D6.3 - PicknPack report

Design and drawings of all sub-components in the flexible packaging system

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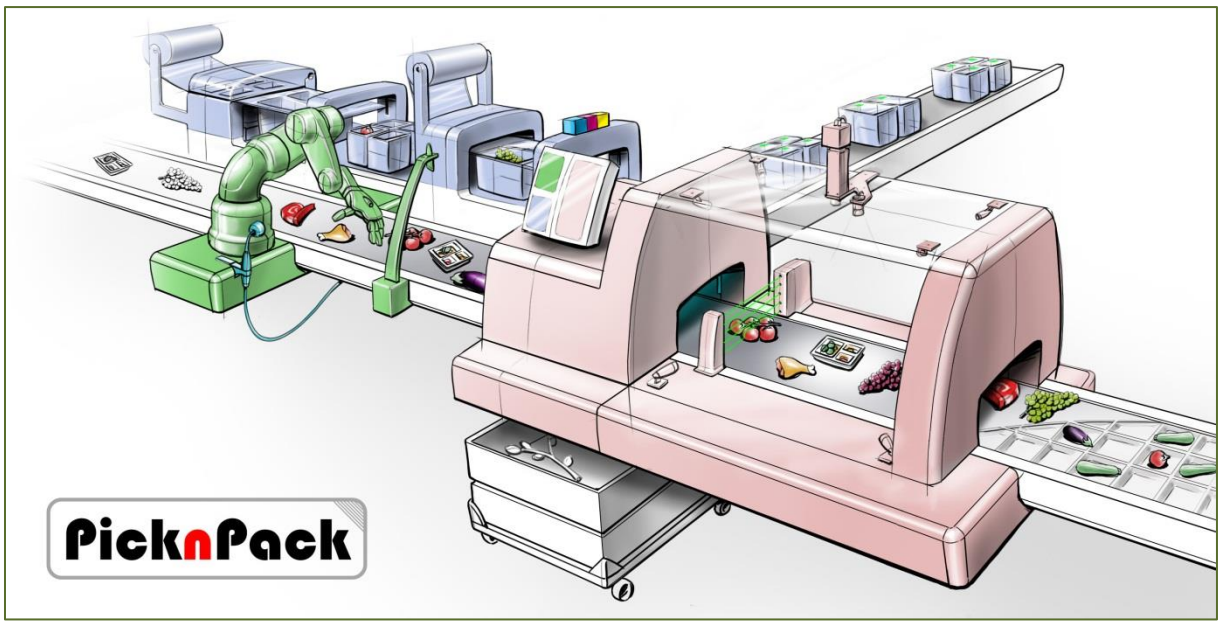

Flexible robotic systems for automated adaptive packaging of fresh and processed food products

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Dissemination level		
PU	Public	X
PR	Restricted to other program participants (including the EC Services)	
RE	Restricted to a group specified by the consortium (including the EC Services)	
CO	Confidential, only for members of the consortium (including the EC Services)	

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1 Introduction

This report shows the conceptual layout drawings of the whole PicknPack line and of all sub-components in the flexible packaging line. After each drawing is an explanation of choice and a discussion of flexibility achieved and / or not achieved, and the challenges to face.

