# Project slotting optimalization program based on python as main software platform.

## The organisation

Herbalife is a world leader in meal replacements, nutritional supplements and skin care products. In the distribution center Venray, the EMEA market is supplied with these products. For 13 surrounding countries, customer orders are handled on a daily basis by means of a pick line where the products are picked and packed.

## The question

The pickline serves 13 different countries. The products for these countries all have a location unique location on this pick line based on a number of characteristics that determine their location. This assignment of locations is done manually. A workable but inefficient method that we think could be easier and better with the help of software.

## Current situation

At the moment slotting is mostly done by hand. With help of some data analytics the historical data is consolidated and used for re-profiling. This takes a lot of time and gives most likely a suboptimal solution.

## To be achieved

Proper stock placement, or slotting, has a major impact on the output and productivity of the picking line. This project should lead to an optimization of the slotting. The aim of a new slotting program is to find a new, more optimal stock allocation based on the current slotting and the pick data of the previous period, taking into account all preconditions. Calculation time should be within an acceptable time frame (max 30 minutes) such that slotting can become more dynamic and we can take small steps every day. In an optimal situation a product can be moved from one location to a new better location within 24 hours. Therefor only a limited number of products can be moved per day the program should take this into account.

## It is more important to be able to move from an existing situation to a new improved situation with a limited number of changes. This can be repeated when finished.

## Preconditions include:

* Available capacity per zone.
* Slotting constrains of the product.
* Turnover rate of a product.
* No two identical products next to each other (think of country-flavor variants).
* Capacity per zone/area evenly distributed throughout the day.
* Only a limited number of products can be moved within a working day. Orders enter the system every 15 minutes per hour with an assigned location when entering which can not be altered once assigned.

## Parameters to consider

A number of possible parameters which can be considered are:

* Low versus high number of stops to complete the box.
* Assigned location within the zone with respect to demand
* A solution not limited to a single optimalisation technique
* Static slotting versus dynamic slotting

## Other possibilities

Nice to have is:

* Based on current slotting profile find the possible problems when a product( or more) are out of stock or in higher demand then expected.
* Slot new products based on a forecast.
* A instruction list for the moves from the old to the new location

# The picking proces

## The picking process: starting part.

Orders for the distributors are broken down into one or more boxes (cubing), depending on the size of the order. There are 4 standalone box sizes, Large, Medium, Small and eXtra Small. Furthermore there is a special multi order tote which holds 4 MXS totes and once.

An order is placed by a distributor located in one of the 13 countries served by the pickline. All orders placed before the cut-off time (13:00) have to be prepared the same day (not later then the ship time) for that particular country. For example Orders for France should be ready at 17:00, orders for Switzerland should be ready 14:30.

The pickline starts boxes based on the ship time and the current load (see figure) of the zone to ensure that all orders are completed in time. A proper balancing of the countries over the zones helps to establishes this.

A screenshot of a computer

Description automatically generatedA graph of a graph

Description automatically generated with medium confidence

Figure 1: Occupation of the pickline zones and a snip of the shiptimes

A barcode on a box

Description automatically generatedAs mentioned orders are divided in one or more boxes. When a box is ready to be picked a correct size box is selected from the box buffer. A side label with a barcode (LPN) is printed and attached to the box. This LPN identifies the box/order thought the pickproces and is read on several places on the pickline to guide the box to the proper zones.

Figure 2: LPN

After the LPN an invoice is printed and added to the box. The weight of the box is captured at the tarra scale. Pick quality is controlled by checking the weight of the box measured several times in the pick process.

The box is now ready for picking in the picking zones of the pickline.

