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PlanVar game

EXPERIMENTING WITH PLANNING UNDER
HIGH VARIABILITY IN THE MAKE INDUSTRY

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How to Plan Your Production Under High Variability?

COOCK Planvar project (2024-2025-2027)

Ongoing

PLANVAR | Planning for Variability in Manufacturing Companies

Region: Flanders

Financed by



The PLANVAR project supports manufacturing companies in rethinking their planning and production management by showing how recently acquired knowledge can be applied. This will enable manufacturing companies to plan complex environments with less effort while using existing or affordable tools, and so further increase their productivity and reliability of delivery.

Timing

Jan 2024 - Dec 2025

Context

More than 70 percent of high-mix-low-volume manufacturing companies report struggling with planning and managing production. This translates into all kinds of problems that hinder performance and productivity, such as excessive planning and replanning work, chaos on the work floor, low delivery reliability and dissatisfied customers.

More specifically, there are two challenges:

- Manufacturing companies are faced with increasing demand variability (fluctuations in mix and volume) and production variability (complex routings, small and large orders, uncertain times, etc.) in their environment, as a result of which their current planning approach no longer works.
- Manufacturers want to be able to effortlessly plan and manage their production with minimal effort using existing or affordable tools.

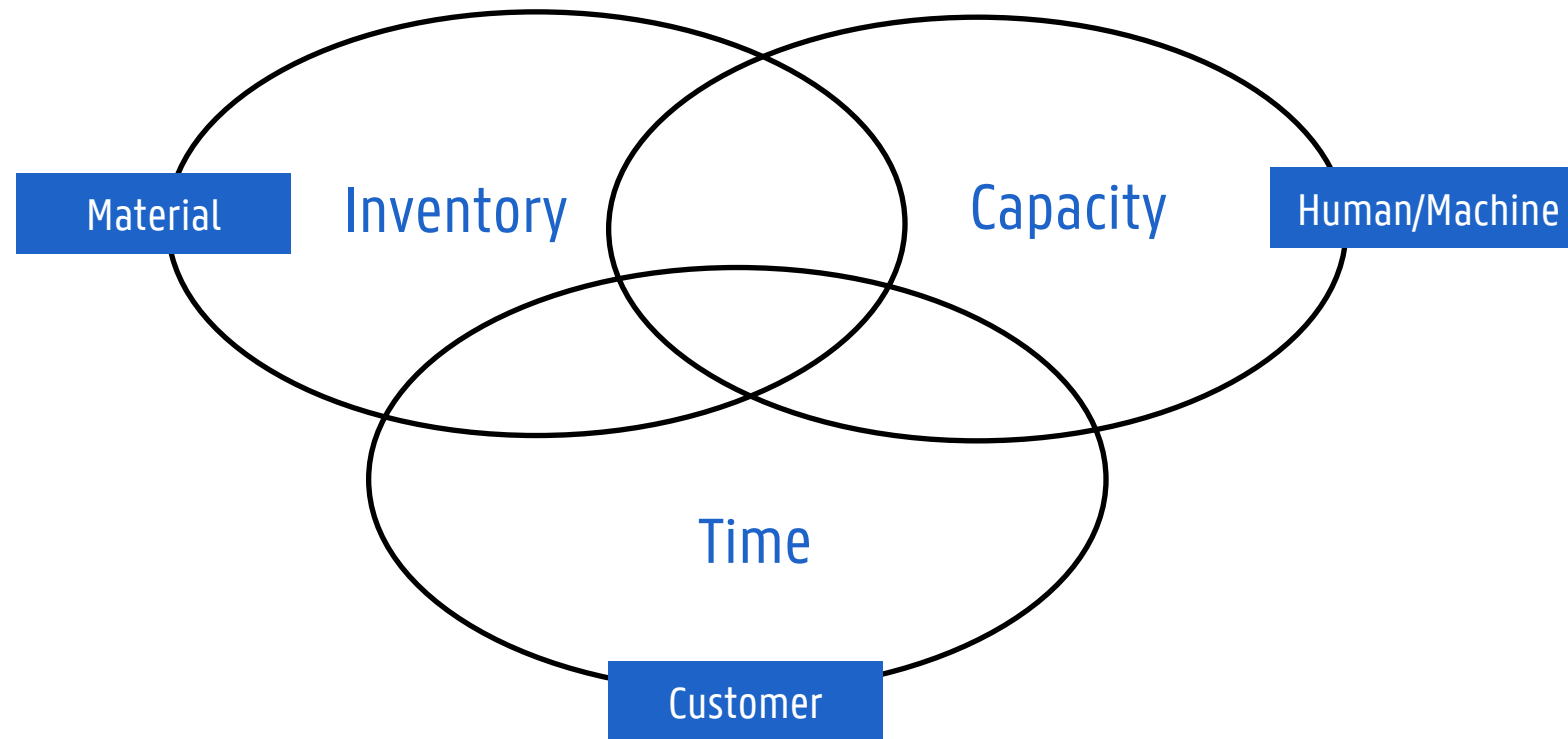
Purpose

The PLANVAR project supports manufacturing industry in rethinking its planning and production management by showing how recently acquired knowledge can be applied. This will enable manufacturing companies to plan complex environments with less effort while using existing or affordable tools, and so further increase their productivity and reliability of delivery.

How to Plan Your Production Under High Variability?

How can you handle the variability?

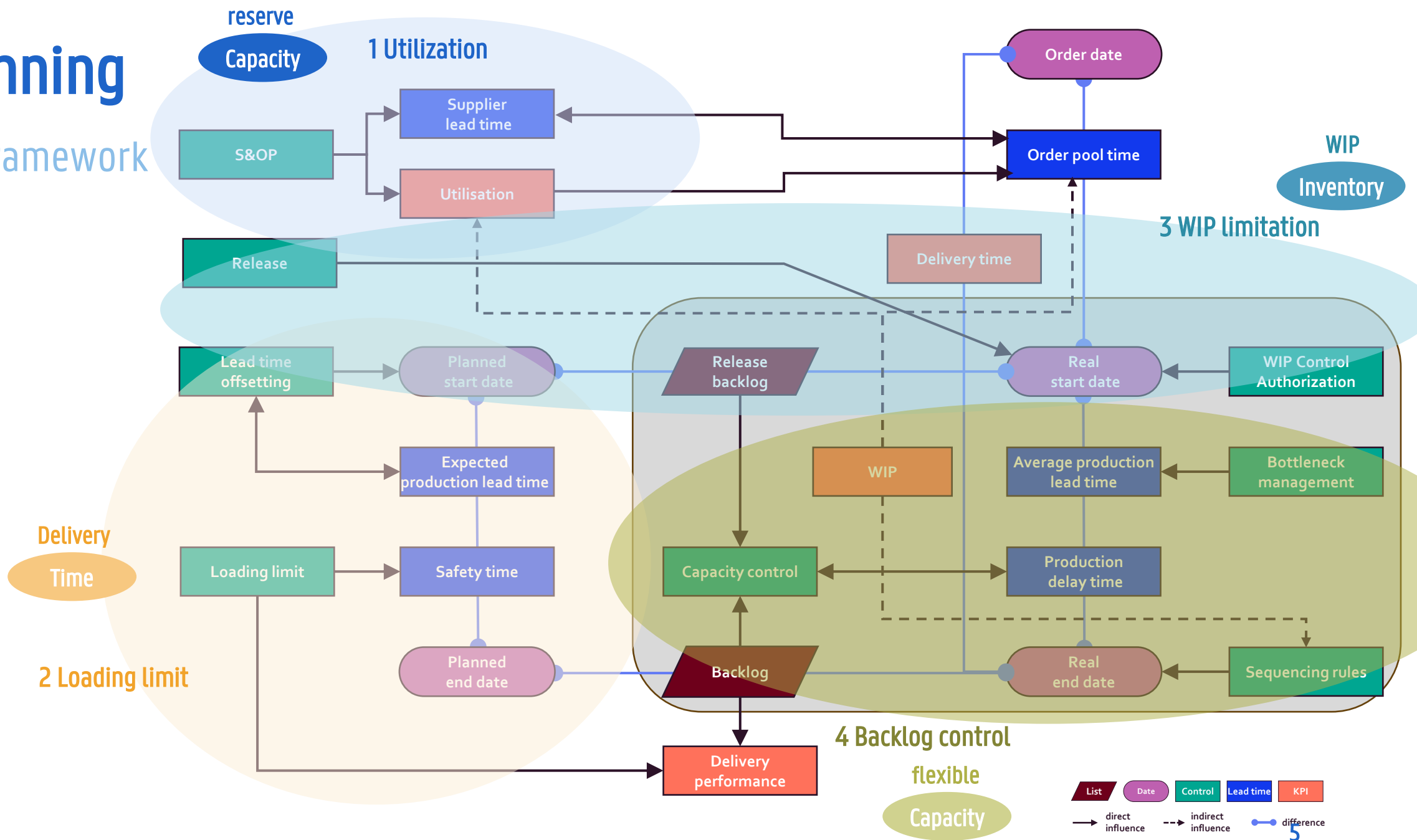
Buffering protects the production system against variability and makes it more manageable.