2 Layout fresh food

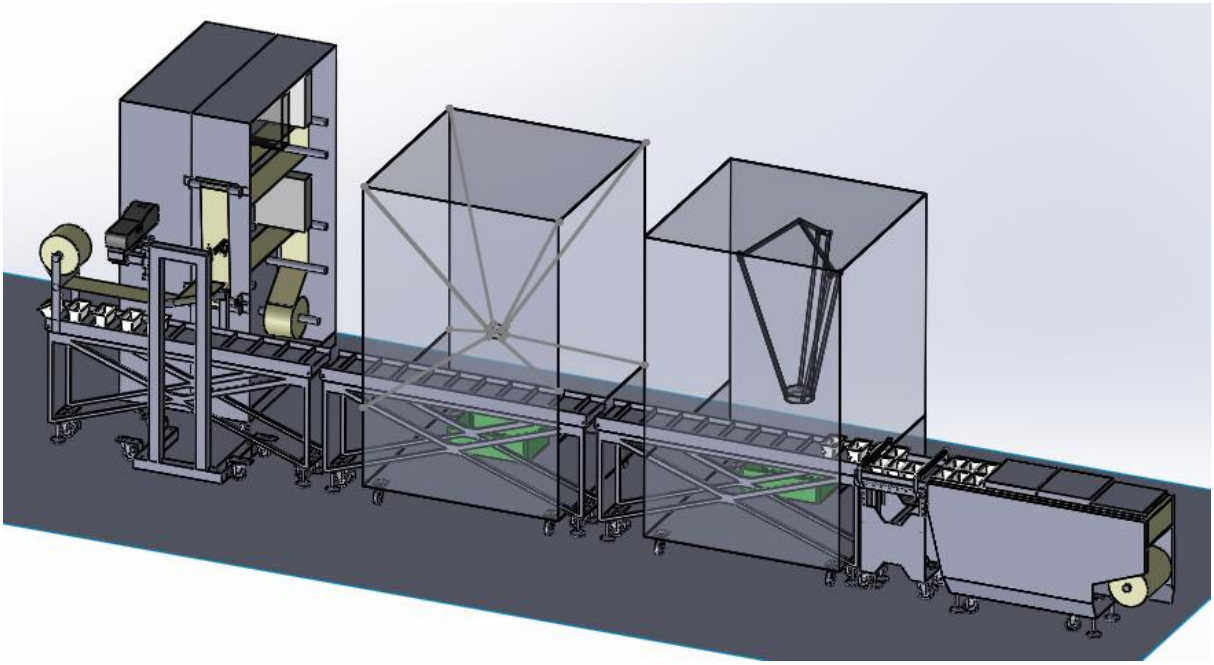

Figure 1: Layout Fresh Food. The trays are separated immediately after thermoforming and conveyed in line, one at a time.

The Flexible Packaging System consists of:

- Thermoformer with integrated cutting (separation) of trays
- In-line conveyor
- Conveyor with belt with flights or other means to keep the trays separate and in position
- (Delta robot from WP7)
- (Cable robot from WP7)
- Print cabinet with coloured ink
- Laser cutter and sealer
- Inspection of sealing
- (End of line handling not considered in this project)

3 Layout ready meal

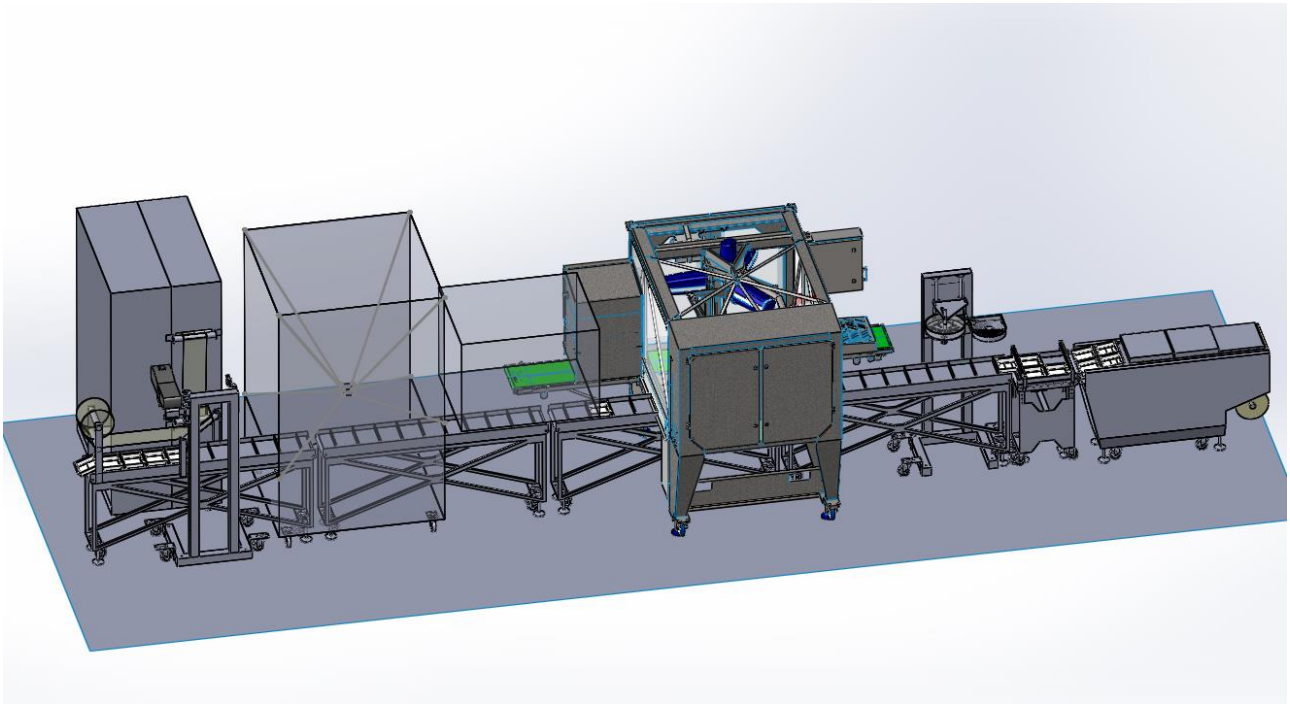

Figure 2: Layout Ready Meal. Same concept as above, but adding of reflective band added.

The Flexible Packaging System consists of:

- Thermoformer with integrated cutting (separation) of trays
- In-line conveyor
- Conveyor with belt with flights or other means to keep the trays separate and in position
- Dispenser of conductive belt
- (Delta robot from WP7)
- (Cable robot from WP7)
- (Dispenser from WP7) (not shown)
- Dispenser of susceptor board (perhaps not needed for the ready meal to be shown in the demonstration) (not shown)
- (Sensing module from WP 7)
- Print cabinet with conductive and coloured ink
- Laser cutter and sealer
- Inspection of sealing
- (End of line handling not considered in this project)

