

Case: Level Operations

Stephanie Coles is the Production Manager at Level Operations, a company operating in Pennsylvania. Level Operations is the manufacturer of safes and security devices which come in a variety of designs. Stephanie recently received a five week projected demand on five distinctly designed safes from the company's marketing department, shown in Table 1. Her job is to create a production schedule to accommodate the demand requirements on a day-to-day basis. Level Operations is operating five days a week with a newly expanded production facility to adapt to increasing demand levels. Production constraints require that cycles produce finished units. Stephanie has determined the manufacturing sequence per cycle to be S7-S8-S9-S1-S2.

Model	S1	S2	S7	S8	S9
Weekly Quantity	120	102	48	90	25

Table 1

What might Stephanie determine as the best production quantity per cycle for each day of the week?

In order to address Stephanie's task to produce a production schedule for forecasted demand over the course of the next five weeks, we applied the JIT/Lean Production philosophy keeping in mind the ultimate goal of Lean Operations,

"To achieve a system that matches supply to consumer demand".

As a result, scheduling was considered with a focus on the optimal way to synchronize supply through a smooth and uninterrupted flow to meet consumer demand.

The Lean production system, which was initiated by Toyota and began as Lean manufacturing in the mid-1900s, was influenced by limited resources in Japan and a sensitivity to waste and inefficiency. Here, waste referred to as anything that neglected to add value or interfered with the production process.

In order to achieve the Lean Operations goal of a *Balanced System*, the extent to which supporting goals are achieved are paramount. The 3 supporting goals are: elimination of disruptions, making the system flexible, and eliminating waste - particularly excess inventory which ultimately proves costly and takes up scarce space.

Keeping in mind the supporting and ultimate goals of Lean Operations, Stephanie's scheduling predicament can easily be addressed using the principles of small lot sizes, level loading and the 'pull system'. For Stephanie, producing in **small lots** allows her to minimize work-in-process inventory which translates to 'waste' in lean operations as well as maintaining flexibility. This is because the production of different safe models throughout the day will provide for a smooth production process. This also results in lower inspection and rework costs when problems with quality occur. **Level loading** calls for a strong emphasis on achieving stable daily mix schedules and allows for a smooth demand level to suppliers. Once it's established, production schedules may remain fixed over a short time horizon and provide a level of certainty to the production system. **Pull systems** allow for customer demand to control the level of production which essentially eliminates the need for inventory which may act as a buffer in identifying problems and resolving them as well as inventory being costly to maintain.

Mixed Model Sequencing

Stephanie's task calls for **Mixed Model Sequencing** which calls for determining the daily production requirements of each model. In Mixed Model Sequencing, we need to address 3 issues:

- Sequence
- Number of Cycles
- Number of Units/Cycle

Stephanie has determined the sequence of production to be S7-S8-S9-S1-S2. Units demanded per week are provided by the demand forecast. Table 2 shows units which can be produced of each model on a daily basis keeping in line with level production.

Day	Pattern					Extra Unit
M	Model S7	Model S8	Model S9	Model S1	Model S2	S7
	10	18	5	24	20	
T	Model S7	Model S8	Model S9	Model S1	Model S2	S2
	9	18	5	24	21	
W	Model S7	Model S8	Model S9	Model S1	Model S2	S7
	10	18	5	24	20	
Th	Model S7	Model S8	Model S9	Model S1	Model S2	S2
	9	18	5	24	21	
F	Model S7	Model S8	Model S9	Model S1	Model S2	S7
	10	18	5	24	20	
Total	48	90	25	120	102	

Table 2

In order to determine daily production of safes, total weekly demand of each model was divided by 5, the number of days in each week. Demand for Models S7 and S2 was not evenly divisible by 5, as a result, additional units were scheduled to be produced with the production of additional units interspersed throughout the week in order to achieve nearly

level production. Monday, Wednesday and Friday production levels differed from Tuesday and Thursday. Due to these differences, cycles and units produced per cycle were different for the 'Monday, Wednesday, Friday' grouping from the 'Tuesday, Thursday' grouping.

Production per cycle for Monday, Wednesday and Friday is shown in Table 3.

Cycle	Pattern					Extra Unit
1	Model S7	Model S8	Model S9	Model S1	Model S2	S8 S1
	2	4	1	5	4	
2	Model S7	Model S8	Model S9	Model S1	Model S2	S1
	2	3	1	5	4	
3	Model S7	Model S8	Model S9	Model S1	Model S2	S8
	2	4	1	4	4	
4	Model S7	Model S8	Model S9	Model S1	Model S2	S1
	2	3	1	5	4	
5	Model S7	Model S8	Model S9	Model S1	Model S2	S8 S1
	2	4	1	5	4	
Total	10	18	5	24	20	

Table 3

The number of cycles was determined as the fewest number of cycles that contained 1 unit of the model with the lowest quantity requirements, which in this case was Model S9. Each daily production quantity was divided by 5 with Models S8 and S1 requiring additional units interspersed between cycles.

The same strategy of determining cycles was used for the 'Tuesday, Thursday' grouping. This is shown in Table 4. The number of cycles was kept at 5 with additional units required of Models S7, S8, S1 and S2. Production Schedules for Models S8 and S1 were kept the same as the previous grouping. Changes in additional units were added for Models S7 and S2 with a focus on leveling production.

Cycle	Pattern					Extra Unit
1	Model S7	Model S8	Model S9	Model S1	Model S2	S8
	2	4	1	5	4	S1 S7
2	Model S7	Model S8	Model S9	Model S1	Model S2	S1
	2	3	1	5	4	S7
3	Model S7	Model S8	Model S9	Model S1	Model S2	S8
	1	4	1	4	5	S2
4	Model S7	Model S8	Model S9	Model S1	Model S2	S1
	2	3	1	5	4	S7
5	Model S7	Model S8	Model S9	Model S1	Model S2	S8
	2	4	1	5	4	S1 S7
Total	9	18	5	24	21	

Table 4