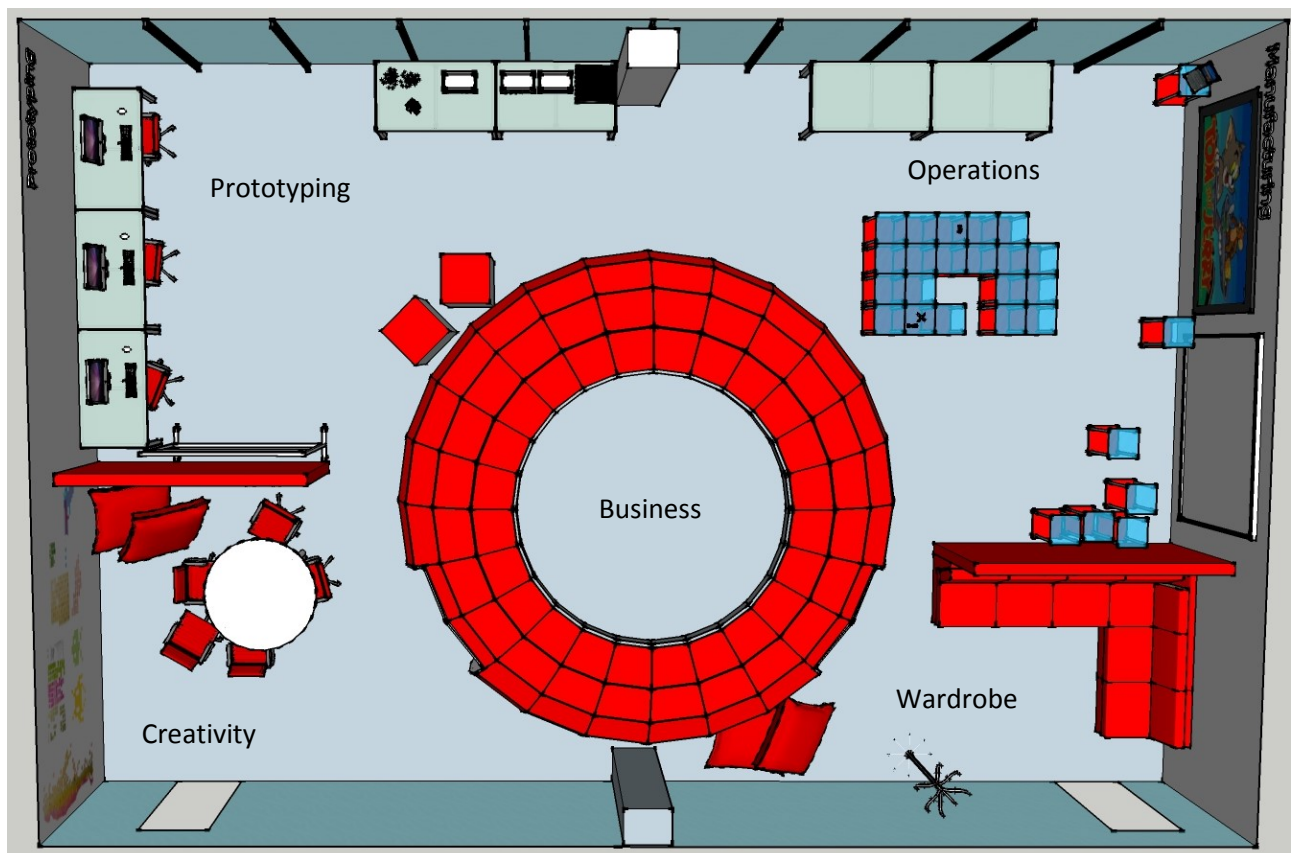
marketing/business..

Figure 1 The innovation lab seen from above

In all of the sections different expert knowledge can be brought in, the lab itself holds different enablers and technologies, that can foster the specific processes in each section. The different sections are briefly described below.

