

Burckhardt Compression AG
Winterthur Hackathon Challenge
2019



Winterthur Hackathon Challenge – Burckhardt Compression

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1. INTRODUCTION

Short lead time is essential for the success of a production organisation. In order to remain competitive, many different fabrication orders have to be completed in ever shorter and shorter timeframes.

Each order competes with other concurrent orders for machine and workstation capacities. This leads to valuable hours and days "lost" in waiting and transport. With your idea, the Production Department will be able to massively reduce overall throughput time per production order.

Innovative planning leads to optimally utilized workstations and the parts to be produced effortlessly flow through production.

2. CHALLENGE

How can the **lead time** of parts [material] be reduced in production, if both the product mix, and the utilization of different workstations/workplaces are subject to strong fluctuation/ variability?

1. Suggest a Model that shall be used for planning Burckhardt's Production in the future.
2. Present a set/sets of optimal parameters for your model.
3. Relevant boundary conditions should be met at all times.
4. Real data is supplied in the data set.

Hints for Challenge

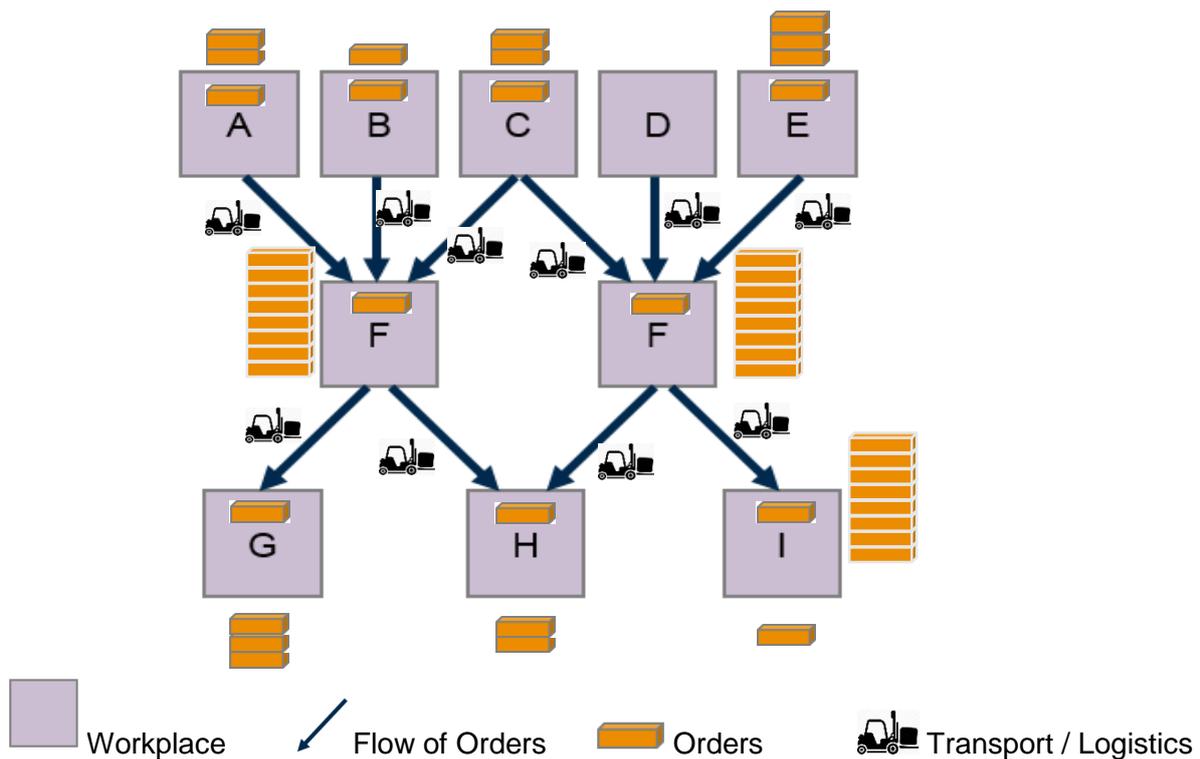
1. Which are the critical workplaces? Bottlenecks?
2. How should workplaces be re-arranged in order to optimize lead time? Layout?
3. According to which set of criteria should the Production Department be planned in the future?

