D7.1 Design objectives and requirements

Fresh and processed food production line

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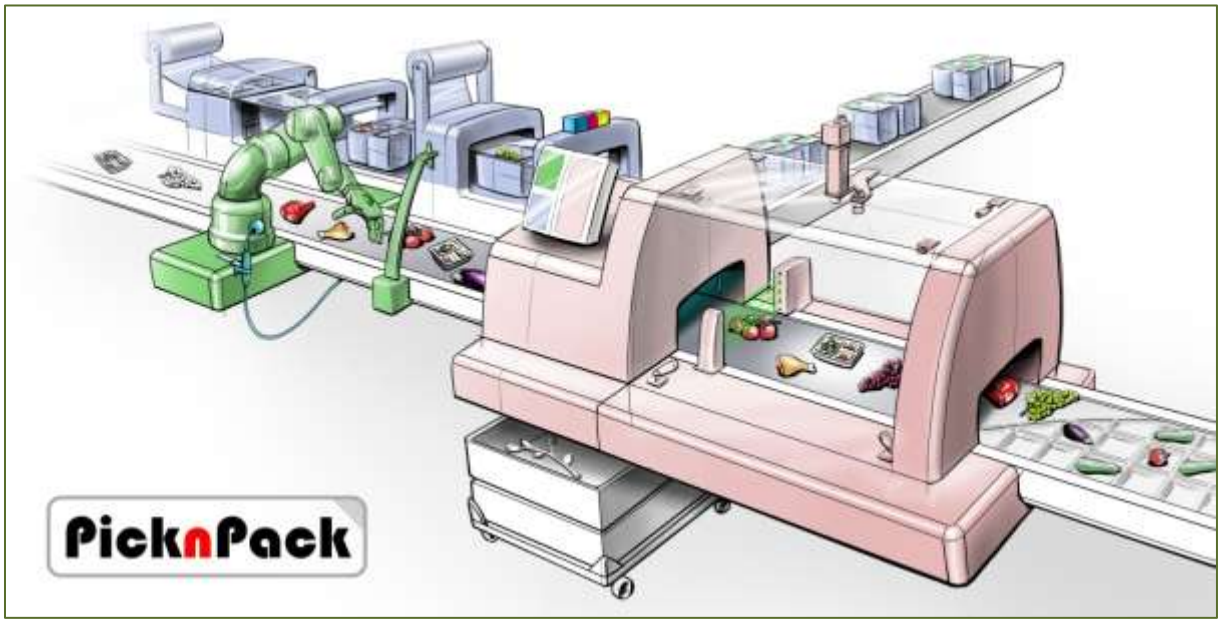

Flexible robotic systems for automated adaptive packaging of fresh and processed food products

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Dissemination level		
PU	Public	X
PR	Restricted to other programme 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)	

1 Introduction

This report describes the design objectives and requirements for the integrated fresh and processed food production line to be built within Work Package 7. Firstly, an overview is given of the functions that are necessary to come to an integrated adaptive processing line for fresh and processed food. These function diagrams have been shared with all the partners to give them the opportunity to add functions or react on our ideas for the functions. The integrated line will be used as a demonstrator at a fresh food packing station, as well as a ready meal production location. Secondly, the requirements set to the functions are explained and given. These requirements are set based on the knowledge gained so far on the system setup. Though it can be that requirements have to change over time, to reach the objectives of the demonstrator system. Finally, sketches of the system layout are given as input for a discussion on the final layout of the demonstrator. The sketches are not finished yet, as more information will be required to properly dimension some parts of the processing line.

The process of defining the design objectives and requirements is an iterative process. By this we mean that setting of requirements is not a fixed procedure that can be done once in the PicknPack project and by that time no things can change anymore. By good argumentation and increasing knowledge during the project, set limits may be moved and requirements can be changed over time. This can and will improve the overall outcome of the project, as long as the rolling list of set requirements and objectives is shared and communicated well with all partners, to ensure proper engagement with the design objectives and requirements.

Until this stage of the projects the requirements for the fresh food production line have been much better defined than for the ready meals production line. Though, we know that one line needs the capability to change over, or adapt, to ready meal or fresh food. This is one of the challenges that will be addressed in the next steps to be made at the end of this deliverable.

