

A new challenge every day.™

Case Study - Assignment



Quick & Right – an engineering challenge!

The engineering project management team is asked to create a design basis for building a new manufacturing facility in Thailand to support the expansion of Fabric Enhancers in developing countries of South-East Asia.

The facility will be located within a newly acquired plant and therefore full production needs to be added to meet the regional demand provided by the commercial team.

Due to stretch timings in FMCG industry, the design basis needs to be presented to the board of directors by the end of the day.



Outcomes

The final Design Basis presentation will include:

- Brief Presentation of the team
- Technical scope overview including Process Flow Diagram
- The process & packing capacity overview
- Feasibility grade capital cost estimate and project schedule
- Feasibility grade operating cost estimate

Criteria:

- Sufficiency of the production plant to meet the commercial demands
- Optimized capital cost
- Optimized operating cost

Engineering challenge:

Fabric Enhancer Production

- Develop the Technical Scope
- minimize the capital and operating cost
- Minimize complexity

**Daily.
Globally.
Personally.
Professionally.**



Detailed Information

The commercial innovation team in Geneva has aligned a plan to enter the new markets with the Tier-1 Premium line-up to communicate P&G position as the best-in-class fabric care company along with the Tier-2 portfolio to enable household penetration of lower income consumers. The launch will be supported by giving free samples of sachets with the purchase of other P&G fabric care products (laundry detergents). The Sachets will also cover the lowest income markets, where consumers shop on the day-to-day basis.

Volume is typically communicated in number of SUs (=Statistical Units) to enable benchmarking across all P&G divisions. The conversion rate between SU and volume is as following

- Premium: 10 litres / SU,
- Tier-2: 20 litres / SU.

The planning team in Warsaw has provided your team with demand predictions.

Demand Predictions for SEA launch					
Country	Average yearly volume (in thousand SU)				
	2018	2019	2020	2021	2022
Premium Bottle Line-up					
Thailand	400	500	600	1000	1600
Singapore	1200	1500	1600	2200	2700
Myanmar	50	50	100	300	350
Laos	100	100	200	400	500
Cambodia	200	250	350	550	700
Vietnam	300	400	600	1100	1400
Malaysia	300	400	500	1100	1400
Premium Sachet Line-up					
Thailand	100	75	50	25	25
Singapore	550	0	0	0	0
Myanmar	50	50	50	50	50
Laos	50	50	50	50	50
Cambodia	50	50	50	50	50
Vietnam	100	75	50	50	50
Malaysia	100	50	50	25	25
Tier-2 Line-up					
Thailand	400	300	200	200	200
Singapore	800	700	500	500	500
Myanmar	50	50	50	50	50
Laos	50	50	50	50	50
Cambodia	200	200	200	200	200
Vietnam	250	200	200	200	200
Malaysia	250	200	200	200	200

Demand distribution per size and line-up for SEA launch						
Bottle Size	Filled volume	Average yearly volume				
ml	ml	2018	2019	2020	2021	2022
Premium Bottle Line-up						
525	500	39%	37%	35%	30%	25%
780	750	21%	19%	17%	15%	13%
1050	1000	17%	17%	17%	17%	17%
1575	1500	15%	16%	17%	20%	24%
2100	2000	8%	11%	14%	18%	21%
Premium Sachet Line-up						
20	20	25%	100%	100%	100%	100%
40	40	75%	0	0	0	0
Tier-2 Line-up						
550	500	65%	65%	65%	65%	65%
1075	1000	30%	30%	30%	30%	30%
1575	1500	5%	5%	5%	5%	5%

The production should be able to cover the peaks of up to 30% caused by an uneven distribution of volume throughout the year. To minimize inventory a change in running formulation is expected every 5 hours on average.

Formulations

The Research & Development team in Newcastle provided your team the formulations for the target markets.

Each formula contains different perfume-intense. On top, there are 6 different dyes and 3 different long-lasting perfumes. All intense perfumes are injected in one injection point as well as all dyes and long-last perfumes. Once the perfume or dye touch the product a change-over procedure needs to be performed (for all downstream equipment).

The change over procedure consists of flushing the equipment with the product of the next run. The amount of liquid needed to flush is determined by the surface area of the pipe / tank wall. Generally, 2-mins of flushing of continuous systems is required. Any tank needs to be flushed by the amount equal to 50% to its volume.

Not following this procedure would result in a severe quality incident by violating the target color or scent.