## Layout

The total pickline is divided into an A1, A2, B and C area. In A1, A2 and B each zone has a mirror zone which has the exact layout of the main zone. This is to double the capacity with respect to available stock and picking capacity. Meaning master zone X consists of 2 zones. Zone a and mirror zone b.

|  |  |  |  |
| --- | --- | --- | --- |
| Area | Master zone | Zone | Mirror zone |
| A1 | A01 | 1 | 2 |
|  | A02 | 3 | 4 |
|  | A03 | 5 | 6 |
| A2 | A04 | 7 | 8 |
|  | A05 | 9 | 10 |
| B | B1 | 11 | 12 |
|  | B2 | 13 | 14 |
|  | B3 | 15 | (no mirror) |
| C | 21 | 21 | (no mirror) |
|  | 22 | 22 | (no mirror) |
|  | 31 | 31 | (no mirror) |
|  | 32 | 32 | (no mirror) |

Tabel 1: layout zones

All zones A1,A2 and B have the same layout.

1. A left and a right side
2. Each with 2 odd numbered levels C and D located at the front of the picker and 4 even numbered levels A,B C and D at the back of the picker
3. Each level has 7 lanes per level in the right part (01..14) and 7 lanes per level in the left part(21..34)

01A02 is a lane in the right back part of zone 1 on A level, 01C01 is also at the right part at the front of the picker. 10D34 is the lane at level D at the left back side of the picker.

A warehouse with many boxes

Description automatically generated with medium confidenceA warehouse with many shelves

Description automatically generated with medium confidenceA metal grid on a shelf

Description automatically generated

Figure 3: left: front and rear view picking zones and right: high value picking zone

The zones 21, 22, 31 and 32 have only levels C and D odd numbered and are in front of the pickers. In this C Area there are also Walk Back Shelves with a special numbering (21A105 for example) which will be explained in the appendix

## The actual picking flow

The box is prepared at the mezzanine for picking (elevated working flour in the warehouse) It has a LPN an invoice an the starting weight is know. A box will enter the actual picking area as described in the layout and enters only the zones holding the products it needs.

For example a distributors has the following order:

|  |  |  |
| --- | --- | --- |
| Product | Amount | Located |
| U | 3 | A01 |
| V | 1 | A03 |
| W | 2 | A03 |
| X | 2 | C zone 31 |

In the above example the box first will enter zone 1 or 2 and waits to be picked. After picking it re-enters the mainline and moves to zone 5 or 6 were it waits to be picked. Again after picking it re-enters the main line. The weight is captured at the scale in the mainline and the box moves to the elevator located after zone 15. The elevator takes the box to the mezzanine, the location of the C area, and there the box enters zone 31. After the last pick the box is again weighed and, if all weights are as expected, a picture is taken of the box. The box then enters the packing area where a packer will add airfill to the box and closes the box. A shipping label is added on top of the box. From there the box will move to a dispatch lane for French boxes as it is a box for a distributor in France.

This is of course a short description of the picking process. For a more detailed understanding a tour will be organized.

## Picking in a zone

The picking system is a pick to light system. A box enters only the zones in which products are located for that

A scale with lights on it

Description automatically generated with medium confidenceA green and black rectangular object with red lights

Description automatically generatedA machine with a display on it

Description automatically generated with medium confidenceBoxes with green and white objects

Description automatically generated

Figure 4: left to right zone controller, box can be picked, arrow indicating picks rear side, 1 item should be picked, products has two lanes, green light at one controller indicates box is picked.

Order. It enters the box buffer with five places for the next boxes to be picked and an actual picking position. When the box enters the actual picking position the LPN is scanned automatic and location displays of the products needed will light up and display the number of products to be taken from that position.

When it is a 2D scannable product the picker scans the QR code at the top of the products and places it in the box, only the required number of products can be scanned  
For all non 2D products the picker takes the required number of products and places them directly in the box and hits the button on the display to signal that the product is placed in the box.

When all products for the box in the zone are picked the picker hits the completion button and the box is released to the main line.

## Profiling

As one can imagine placing products somewhere in a lane in a zone on a certain level with a certain capacity impacts the picking process. If a high demand product is placed in lower left location. A picker walks many times to that location.

When placing only French products in a certain zone will create a high capacity constrain on that particular zone on particular times of the day.  
As the pickline serves many countries. The same product is available in country specific versions. For a picker they look all the same. Placing them side by side can result in non detectable picking errors.