2 Function overview

The function overview (Figure 1) shows all the functions of the demonstrator ordered and linked together from input of products to output of products in shelf ready boxes. The function overview is created based on the information obtained from questionnaires and input from WP2 (systems integration), WP3 (track trace), WP4 (sensing systems), WP5 (handling system), WP6 (packaging) and WP8 (hygienic handling). Within deliverable 5.1 “Report on system requirements (handling)” and deliverable 6.1 “Industrial requirements for packaging lines” the specific systems for handling and packaging have been further defined and specified. Furthermore we have taken into account the information we gathered during the kick-off meeting November 2012. During the kick-off meeting we had an interactive workshop where each participant was allowed to sketch his or her own pick and pack demonstrator line. These sketches showed many analogues which can be mainly described as linear systems that have inputs of buffered products and outputs of buffered products. In between

these two inputs and outputs the fresh food and ready meals were singulated, sensed, handled and packaged.

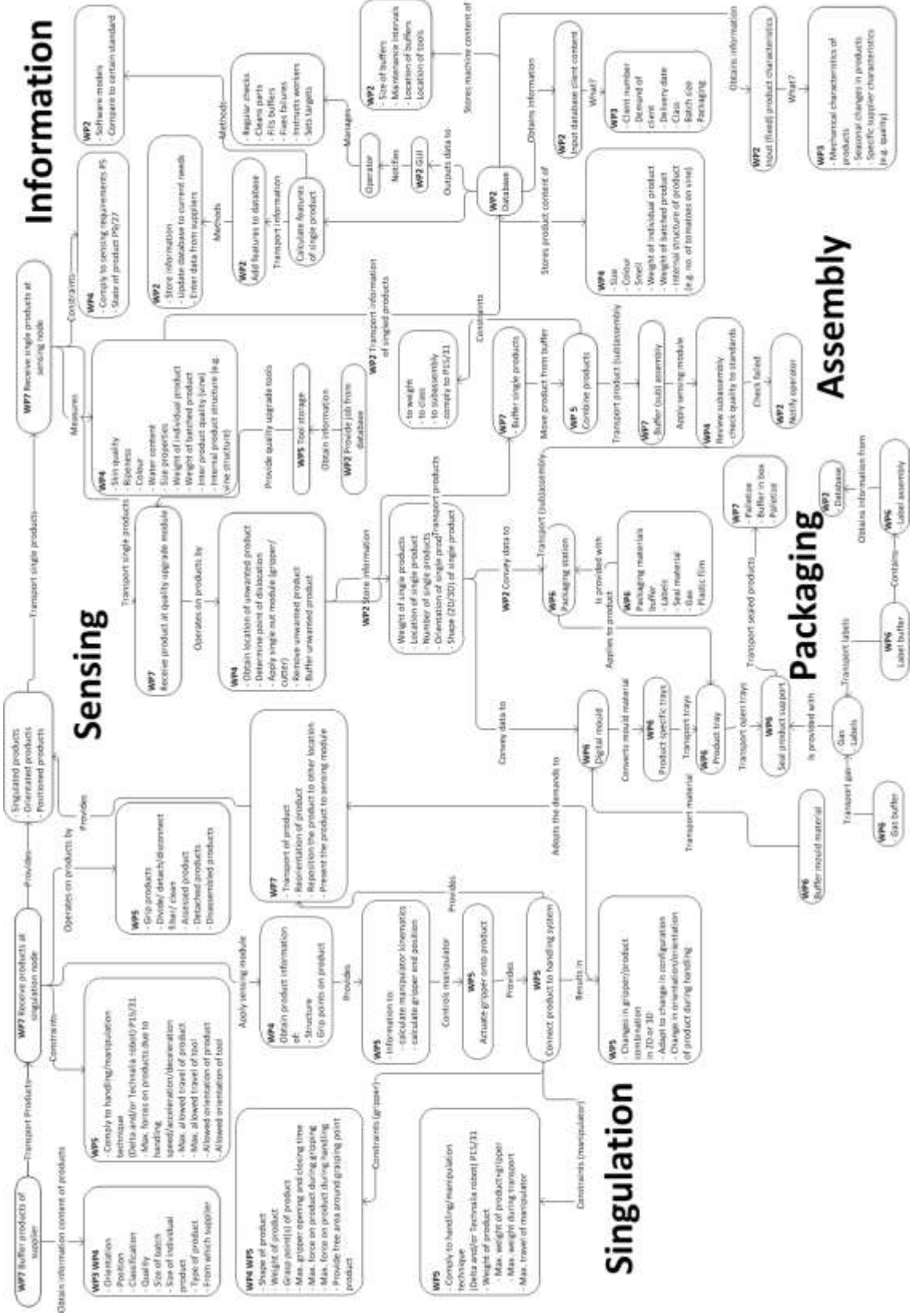

Figure 1 Function overview of the functions for the demonstrator for the integrated processing line