Creativity

The creativity section see Figure 2, is designed to actively pursue ideation. Writable surfaces and a comfortable environment allow participants to explore, rethink, and discuss ideas, disregarding the problem background. The ideation success depends on an experienced facilitator or
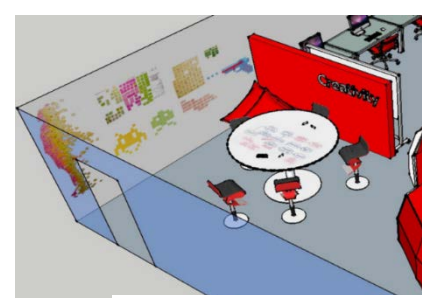

Figure 2 The Creativity Section

adequate creativity experience of the participants.

Design/Prototyping

This stage contains tools to pursue active prototyping see Figure 3. Besides access to 3D modelling software, there is material samples to build prototype mock-ups that enhance ideas through tangibility. A material library allows handling of different substances. In the end, this stage significantly increases both the idea and the feasibility, which should be a prerequisite to consider operations and design aspects.

Figure 3 The Prototyping Section

Operations/Manufacturing (SMART FACTORY LAB)

The operations is where we have developed the Smart Factory Lab, where innovative experiments may be performed. The core output is to take whatever product or service, that has been developed in the Prototyping section and take it through the manufacturing innovation phase to realization. The setup is centered around the reconfigurable environment which are designed for seamless integration and reconfiguring, based on moveable workstations for mapping and working innovatively with materials, processes and supply chain.
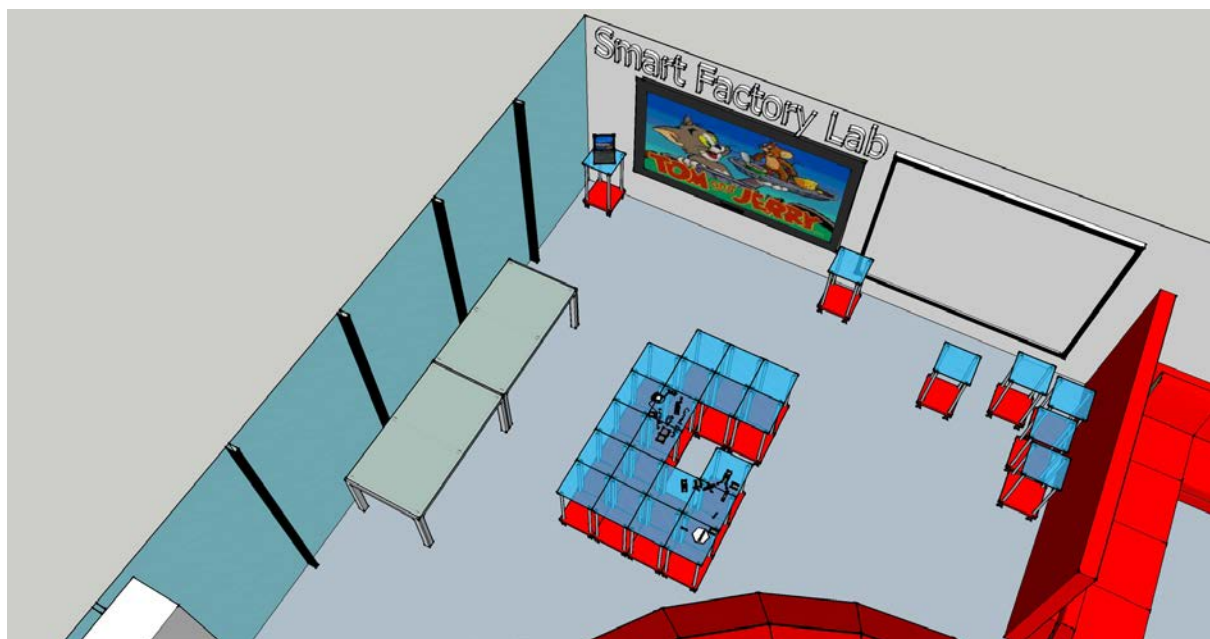