An optimal profiling takes these and many other variables into account. Finding an optimal solution is not possible by hand.

The figure below shows the current balance on the pickline. Green is the current balance, red is balance when a new product is launched coming weeks. We use this sheet to help use with the manual reprofiling.

A screenshot of a computer screen

Description automatically generated

Figure 5: part of the balance sheet used in reprofile

Defining the (theoretical) optimal solution will be done in a mutual effort.

# Appendix

# Possible Tool Setup

The tool could be build up with below data structure (to be discussed) and functionallity:

## Zones table/Locations master data

All relevant location data needed for re-profile calculation/simulation such as:

* Location address eg 01A01
* Slot Height (cm)
* Slot Width (cm)
* Slot Length (cm)
* Max Weight (kg - 999 when not applicable) (box/lane)

## Sku master data

All relevant sku data needed for re-profile calculation/simulation such as:  
During the development dummy data will be provided

* Sku number (sell and stocking)
* Description
* Product weight and dimensions
* Box weight and dimensions
* Box Quantity
* 2D
* Stackable / knife opening / container quantity

## PICK data

Used to gather the following data per sku per period (day/month)  
During the development dummy data will be provided

* Average, standard deviation, median
* Countries (e.g. DE;FR;NL - ALL for all countries)
* Correlation data

## Xreff

Oracle allocation table with per warehouse (country) sku combination the assigned active location

PWH|SellSKU|SubInv|StockSKU|Description|XQty|Locator|Barcode|UOM|Enabled|Start Date|End Date

28|0003|EHLV20|1014BE|TANG KUEI|1|DISC||EA|Y|07-09-2006|

28|0006|EHLV20|0006BE|HERBAL ALOE DRINK - CONCENTRATED DRINK SYRUP OF THE ALOE VERA PLANT|1|07C10|N|EA|Y|12-06-2012|

28|001A|EHLV20|001A|HERBALIFE SKIN TROLLEY BAG - EU|1|DISC|N|EA|Y|25-03-2015|

28|0020|EHLV20|2032NL|XTRA CAL|1|21C05|N|EA|Y|15-04-2023|

## Re-profile table

All relevant re-profile data according to re-profile/simulation actions done such as:

* Run Date
* Approved (Yes = Final / No = Simulation)
* Approval Date
* Remarks
* Number of skus re-located
* Number of skus skipped (Static locations)

## Outline program

Starting point should be the cross ref file with the current allocations of sku’s to locations this file is always leading.

Masterdata such as locations/zones and sku is stored in a file structure to maintain maximum flexibility.

Settings which are likely to be altered in the future should be stored in a configuration file to maintain flexibility in the future.

The pickdata should be updated and stored to avoid recalculation at each run

Results of the program have to be stored in files.

Development of the program should be modular, hence use more files instead of one large program file.

Development should be in an agile way of working

Use github for development and source control

Python is the preferred language. Using other programming languages only for specific task when it suits the project best.  
Calculation Parameters

Several options which should be available in this tool:

* Must have: Upload new sales data and convert it to meaningful statistics
* Must have: Run a full reprofile for the complete pickline
* Must have: Run partial reprofiles for part of the line, for example only area A1
* Nice to have: Create move list to guide the reprofile (layout to be discussed)
* Must have: Create partial reprofiles with max N sku’s reallocated (N is a parameter)
* Must have: Add new items to the pickline in the current profile
* Nice to have: Remove items from the pickline in the current profile (it shows in the Xreff data once depleted)
* Nice to have: It should be possible to assign a fixed location to one of more sku’s
* Nice to have: Options per item (or select all) when Items are not in uploaded sales data but in tool:
  + - Remove from pickline and tool
    - Set to zero sales but keep on pickline and in tool
    - Warning (ok/cancel) when items not in tool but in uploaded sales data:
    - When OK then items will be added in tool with corresponding sales behaviour