An overview list of the main functions is given in Table 1. Main points of importance are that in between most steps or functions there is always a step of "transportation" of the product. This step of transportation can also be used to change the orientation of the product if this is so required, though it is not yet defined if a change in orientation is required between steps. We have defined the functions of the sensing modules as an "upgrade of quality information" function. This is a more general description and also justifies better the inclusion of the information in the information database. The work packages involved and responsible for the functions have also been identified.

Table 1 Main functions and corresponding work package

Requirement	Work package
Buffer products of supplier	WP7, Marel
Transport product	WP7, Marel
Receive products at singulation node	WP7, to determine
Apply sensing module	WP4
Connect product to handling system	WP5
Transport product	WP7
Transport singulated products	WP7
Upgrade quality information of product	WP4
Transport information of singled product to database	WP2
Convey data to packaging module	WP2
Prepare mould	WP6
Combine singulated products into assembly	WP7
Transport assembly into package	WP5
Put packages in shelf ready box	WP5

3 Requirements for the integrated processing line

Table 2 Requirements for the PicknPack demonstrator

Nr	Stakeholder	Requirement	Fixed	Variable	Desirable
1	All, WP7	Demonstrator has to be transportable	x		
2	All, WP7	Demonstrator has to fit inside N 20 ft. container		x	
3	All, WP7	Demonstrator has to fit inside N 40 ft. container		x	
4	All, WP7	Demonstrator has to be powered on site by 380 V	x		
5	WP 8	Demonstrator must be food safe	x		
6	WP 8	Ingoing binned products are clean		x	
7	WP 7	Ingoing products are stored in a bin of a standard size and shape		x	
8	WP 7	Products not in standard bin will be transferred to a standard bin	x		
9	WP 3	Ingoing food items can be traced to origin	x		
10	WP 3	Outgoing food items contain tracing information	x		
11	WP 2, 3	Track trace information is stored in the demonstrator		x	
12	WP 2,3	Track trace information is manually fed into the system		x	
13	WP 2,3	Track trace information is automatically fed into the system		x	
14	WP 5	N singulation module(s) handles > 30 picks/min	x		

15	WP 5	N singulation module(s) output products in known position		x	
16	WP 5	N singulation module(s) output products in known orientation		x	
17	WP 7	Transport in between modules must handle > 30 products/min	x		
18	WP 4	N sensing unit(s) brix handle > 30 products/min	x		
19	WP 4	N sensing unit(s) sugar content handle > 30 products/min	x		
20	WP 4	N sensing unit(s) colour handle > 30 products/min	x		
21	WP 5	Maximum gripper weight < 1.5 kg		x	
22	WP 5	Maximum travel product in X < robot reach X			
23	WP 5	Maximum travel product in Y < robot reach Y			
24	WP 5	Maximum travel product in Z < robot reach Z			
25	WP 2	Demonstrator parts report results to database		x	
26	WP 2	Demonstrator parts report results -> database using X bus system		x	
27	WP 2	Demonstrator part report results to other parts using X bus system		x	
28	WP 4	First Sensing module measures size of > 30 products/min	x		
29	WP 4	First Sensing module measures shape of > 30 products/min	x		
30	WP 4	First Sensing module measures colour of > 30 products/min	x		
31	WP 4	First Sensing module measures chemical inform. of > 30 products/min	x		
32	WP 4	First Sensing module measures water content of > 30 products/min	x		
33	WP 4	First Sensing module measures internal structure of > 30 products/min	x		
34	WP 4	Ready meal sensing unit measures size of > 30 products/min	x		
35	WP 4	Ready meal sensing unit measures shape of > 30 products/min	x		
36	WP 4	Ready meal sensing unit measures colour of > 30 products/min	x		
37	WP 4	Ready meal sensing unit measures chemical inform. of > 30 products/min	x		
38	WP 4	Ready meal sensing unit measures water content of > 30 products/min	x		
39	WP 4	Ready meal sensing unit measures internal structure of > 30 products/min	x		
40	WP 5	Transport units handles grapes/tomatoes/mangoes		x	
41	WP 5	Bin picking unit handles grapes/tomatoes/mangoes		x	
42	WP 4	Sensing units obtains information of grapes/tomatoes/mangoes		x	
43	WP 5, 7	Palletizing is done manually		x	
44	WP 7	Demonstrator stands on a flat floor		x	
45	WP 7	Demonstrator stands on a concrete floor			x
46	WP 7	Demonstrator is onsite setup in 1 day			x
47	All, WP 7	Demonstrator is managed onsite by a PicknPack member		x	
48	All, WP 7	Demonstrator is 1 week at a site		x	
49	All, WP 7	Demonstrator is operated by a local technician			x
50	WP 5, 7	Manipulator workspace cannot be accessed by humans	x		
51	All, WP 7	Each demonstrator part has a informative sign		x	
52	All, WP 7	Each demonstrator part can operate on its own			x
53	WP 7	Product flows inside the demonstrator are not accessible by humans		x	
54	WP 7	Product flows inside the demonstrator are shielded from environment		x	