Figure 4 The Smart Factory Section

Most companies and innovation tasks will be different and have different innovation challenges, but in a typical session in the Smart Factory Lab, may contain activities related to material, manufacturing processes, production , material handling/transport, supply chain and final product/service cost price calculations. In graphic 5 and 6 a startup agenda can be seen.
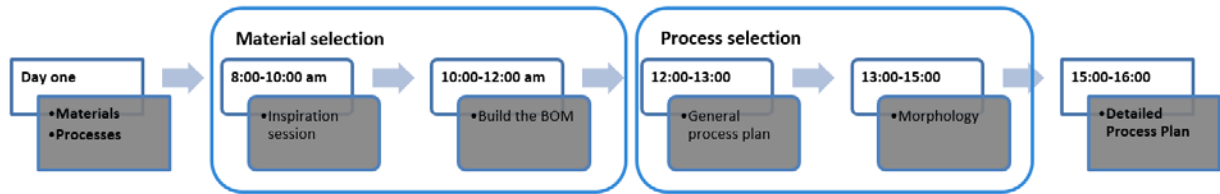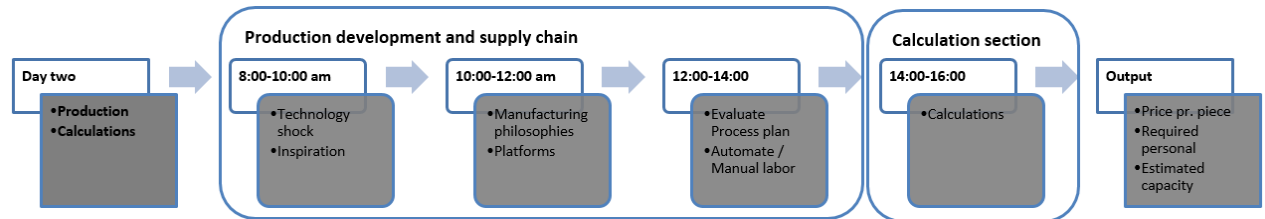
Figure 5, Agenda day one

Figure 6, Agenda day two

The diversity of the Smart Factory Lab

In the Region of Southern Denmark, most companies are SMEs. The Smart Factory lab is targeting the companies in the region especially the SMEs. In order to help a broad target group the Lab will need to be super flexible. The innovation capabilities are within the production technology, automation, Lean tools and digitalization. This is in line with the theory behind Lean Automation, where the purpose is to make simple and inexpensive automation targeted SMEs.

The flexibility is achieved through a highly reconfigurable setup, where even the workstation-base is reconfigurable. Through the base unit and a diverse portfolio of physical and flexible tools to build with on top, alongside a computer program, it is possible to map select, develop and map the materials, processes, production and supply chain.

Tools and enablers

The mechatronics can be modelled through flexible and reconfigurable tools. Data processing, signaling and basic actuation can be modelled and simulated through a modelling tool like LittleBits. It is a module based product where all bits and pieces fit together by magnets, they have simple

process signals that can sense and actuate to a great extent. There are sensors for temperature, light, movement, bending and pressure, the actuators counts among others DC motor, servo motors, air-fans, light and sound in many different designs. Further there are a diversity of user bottoms, logic command bits, Arduino and Cloud bits etc. with this set of tools it is possible to map and simulate a broad range of processes and signaling internally in a production as well as externally in the supply chain.
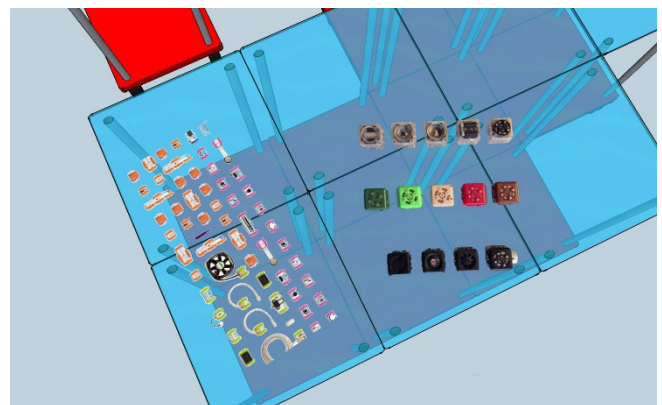