4 Thermoformer

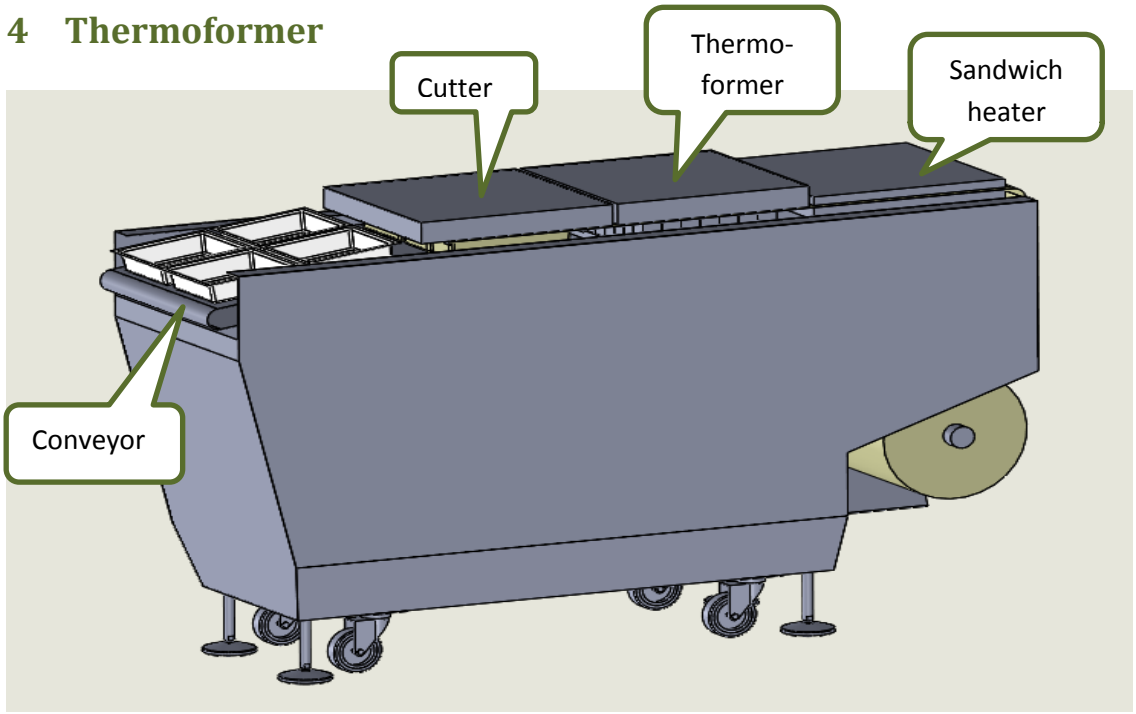

Figure 3: Thermoformer

The thermoformer consists of:

- Feeding system for roll
  - Roll width: 420 mm Thickness: 0,5 - 0,75(?) mm Material: APET; CPET
- Sandwich heater 400 x 400 mm
- Thermoformer 400 x 400 mm, max. forming depth 100 mm
- Flexible mould 400 x 400 mm. Weight < 60 kg, but will vary
- Pick-and-place manipulator for flexible mould
- Transversal cutter(s), programmable
- Flexible longitudinal cutter(s) (1 or 2), programmable
- Drive for roll, programmable
- Conveyor belt or manipulator in order to transfer trays to line or to “in-line conveyor”

Approximate size of thermoforming machine: 520 x 2000 x 1100 mm

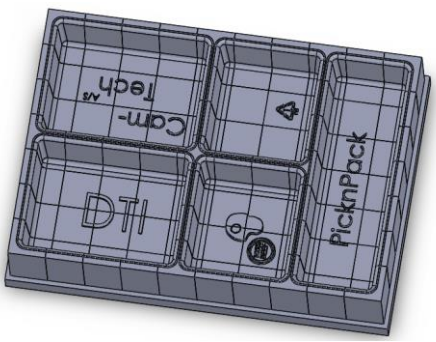

Figure 4: Flexible mould

Discussions:

Should the thermoforming be by means of vacuum or pressure?

How is it possible to create trays for vine fruit (200 x 120 x 100 mm deep) in a good quality?

Where should reordering of flexible mould happen?

Cutting system?

Cutting in both longitudinal and transversal direction?