3. BACKGROUND

In order to run a production in a high cost country like Switzerland, sustainably and successfully specific USPs (unique selling proposition) are required. It is essential to be highly flexible and also to guarantee short lead times while catering for a high product variability (ranging from one-off items to small series).

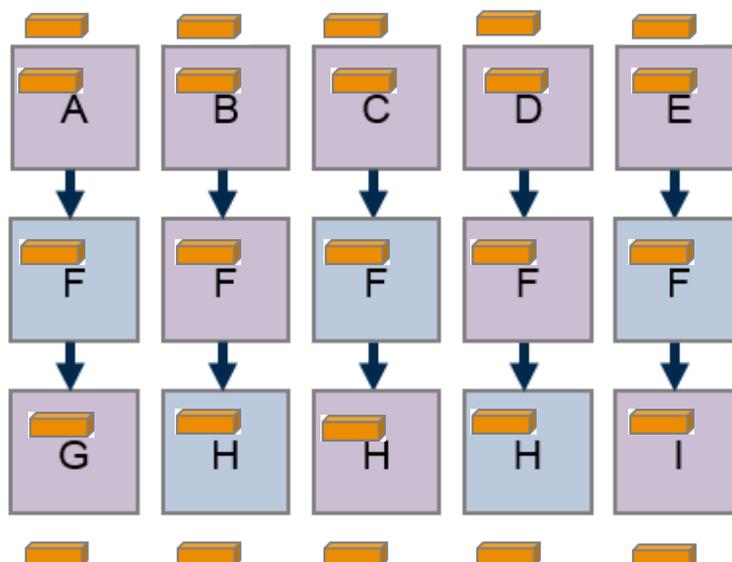
3.1. Result of today's planning

In today's arrangement of production equipment and workplaces orders (parts/materials) compete for work centre / workplace capacity. The results are: Traffic jams, waiting times and high stocks in front of the workplaces.



3.2. Ideal planning

This is purely theoretical, not achievable in practice. The orders (parts / materials) are passed on from one workplace to the next in such a way that stocks are kept as small as possible (if possible, no waiting time).



3.3. A production journey in the life of a Burckhardt Compression Product Order (Current Situation)

1. My name is Cylinder [material] and I am a key material / element of the final compressor.
2. I arrive as a (raw) material and wait in stock until production is ready for my first operation [operation nr.] The first operation can for example be a check of my raw weight.
3. By the way, we are two, my twin [amount], who looks exactly as myself, is always with me.
4. Practically everything I have to live through, she also faces just a short time after myself. After the check, I wait patiently until I am transported away. This sometimes takes a while (see transport times in Appendix 1), because many parts/materials are constantly being transported throughout the production department at every point in time.
5. As I am over 25kg [gross weight] I have to wait a rather long time because there are not too many means of transport that can transport my weight. Loading me onto a trailer takes time and even requires a crane.
6. Finally, I am being picked up. This time it took me almost 2 days to get to the next workplace where I will be milled, in order to transform my outer contours into the desired shape.
7. Unfortunately, this workplace is booked beyond capacity. 5 other work orders / parts / materials are waiting here for processing. By the way, the sequence of operations I have to undergo is fixed, even if I would like to skip a few, I am not allowed to do so.
8. After 2 days, my Order Manager realises that I am more time critical than the other work orders ahead of me. Apparently my customer has a high priority. Thus I am pushed forward together with my twin sister to the first place. Bad luck for the other colleagues (work orders) who now have to wait even longer.
9. First, the workplace has to be prepared for the next operation [plan - setup time]. This is a special procedure to prepare myself for the workplace and vice versa. This is good for my twin sister since she looks exactly the same and follows right after myself on the same workplace, she does not have to go through this procedure again. If we were separated, or if another colleague had forced his way between us, which sometimes happens, she would have had to go through the same set-up / preparation procedure.
10. After some time, [plan - processing time] my sister and I have finished being processed and look much nicer than before.
11. Now I am being transported to another workplace: Quality Control [workcenter]