Within Work Package 7, integration, we have to put special attention to a smooth product flow from module to module. Therefore conveyor tracking is proposed. This means that the conveyor belt is moving at constant speed during anytime. In the meantime the Quality assessment module and handling and packaging module can operate on the products on the line.

4 Sketches of the system layout

Based on input of the partners we have sketched the preliminary system layout, as shown in Figure 2.

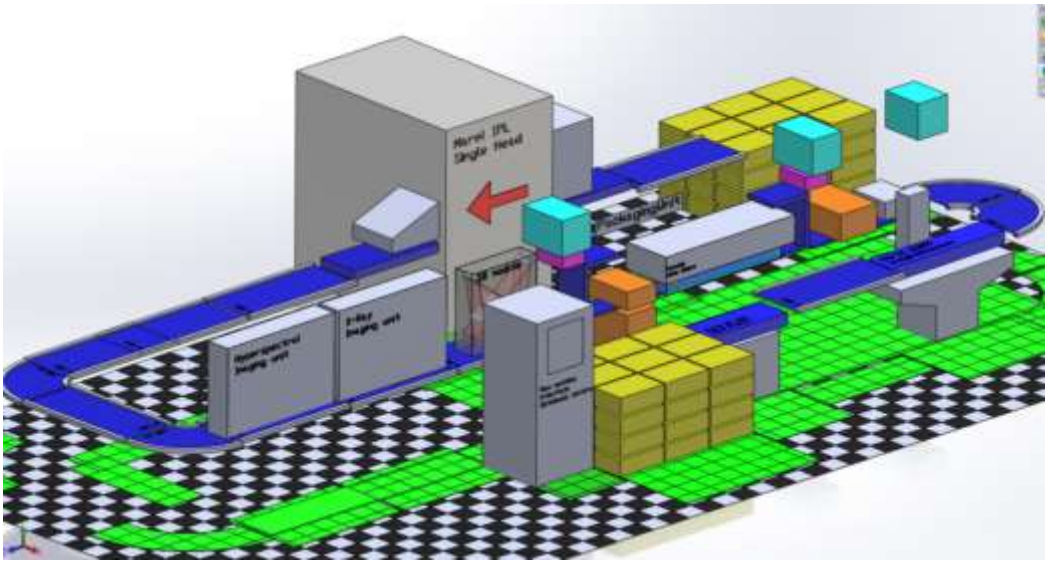

Figure 2 Overview sketch of integrated processing line, checkerboard represents 0.25 x 0.25 m

At the start of the production line products are singulated from harvest bin or from crates with premade ingredients for ready meals. The singulation can be done by robot cell, so called crate picking, or by manual labour, depending on the achievements in the project. Then the quality assessment module is shown, until now as a large box covering the conveyor belt as we do not know yet the dimensions of the sensing units from WP4, sensing. After sensing the conveyor belt is entering the robotic workcell such that the products can be placed into the package. The package station will have to be integrated or at least be very close to the robotic workcell, as the products have to be picked from the conveyor and placed into the package that is in the packaging line. This is an important step where physical links have to be made between WP5 and WP6. Finally the packaged products have to be put into shelf ready boxes and to be palletized.