5 In-line conveyor or simple line manipulator with suction cup

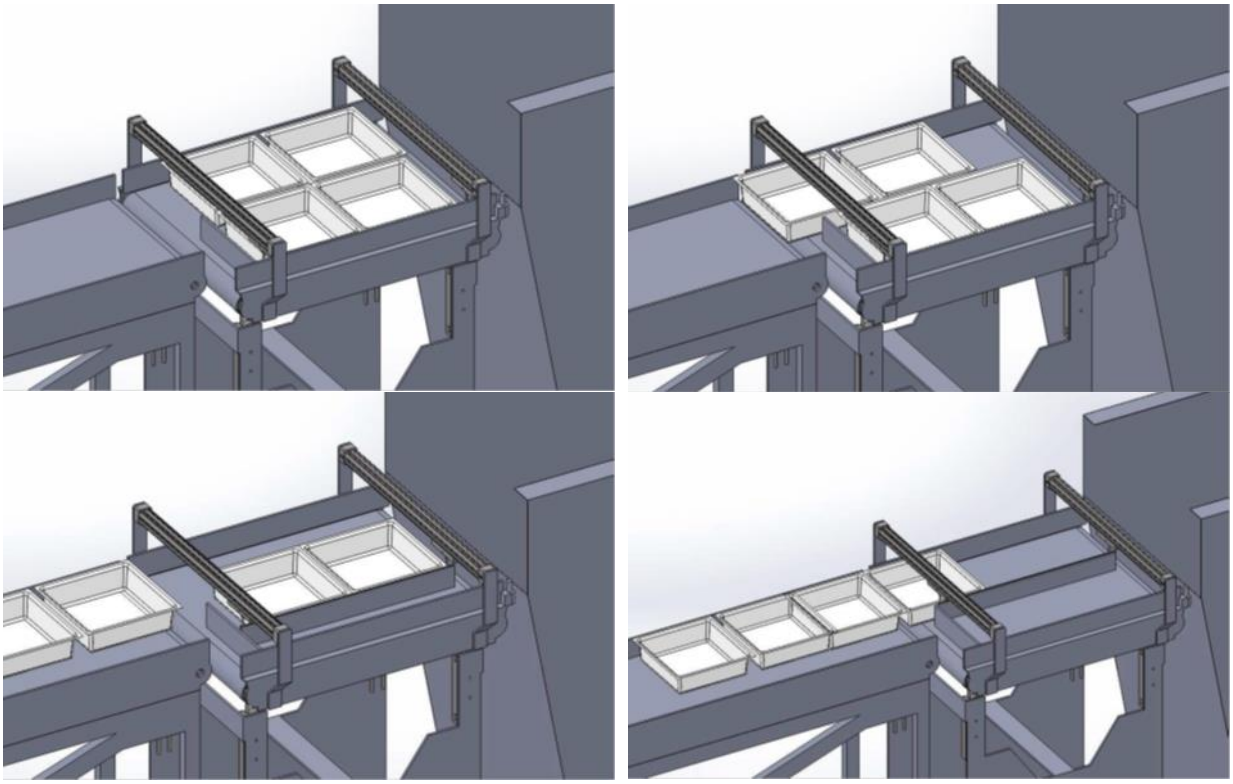

Figure 5: In-line conveyor and its function

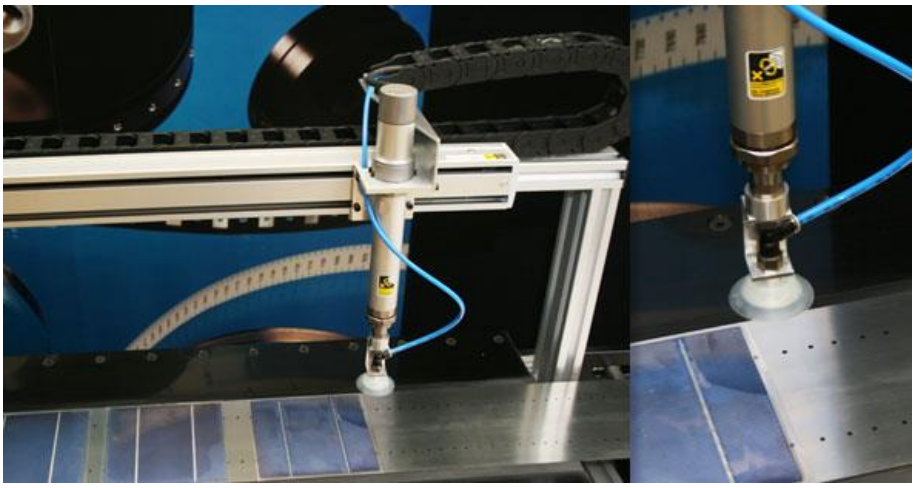

Figure 6: Stainless steel band with holes for vacuum, and linear suction disk pick-and-place mechanism

Here is a video which shows a vacuum system that might be used for the placement of trays: http://www.belttechnologies.com/applications/vacuum-belts/

6 Conveyor

The main task for the conveyor is to provide access to (up to) 30 trays per minute for the remainder of the line.

The conveyor line is defined by other contributors of this project to run at a constant (but variable) speed.

For enhanced flexibility of line, it might be nice to have the conveyor separated into more parts each of a length of for instance 2 m, but this would give issues on controlling the speed and many driving motors. Also coupling of drives will give issues. And also for hygienic reasons it is preferred to have as few legs as possible.

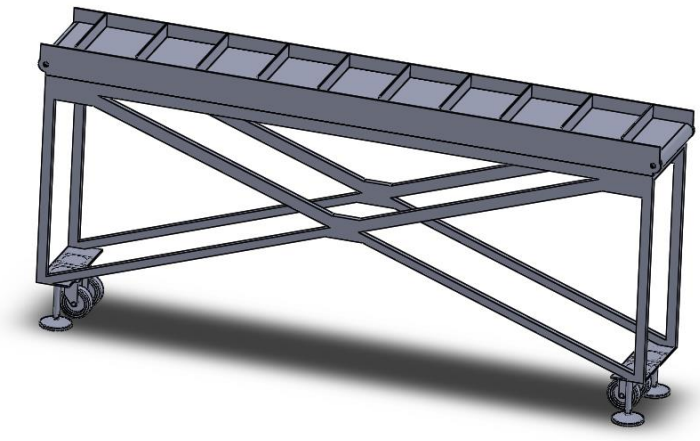

Figure 7: A two meter conveyor with belt with flights

It might be possible, though, to separate the last part of the conveyor belt, the part for application of top-film and laser cutting and sealing. If we did so, this process could happen as a stop-and-go process, 1 sec. stop; 1 sec. go.