12. Oh my, it turns out that I have a non-conformity. I have to re-take a few operations.
13. A rework work order (NAFAUF) is quickly created and I will be pushed through a few workplaces again as I am highest priority. Now that I am really important, I do not have to wait in line almost anywhere, unlike many of my "normal (priority)" colleagues.
14. By the way, my twin sister did not wait for me and was able to continue her work according to the normal schedule after Quality Control. But that is not always the case. Sometimes, she waits for me.
15. Finally, I was able to catch up to her again. I have undergone all additional operations according to a special re-work work order (NAFAUF, see above). Now I am back in my normal work plan. With this I have lost my high-priority status.
16. As the next workplace is completely overloaded, my Order Manager must decide whether I take the next operation on an alternative workcenter / workplace [workcenter] or whether the operation should be carried out with an outsourcing provider outside of Burckhardt's workshop. This would be particularly disadvantageous, as an external step prolongs my turnaround / lead time by a whopping 28 calendar days.
17. Luckily there is still some spare capacity on an alternative workplace so I do not lose too much time. After this operation, I am finally finished and ready for assembly.

In my wildest dreams I would be seamlessly passed from workplace to workplace, from operation to operation and this would be fantastic.

Unfortunately, my Order Manager tells me, however, that the utilization of workplaces is important. Due to cost reasons, he cannot simply leave expensive workplaces empty for a long time. Indeed, a difficult problem.

I really hope that someday a genius will help solve this problem.

#lookingforthenextEINSTEIN

4. APPENDIX 1

A work order [order] consists of one or more parts.

The workstations/workplaces [workcenter] are listed in the file Workcenters.xlsx The standard working time per workstation / workplace is described in the file Calendar_Models.xlsx

4.1. Boundary Conditions (these are mandatory)

1. Every data point in the attached files is unique
2. The solution / approach chosen should be realistic (i.e. an implementation in the real world should be principally feasible)
3. Normal capacity for staff:
 - 220 working days in 365 calendar days (without overtime)
4. Possible overtime
 - Personnel: According to file Calendar_Models.xlsx
5. The order/sequence of operation within an order [FAUF] or NAFAUF is fixed and cannot be changed.
6. NAFAUF: An order starting with the letter (e.g. A1311258A) is a special order (likely caused by some earlier faulty processing / non-conformity to specifications) and must always be treated as a priority because this is a necessary rework of a material that must be quickly available again.
7. Transport time:
 - The transport time of a part > 25 kg is a minimum of 1 day
 - The transport time of a part <25 kg is at least 0.5 days (suggested modifications should be according to APPENDIX 2 "possible aids / suggestions")

4.2. Information

1. The data represents one calendar year of production (12 months)
2. An order can be made up of several lines
3. Subsequent lines without an order number define a possible alternative operation plan / sequence of operations for the same material. (e.g. one could use this so-called "alternative routing" through the workshop in order to obtain the same material at the end)
4. The alternative operation plans differ:
 - By the plan group counter [plan group counter]
 - in each case by possible other routings / sequences of operations and/or other workplaces (e.g. outsourced processing at third party suppliers).
5. The minimum duration of a work order [order] within one workplace / workstation is calculated as follows: $T_{TOT} = [\text{plan - processing time}] \times [\text{amount}] + [\text{plan - setup time}]$

5. APPENDIX 2

5.1. Possible aids / suggestions

1. The lead time is directly proportional to the number of orders in production → the lower the number of parts present in the production process at a particular time, the shorter the lead time.
2. Splitting of production lots:
[amount]
 - Example: Instead four items / "materials" at the same time produce two parts twice.
While this leads to double setup time [plan - setup time] and principally higher costs, it can have an overall positive effect on the lead time, since the processing time [plan - processing time] could be halved.
3. Possibility to combine workplaces to so called "cells" [combineable]
4. Possibility to multiply workplaces [multipliable]
→ Reduction of transportation times
5. Strategic buffers / stocks in order to reduce the overall throughput / lead time?
6. Simulation tool: Possibility to easily compare different scenarios

6. APPENDIX 3

6.1. About Burckhardt Compression

Burckhardt Compression is a worldwide market leader for reciprocating compressor systems and the only manufacturer and service provider that covers a full range of reciprocating compressor technologies and services. Its customized compressor systems are used in the upstream oil & gas, gas transport and storage, refinery, chemical, petrochemical and industrial gas sectors. Burckhardt Compression's leading technology, high-quality compressor components and full range of services help customers all around the world minimize the life cycle costs of their reciprocating compressor systems. For 175 years its highly skilled workforce has crafted superior solutions and set the benchmark in the gas compression industry.