Fabric Enhancer Formulation														
	Variant	Water	Active	NaCl	Perfume long lasting	CaCl2	Antifoam	pH agent	Dye	Preservative	Chelant	Perfume intense	Anti-freeze	Structurant
Premiums	Ocean Escape	71.108%	23%	1%	0.975%	0.015%	0.081%	0.009%	0.035%	0.045%	0.007%	3.03%	0.60%	0.10%
	Wild Flower	71.061%	23%	1%	0.875%	0.015%	0.081%	0.009%	0.032%	0.045%	0.007%	3.13%	0.60%	0.15%
	Ruby Jasmine	71.133%	23%	1%	1.034%	0.015%	0.081%	0.009%	0.000%	0.045%	0.007%	2.97%	0.60%	0.11%
	Golden Orchid	71.123%	23%	1%	1.112%	0.015%	0.081%	0.009%	0.000%	0.045%	0.007%	2.89%	0.60%	0.12%
	Black Diamond	71.193%	23%	1%	0.965%	0.015%	0.081%	0.009%	0.000%	0.045%	0.007%	3.04%	0.60%	0.05%
	Amber Flower	71.078%	23%	1%	1.345%	0.015%	0.081%	0.009%	0.025%	0.045%	0.007%	2.66%	0.60%	0.14%
	Amethyst	70.625%	23%	1%	1.475%	0.015%	0.081%	0.009%	0.498%	0.045%	0.007%	2.53%	0.60%	0.12%
	Pink Topaz	70.608%	23%	1%	1.789%	0.015%	0.081%	0.009%	0.585%	0.045%	0.007%	2.21%	0.60%	0.05%
	Ivory Flower	71.163%	23%	1%	2.112%	0.015%	0.081%	0.009%	0.030%	0.045%	0.007%	1.89%	0.60%	0.05%
Pearly White	71.163%	23%	1%	2.345%	0.015%	0.081%	0.009%	0.000%	0.045%	0.007%	1.66%	0.60%	0.08%	
Tier-2	Summer Breeze	82.036%	13%	0.70%	0.000%	0.01%	0.081%	0.009%	0.000%	0.045%	0.007%	3.32%	0.60%	0.19%
	Moonlight Harmony	82.139%	13%	0.70%	0.000%	0.01%	0.081%	0.009%	0.037%	0.045%	0.007%	3.20%	0.60%	0.17%
	Fresh Meadows	82.251%	13%	0.70%	0.000%	0.01%	0.081%	0.009%	0.045%	0.045%	0.007%	3.10%	0.60%	0.15%
	Floral	82.333%	13%	0.70%	0.000%	0.01%	0.081%	0.009%	0.050%	0.045%	0.007%	3.01%	0.60%	0.16%

Raw Material Data

The Material and Process Delivery team located in Brussels identified the optimal raw material suppliers and provided the engineering project team the storage and handling requirements.

Water

Clean process water is available at the acquired site. The water is treated using a water treatment plant. Ozone is used for its protection against microbial growth.

Recommended material of construction: SS316L

Active

The active raw material is produced in another P&G plant in the region and will be delivered in heated trucks containing 20m³ of material.

The material needs to be heated all the time to prevent solidification.

Recommended material of construction: SS316L

NaCl

A 20% liquid solution is prepared on site using powdered salt and clean process water.

Recommended material of construction: data missing

Perfume (long lasting)

Long-lasting perfumes are produced in another P&G plant in the region and will be delivered in cubitainers containing 1m³ of material. Due to potential phase separation, the material needs to be mixed before use.

Recommended material of construction: SS316L

Perfume (intense)

Intense perfumes are produced in another P&G plant in the region and will be delivered in drums containing 180 litres of material.

Recommended material of construction: SS316L

CaCl₂

A 25% liquid solution is prepared on site using powdered salt and clean process water.

Recommended material of construction: data missing

Antifoam

Antifoaming agent will be delivered in drums containing 180 litres of material.

Recommended material of construction: SS316L

pH agent

pH agent will be delivered in cubitainers containing 1000 litres of material.

Recommended material of construction: PVDF

Preservative

The preservative will be delivered in cubitainers containing 1m³ of material.

Recommended material of construction: SS316L

Dye

Dyes are prepared in batches using powder, process water and pH agent.

Recommended material of construction: PVDF

Chelant

The chelant will be delivered in cubitainers containing 1m³ of material.

Recommended material of construction: SS316L

Anti-freeze

The chelant will be delivered in cubitainers containing 1m³ of material. Due to high viscosity, the material should be heated to 40°C.

Recommended material of construction: SS316L

Structurant

Structurant will be delivered in cubitainers containing 1m³ of material. Due to potential phase separation, the material needs to be mixed before use.

Recommended material of construction: SS316L

Equipment Menu – Process

The designers located in Czech Republic has provided your team with the different type of equipment and the estimated cost. However it is up to your team to choose the equipment according to your formulation and capacity needs. The continuous and batch units are standardized to enable reapplication across P&G, but the additional supply systems can be according to custom design. If the cost is not in the attached catalog, it can be extrapolated / estimated.