Many of the posts have sensors or cameras included that can tell, exactly where the trays are located. But for the top film with printed information it will be necessary for the trays to be correctly aligned, and to be at a well-defined position at a well-defined time.

Discussion:
There are many possibilities for the conveyor, depending on which task should be solved:

1) Conveying of single, empty trays
2) Conveying of one row of trays
3) Conveying of a set of trays (one thermoforming lot)

In our choice of solution the main objectives have been that it should also provide a good solution for:

- Cutting feature necessary in the thermoformer
- Printing: As narrow a top film as possible
- Laser sealing: Here we want as few dividing ribs as possible in order to sustain the possibility to apply a constraint onto the top film prior to the sealing process, because the sealing process is not tolerant to gaps between film and tray.

6.1 Conveying of single, empty trays.

Separating the trays into single trays is the best solution to both printing and laser sealing issues, if the tray is guided in a way, that ensures position and aligning with top film.

The mechanical act of cutting the trays immediately after thermoforming might have to be quite advanced, if flexibility of possibilities of moulding trays should be kept high. A laser cutter mounted on the thermoformer would solve this, but might not be within reach for the demonstrator. So if this solution will be chosen, we should go for a simple cutting feature and accept lower flexibility in moulding of trays, and then demonstrate at a side how the laser will be able to cut any shape and combination of tray if mounted on the thermoformer.

It might be difficult to deal with trays of different height in same batch. So far it has been decided to make constraint to flexibility that within this solution the height of the trays should be the same batch wise.

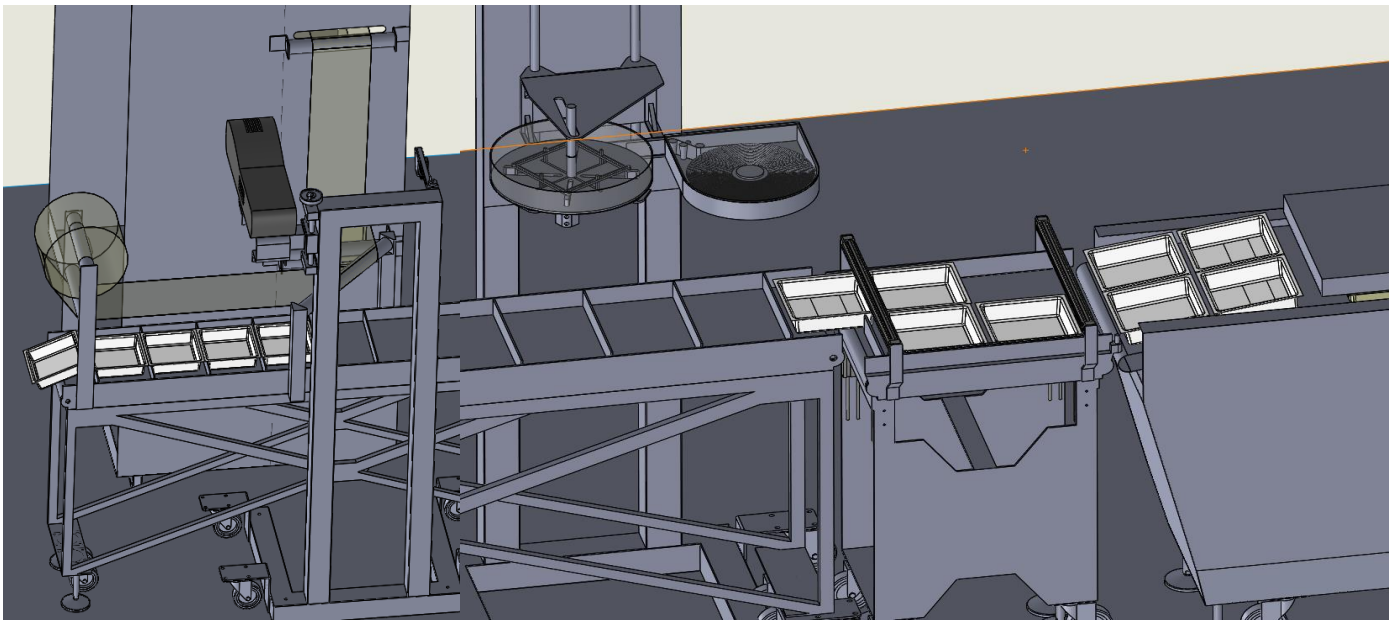

Figure 8 Single, empty trays in thermoformer and under laser cutter

Conveying of single, empty trays is a very difficult task. The trays only have little weight, so they will be subject to roll over, fall of the line, displace, make overlap and so on. A high tray with a small base and made out of thin foil (wacky quality) will present the worst case.