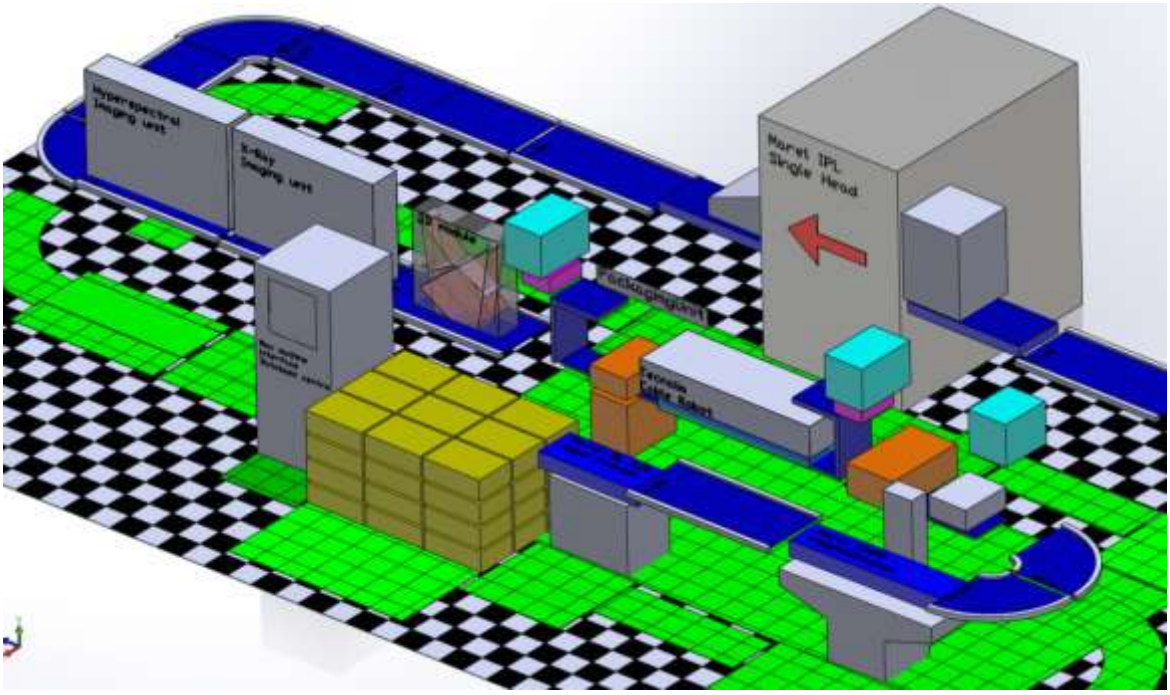

Figure 3: second view of integrated processing line, green surfaces are floor spaces for human operators.

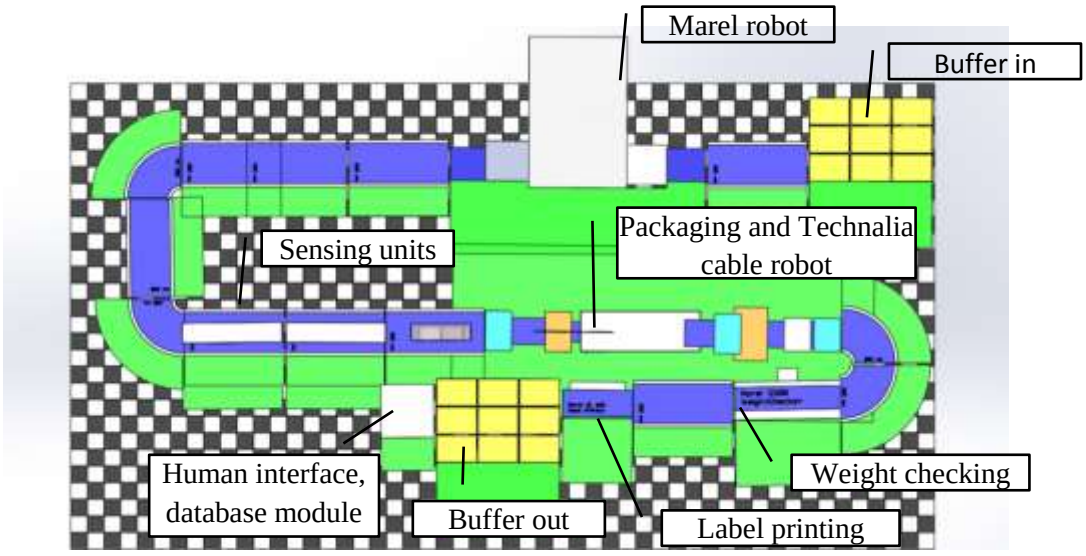

Figure 4: top view of the integrated processing line setup. Dimensions are 26x14 metres.