In case a flush of the equipment is needed, the system produces an unusable material with the volume equal to the size of the tank.

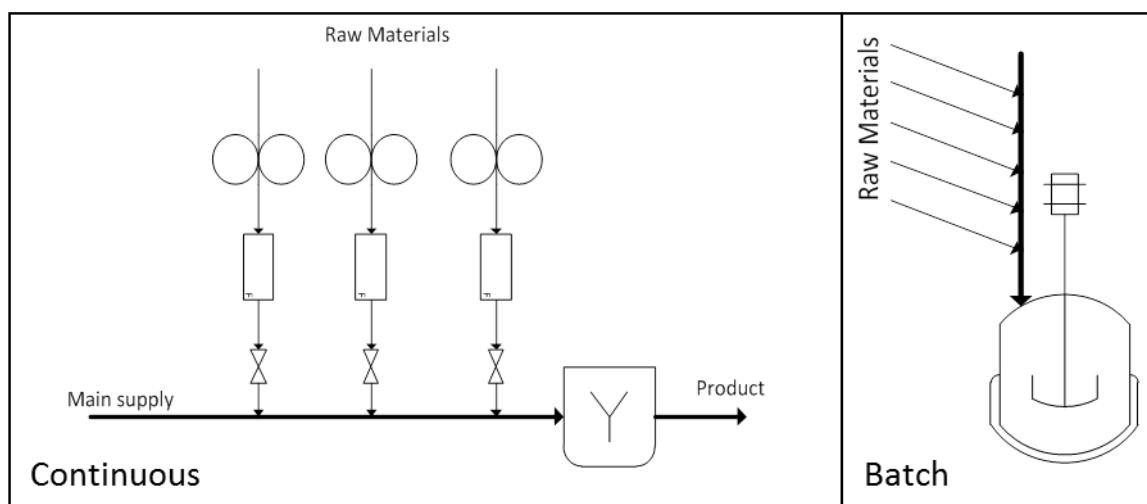
The lead-time for batch units is 20 weeks. The lead-time for continuous units is 16 weeks.

The Raw Material supply to the continuous and batch units need to be designed locally. The data are provided by the Material and Process Delivery team separately.

Continuous Mixing Units													
Cost (thousand USD)		Number of systems											
		2	3	4	5	6	7	8	9	10	11	12	13
Speed (m3 / hour)	8	220	280	340	400	460	520	580	640	700	980	1060	1140
	15	290	360	430	500	570	640	710	780	850	1140	1230	1320
	22	360	440	520	600	680	760	840	920	1000	1300	1400	1500
	45	420	505	590	675	760	845	930	1015	1100	1405	1510	1615

Batch Units		
Size m3	Time to produce 1 batch (min)	Cost (MUSD)
2.5	20	250
5	30	400
10	40	600

Continuous vs. Batch Unit

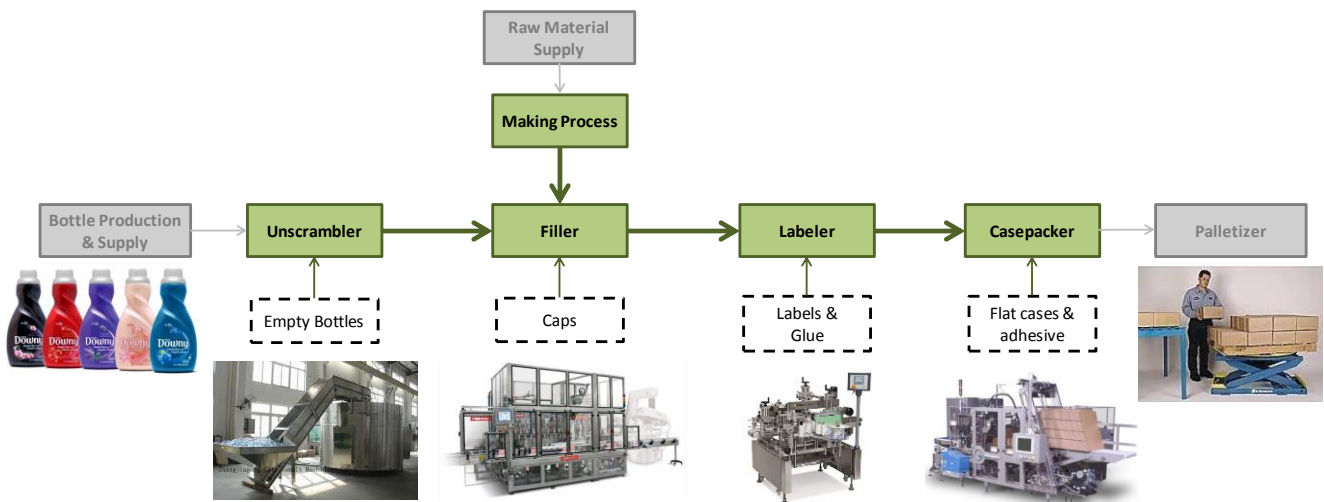


One person can typically operate one continuous or one batch unit. The raw material unloading takes approximately following times:

- Drum change – 40 mins
- Cubitainer change – 60 mins
- Truck unloading – 100 mins

Equipment menu – Packing

P&G strategy is to standardize manufacturing equipment globally to leverage its scale. The Global Technology Leaders within the engineering department in Czech Republic has provided the project team with the menu of standard packing equipment along with the estimated cost and speed.



		Bottle Packing				Sachet Packing
		Unscrambler	Filler	Labeler	Casepacker	Sachet packing machine
A	Technology	Linear unscrambler	Rotary filler	Rotary labeller 1	Fully automated casepacker	Sachet Machine-1
	Cost	\$300,000	\$800,000	\$600,000	\$700,000	\$350,000
	Delivery Time	15 weeks	25 wks	18 wks	30 weeks	18 weeks
	Throughput	200 1L bottle/min	300 1L bottle / min	300 1L bottle/min	350 1L bottle/min	300 sachets / min regardless of size
	Technology development	None	None	Intense	None	None
Additional Info		This technology exist at P&G running the same bottles in another site. The bottles however are 2-3 grams lighter than the bottle planned to run in the new site	Existing technology at P&G can be speeded up to 400 1L bottle / min with additional investment of 200 \$	This kind of process is new at P&G and needs development + the speeds may be also an issue. Learning plan is needed	proven system at P&G, running in other plants with same bottle.	Sachet Machine already in use in another P&G site. Additional 3 people are needed to put sachets to cases. A Sachet case packer can be purchased for additional \$250,000
B	Technology	Linear Unscrambler 2	Rotary filler	Rotary Labeler 2	Semi automated casepacker	Sachet Machine-2
	Cost	\$150,000	\$500,000	\$1,000,000	\$300,000	\$600,000
	Delivery Time	10 weeks	18 wks	25 wks	25 weeks	20 weeks
	Throughput	200 1L bottle/min	200 1L bottle / min	250 1L bottle / min	250 1L bottle/ min	500 sachets / min regardless of size
	Technology development	High	None	medium / high	medium	Medium
Additional Info		This process is completely new at P&G, new centerlines and process need to be developed and qualified if the decision is to adopt this technology	Existing technology at P&G does not support additional speed up	process existing at P&G running at different bottle	Additional development need to be executed to prove this solution to the new bottle. Also the speeds above 150 bottles / min were never tested before.	Sachet Machine already in use in another P&G site, but not for the same product.
C	Technology	Horizontal Unscrambler	Linear Filler		Manual Case packing	
	Cost	450,000\$	300,000 \$		10,000 \$ + ongoing cost for people	
	Delivery Time	20 weeks	15 weeks		3 wks	
	Throughput	400 1L bottle/min	100 1L bottle/min		15 bottles/min / person	
	Technology development	None	None		none	
Additional Info		This technology exist at P&G however not running at the maximum throughput and at other bottle	Due to lay out arrangement it can be installed in parallel with another linear filler for future speed up. The liquid is fed from the same tank.		Additional ongoing cost to keep contractors for manual packing. Due to Safety requirements, not more than 15 people can be working in the area.	

The packing line filling machine needs a stable supply of liquid from a tank. The requirement is to keep the packing line running all the time. Packing line stopping due to absence of product results in severe losses.

Flushing the packing line during a Change-over procedure results in 200 litres of unpackable product.

The overall reliability of a packing line is 85%. 5% of capacity is lost due to machine stops, 5% due to preventive maintenance and 5% due to Change-overs between sizes and variants. If both Premium and Tier-2 line-up bottles are being produced at the same line, the loss due to Change-overs will increase to 10%.

Operating Cost

Rakona plant manager will change assignment to become a Thailand plant manager and requested the cost for operating the new equipment and cost for material scrap.

The people cost in Thailand is 10 USD / hour.

The cost to scrap the finished product is 1200 USD / m³.

Process Flow Diagram

Process Flow Diagrams depict the conceptual design of a manufacturing facility including packing and process design including raw material supply. For the purpose of this presentation, please assume the following items to be essential – other information optional:

- Packing equipment with conveyor connections
- Tanks
- Pumps
- Critical equipment (Mass Flow Meters, Agitators)
- Approximate flow ranges through the pipes