However some possibilities have been found:

- We visited Marel in Aarhus, Denmark, to see their solution. The belt used by Marel was consisting of plastic chain links, with flights incorporated at specified places for separation of trays. Longitudinal guidance was by means of steel bars, adjustable by cylinders. When another size of tray is needed, then the appropriate flights were chosen. It had to be ensured, that the division of flights fitted to the total length of the belt, or some chain links had to be inserted / removed. If we choose this solution we would most likely decide to have a fixed distance, say 210 mm, between the flights, so if the trays are shorter they would still be conveyed at the distance of 210 mm.

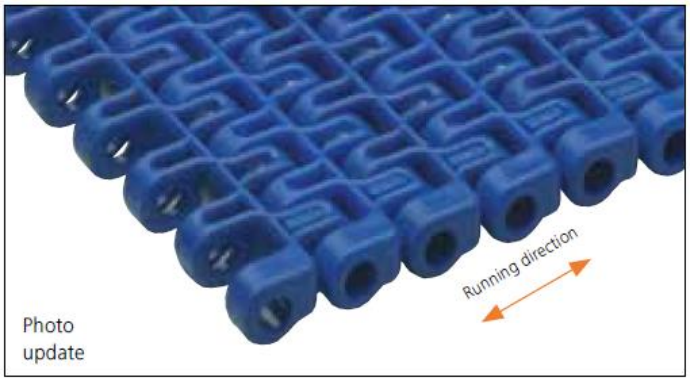

Figure 9: Marel belt with optional flights (not shown)

- At Marel they also showed us another kind of belt, which they were going to investigate: “Sticky” band with silicone lining with good friction effect. The idea is that the trays should be placed in the correct position and aligned when placed on the band, and that the trays then would stick (!) to that position. If they don’t, it will be a mess! Advantage is that there are no flights on the band, so the band length doesn’t have to be adjusted. Marel is going to test this band for its cleanability.
- Stainless steel band from Belt Technologies (see figure 6) with possibility of applying vacuum and / or fixture items. We called the Danish supplier of this American (English?) product, and he said, that he thought the band would be able to do the job described, but emphasized that the largest issue would be the price. Advantages of this band is it accuracy, and the material is for sure cleanable. This represents a hygienic option to keep control of the position of the packs as they pass under the robot and onward to the laser. It will reduce the chance of the pack moving and being out of position for print registration and sealing. This band should be investigated further.

6.2 Conveying of a row of empty trays.

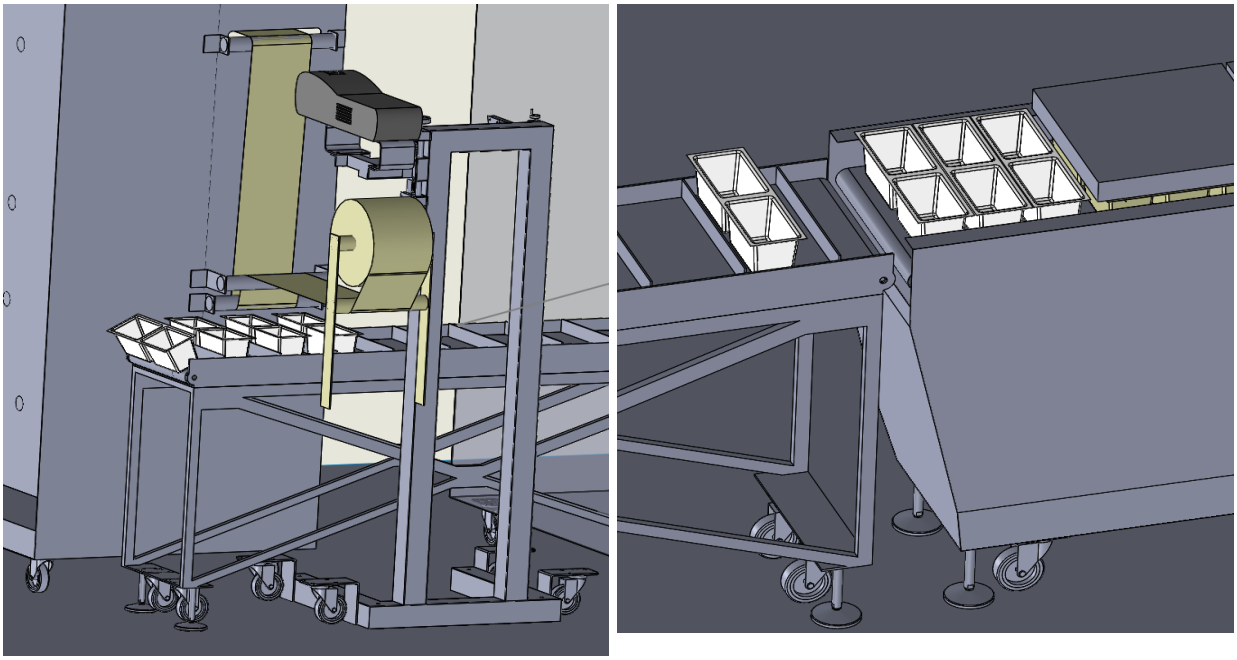

Figure 10: Conveying one row of trays at a time could happen on a belt (as shown) or in clamps.