5 Next steps for integration of the demonstrator

Further information on the specification and composition of ready meals is required. Questions to be answered are a.o. what are the basic inputs for the ready meals? Are these pre-made pizza bottoms that only need to be topped up with salami? Or do we need to put additional ingredients on top?

A still open question is whether we want to reach exact weights when filling packages with fresh food. If this is required there is a lot of 'old fashioned' mechanization needed to buffer, transport and assemble tomatoes to the right weight. We prefer to leave this function out of the demonstrator, in our opinion it is not something new it already exists in practice. We propose that after the truss is graded, sensed and put into a moulded packaging we print the amount of grams on the package.

Modules have to be physically connected but also the information exchange has to be realised. Through what interface will the modules share their data? Proposal is to have an Ethernet connection to share data to the information layer framework built by WP2.

For the integration of the information layers in the demonstrators we foresee that each module has its own middleware communication system. Though on top of this middleware communication system a layer that connects the systems is required as information has to be shared between processes. It is possible to use the Robotic Operating System (ROS) as layer on top of the middleware systems to be used for sensing, handling and packaging. Though the implementation of the information and communication structure has to be precisely defined together with WP2 which is coordinating the flexible systems integration.

Although the setup looks final we have to stress that the design is an on-going process. The figures above only indicate what the setup might look like, the length of conveyor belts for example has to be determined yet. The 3D design able us to play around with the setup and in the coming month we need the advice from other WP's to keep updating the layout.

6 Annex 1 - Function Overview

The following figures show the top level functions of the complete demonstrator. Is has been cut up into three pieces although it is one diagram. The first shows the functions that are related to the singulation step. After that the function diagrams of sensing, packaging, assembly and information are showed. Most of the functions have a WP label which shows the work package that is responsible for this function.