SIX Swiss Exchange: BCHN

Weitere Informationen unter <http://www.burckhardtcompression.com>

7. APPENDIX 4

7.1. Data Description

The following table describes all necessary fields of the provided data.

Some terms are used interchangeably throughout this appendix as well as in other areas of this document:

- Workcenter = workplace = workstation
- Activity = operation
- Material = part(s)

Key	Description
operation nr.	Each production order has several activities / operations. The nr. shows the sequence
actual - processing time	actual processing time: how much time did it really take
actual - setup time	actual setup time: how much time did it really take
actual - start operation	the actual start of the operation
actual end – operation	the actual end of the operation
actual end – order	actual end of the whole production order (end of latest operation)
actual start – order	actual start of the whole production order (start of first operation)
Amount	quantity of material produced within the production order
amount machines	how many machines are placed in this workcenter / workplace
basic material	basic material
Calendar	defines which type of calendar is relevant for this workcenter see file "Calendar_Models.xlsx" e.g.: - 2 shifts - 3 shifts ...
Combineable	Defines if the workcenter can be combined / merged with another workcenter to so-called "cells"
costrate per hour	defines the price of every hour performed by the workcenter. Cost of production order will include: (actual setup time + actual processing time) x costrate per hour
currency (extended workbench)	currency of the price of the extended workbench

delivery time (extended workbench)	the standard delivery time of an extended workbench extended workbench is an external supplier - generally longer lead time than internal lead time
dimensions	dimensions
division	defines for what product line the part was designed initially
gross weight	gross weight of the material
material	material - key for all items produced / purchased in company
material group	defines, what kind of material it is.
material text	(technical) designation of material
min lot size	minimum lot size (if defined) defines which quantity the production order should produce at least
min. lead time	defines the current setting for the waiting time. "Total lead time of operation " = Min("team factor" * ("setup" + "processing time"); "min lead time")
multipliable	Defines if the workcenter can be multiplied / Whether you can easily add another one of this workcenter to increase capacity
net capacity in %	is the factor to calculate the capacity of the workcenter: the calendar shows how much hours are theoretical available the factor displays the efficiency of these available hours. e.g.: standard calendar (0) has 40 hours per week with a factor of 50% the capacity is 20 hours per week
net price (extended workbench)	Net price of extended workbench. Has to be multiplied by amount (of production order) and has to be divided by price unit
net weight	net weight of the material
order	production order (FAUF) used to produce a specific quantity of material within a certain timeframe
plan - processing time	plan of the processing time: how much time does it take to process (machine/assembly/test) the material defined by experience
plan - setup time	plan of the setup time: how much time does it take to prepare the workcenter for that individual material defined by experience

plan group	<p>plan group (+group counter) are keys for a routing. A routing defines the sequence of the production order.</p> <ul style="list-style-type: none"> - sequence of each step (operation) - workcenter of each step - processing / setup times for each step
plan group counter	<p>There can be different variations of routings for every plan group. The plan group counter helps to distinguish between them. SAP prefers to take the lowest plan group counter as a standard. An Order Manager can override this according to his production planning desires / requirements.</p>
price unit (extended workbench)	defines for how many pieces the price is defined
product hierarchy	defines for what product type the part was designed initially
team factor	<p>defines the current setting for the waiting time. "Total leadtime of operation " = Min("team factor" * ("setup" + "processing time"); "min leadtime")</p>
text operation	text of operation / short description of operation
text plan	<p>Text of the plan / short description of the plan Gives an indication, for what materials it is used</p>
text workcenter	Description / designation of workcenter
unit - act - processing time	unit of the actual processing time
unit - act - setup time	unit of the actual setup time
unit - plan - processing time	unit of the plan processing time
unit - plan - setup time	unit of the plan setup time
unit (gross weight)	unit of gross weight
unit (net weight)	unit of net weight
workcenter	<p>The Workshop is divided in different workcenters / workplaces / workstations</p> <p>These can be: small machines, big machines, manual workcenters</p>