The cutting act in the thermoformer will only have to be in one direction, but still has to be programmable / adjustable, as it will be subject to change how many trays are in a row or a line from the flexible mould.

Two or three trays in a row will support each other. They might be conveyed the same way as the single trays, but will be a much more stable item to convey. It might also be possible to convey the trays in clamps.

The final separation of the trays will be made by the laser cutter and sealer. When the trays get to the laser sealing and cutting station, they might be directed along the line or perpendicular to the line. If they are directed along the line, a constant speed conveyor can be used. If it is perpendicular to the line (as shown in figure 10), a stop-and-go process should be implemented to this part of the line, because the print cabinet will be too heavy to follow the conveyor band, and it would make the printing process unstable.

6.3 Conveying of a set of empty trays

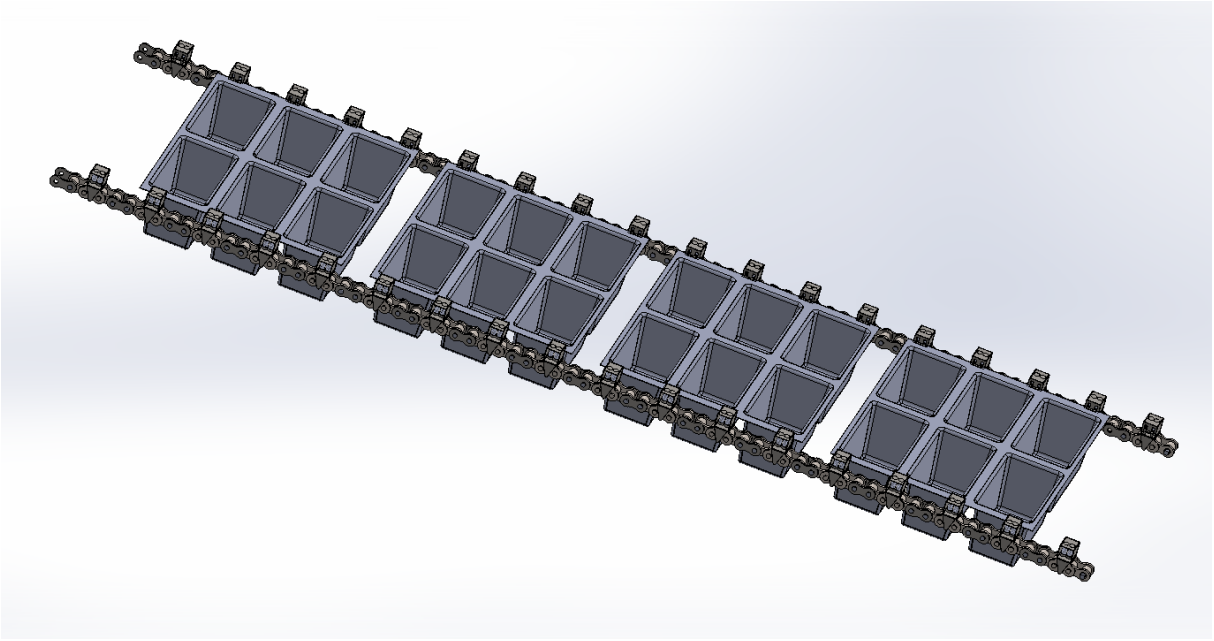

Figure 11: Four sets of trays conveyed in clamps.

This solution makes the cutting of the trays from the thermoformer very simple.

After the cutting, it would be an obvious solution to keep on conveying the set of trays in another set of clamps on the constant speed conveyor. Then the whole conveying line will resemble an ordinary packaging line following a thermoformer, only it would be constant speed.

It will have to be investigated, if the laser sealing and cutting feature will be able to seal and cut a whole set of trays in one process. The width of the top film will be 420 mm. In order to keep cost down on print cabinet we might choose to print on only half of the film.

As the trays are conveyed in clamps they can be of different height. When the trays have been cut (by the laser cutter) we will have to provide for an end-of-line conveyor which can catch the trays in a gentle way.

This solution will also provide the best set-up of trays to the filling robots, as it will present the largest number of trays available within the reach of the robots. Therefore it will provide the most time available to fill any of the trays, and the best option to pick the desired tray if the trays are not alike.

However, all the conveying principles will be able to present 30 trays per minute to the filling system and all three systems will have their advantages and disadvantages to the filling systems (WP7).

7 Dispenser for foil belt for microwave heating of ready meal

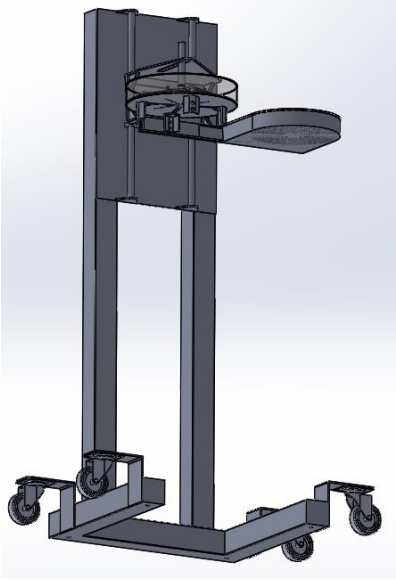

Figure 12: Foil belt dispenser

For the proper microwave heating of a ready meal different means must be applied dependent on the actual meal. For a meal consisting of cooked potatoes, peas, cooked meat, this would propably be:

- A foil belt along the sides
- Reflective pattern on top film (to be made by the ink jet printing process)
- Reflective pattern on bottom of tray

For other meals (e.g. Shepherd's pie) also:

- Susceptor board might have to be added.