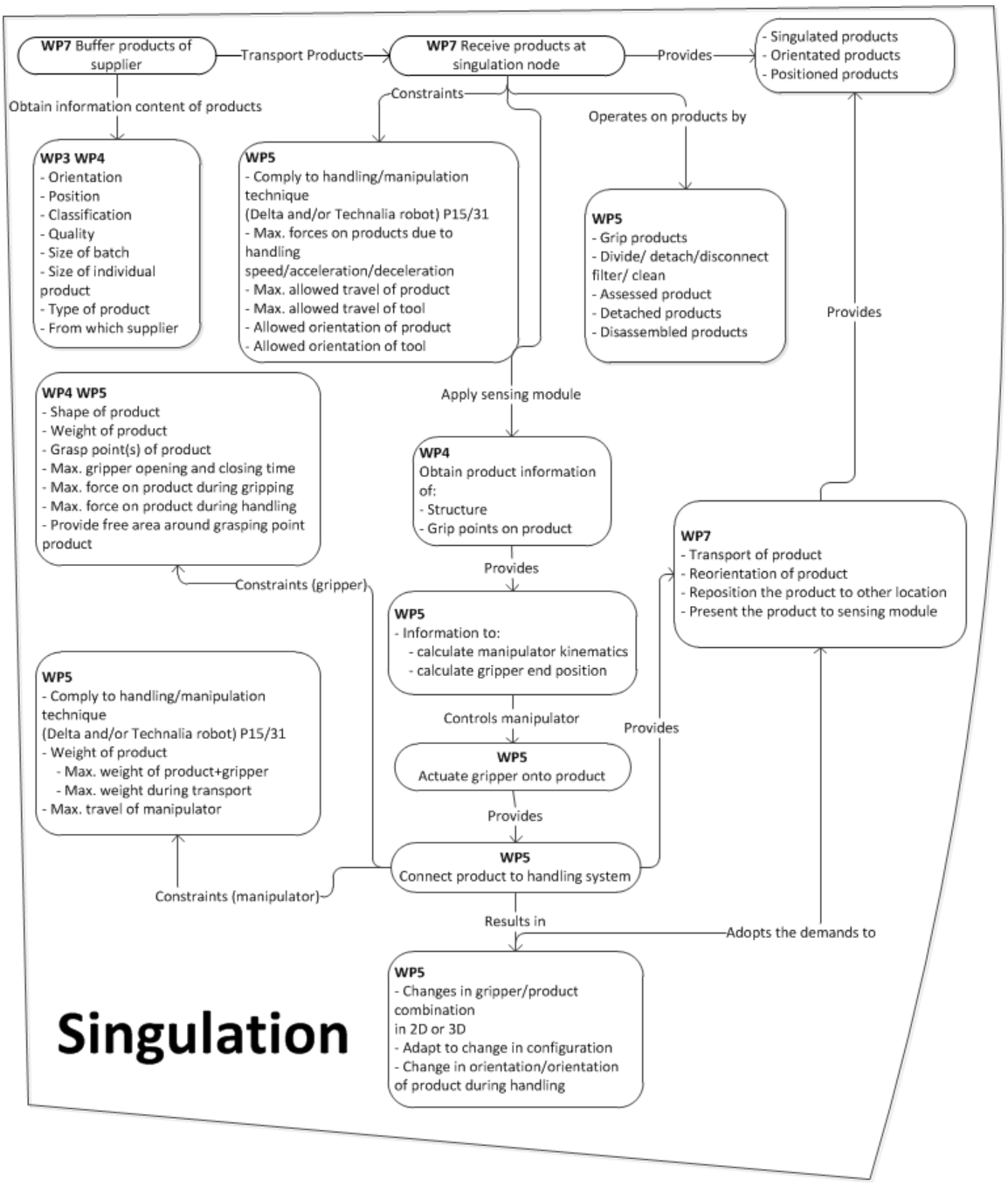

Figure 5: function diagram related to singulation.