Figure 7 LittleBits and Cubelets

Another tool like Cubelets is a highly modular tool as well. The purpose is to simulate transportation, where the speed and capacity can be simulated. This tool is for simulating physical transportation in

the supply chain as well as internal transportation, where it can simulate the work of for example robots, AGVs., ASRS etc. Of course the simulation will be a basic representation of reality, but the point is to get inspiration and come up with new and innovative solutions

A major purpose about the Smart Factory lab is to get SMEs and technology/automation providers to think more module based and reconfigurable in the future solutions.

The Innovation lab in general and the Smart Factory lab in particular is expected to be a very active innovation environment, where SMEs from the region will be able to collaborate on new innovative solutions.

Supply Chain, Production and Process mapping/Simulation

The work with mapping and simulation starts by putting together a suited amount of reconfigurable units. The Supply Chain can be mapped with the symbols from the well-known Lean tool called Value Stream Mapping, though this setup differs because it is based on tangible symbols, that can be moved around while discussing see Figure 8. The 3D printed and laser cutted symbols function very well with the more sophisticated enabling technologies, and makes in unison a very powerful mapping and simulation tool of a given supply chain. The
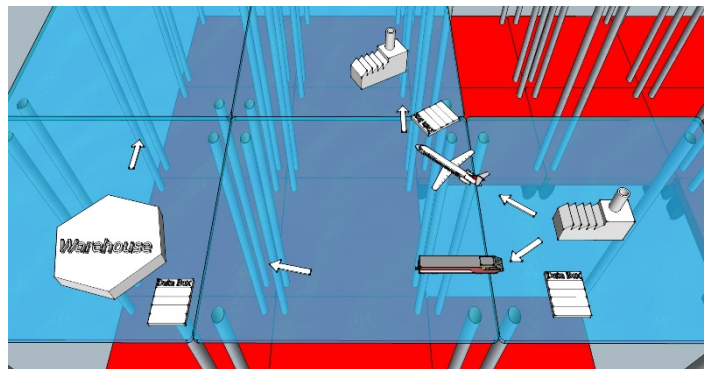

Figure 8 Tangible Supply Chain Mapping

Reconfigurable holds yet another feature, they are designed to function as whiteboards used for sketching as well, and can therefore hold a lot of information as can also be seen in figure 9.

In Figure 9 is an example mapped a simple process . The mapping/simulation works to a great extent exactly like the supply chain mapping, and will also make use of both LittleBits and Cubelets ro embed the mechatronics control.
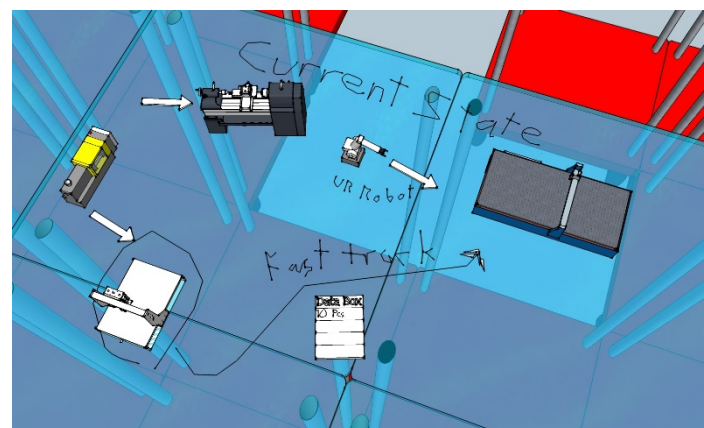
The mapping yields a better understanding of where to mount machines to have the optimal flow in the production and how much of a difference the rearrangement will

Figure 9, Process mapping

impact the production. Further it will help with decision making when it comes to new investments both in new standalone machines, but also regarding peripheral automation, such as robotic feeders and AGVs.