And it might also be necessary to incorporate

- Valves in the sealing area.

8 Print cabinet

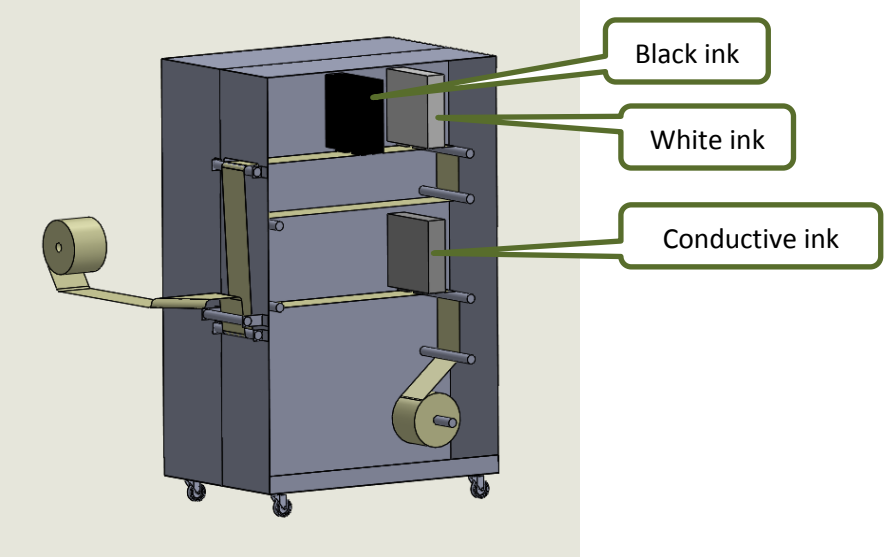

Figure 13: Print cabinet

The print cabinet is thought to have access to the roll of top film from one side and to the ink supply from the other side. Both sides will be covered by cabinet doors.

9 Laser cutter and sealing system

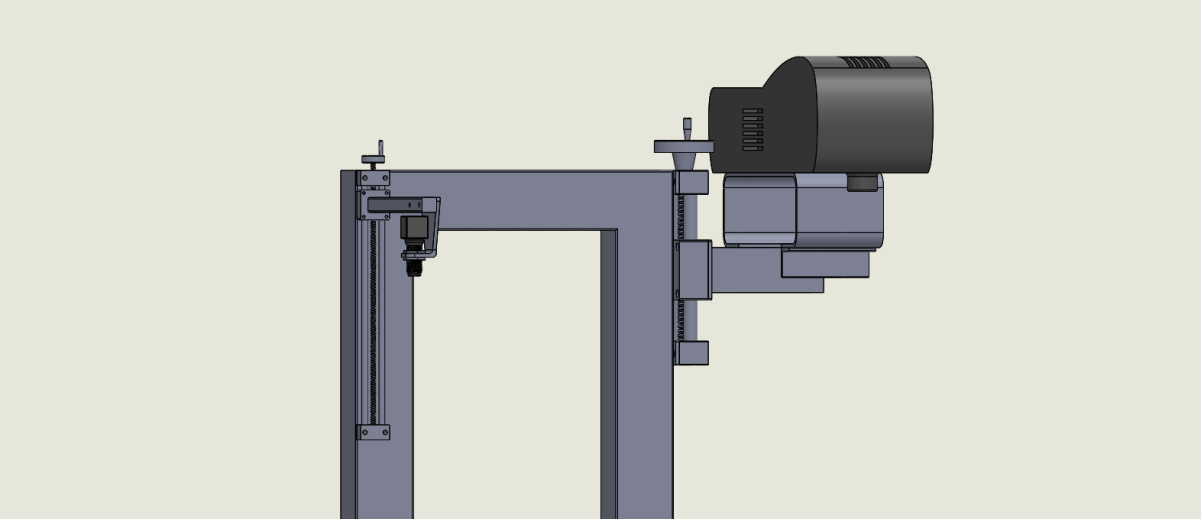

Figure 14: Laser cutter and sealer

The laser cutter and sealing system can work with a stop-and-go process (approximately 1 sec. stop, 1 sec. go) but might also work with constant speed conveyor. The laser is able to handle an area (window) of approximately 400 x 400 mm at a time.

It still has to be proven:

- if the sealing system can seal the slightly uneven surface made by the brick mould, and
- if it is able to seal a whole set of trays

Another option that might be useful, will be

- Valves for secure microwaving of ready meals.

10 Seal integrity check system

Will most likely be an incorporate part of the Laser cutter and sealing system?