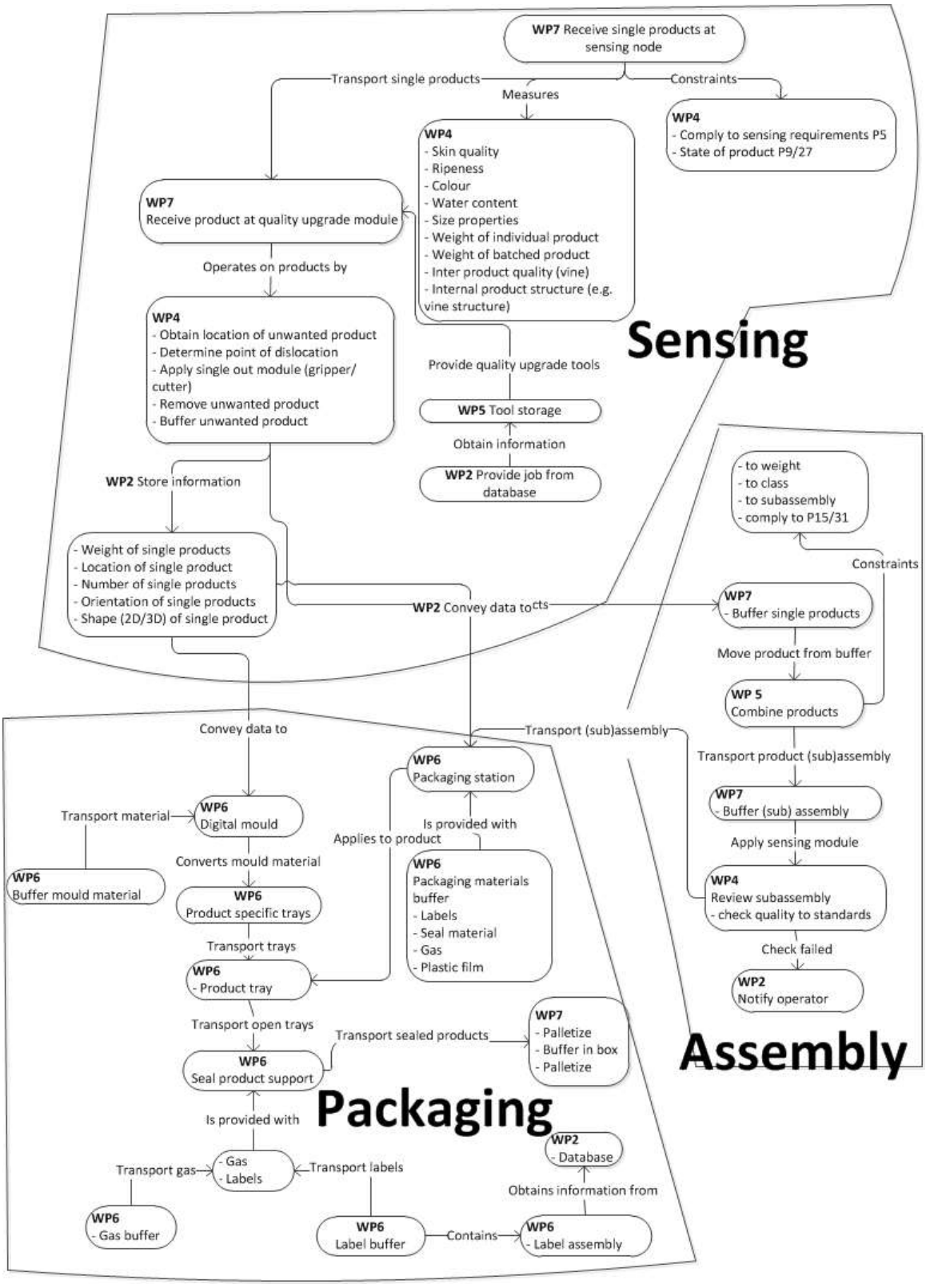

Figure 6: function diagram related to packaging, sensing and assembly.

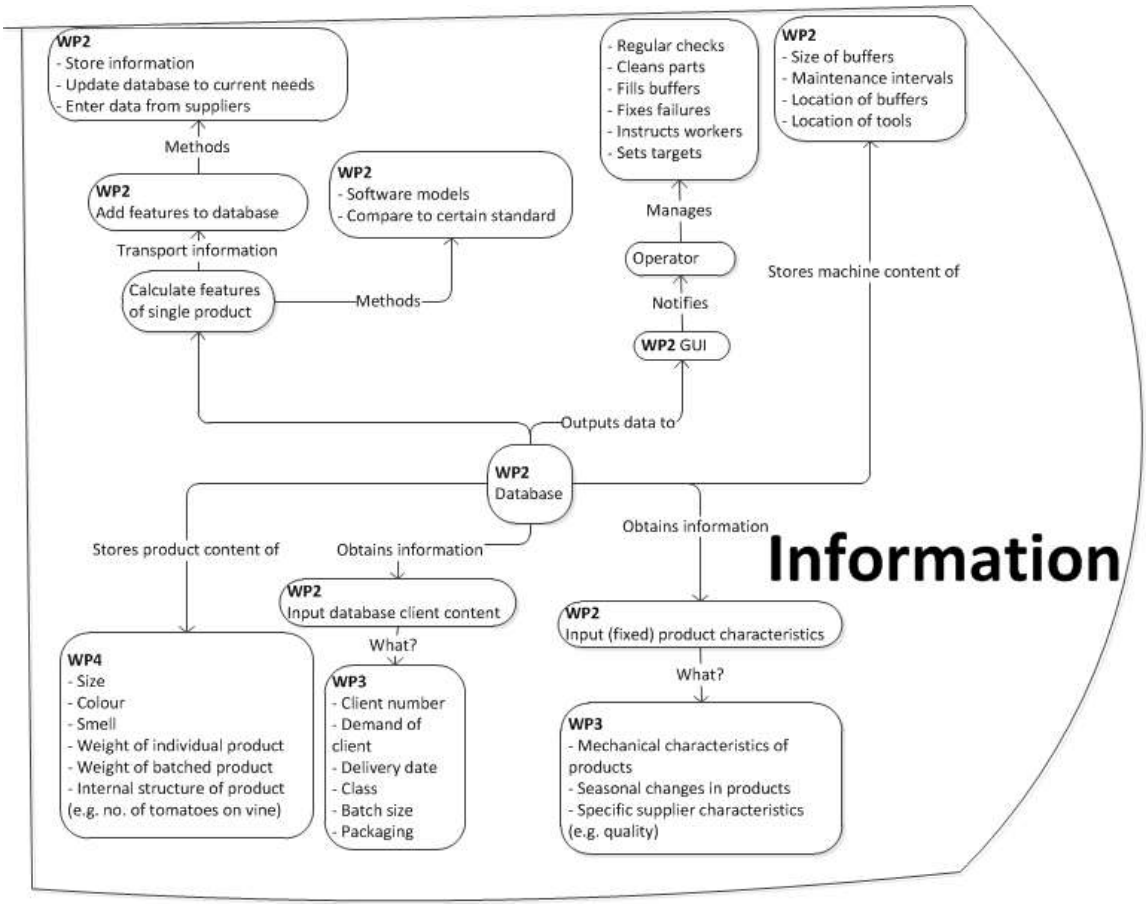

Figure 7: function diagram related to information.