But buffering also costs money ...

Planning

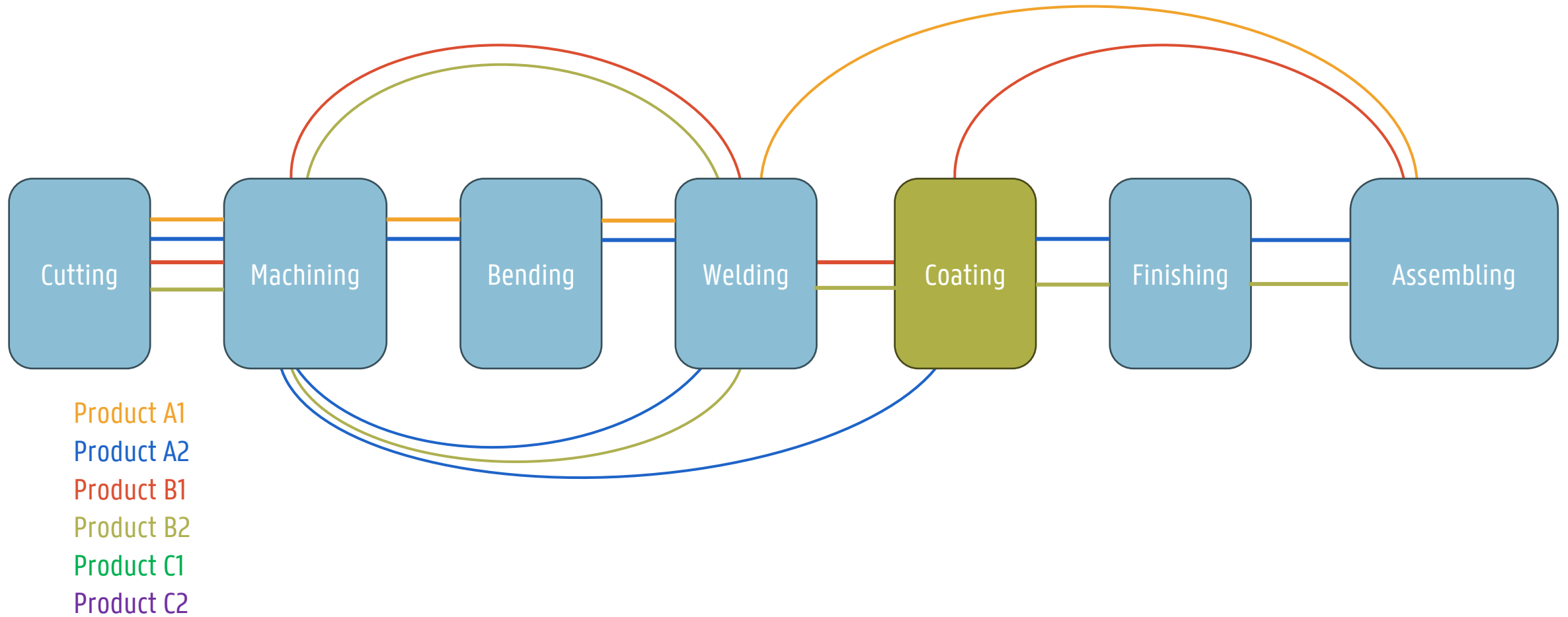
The framework



Learning while playing



Start scenario - configuration



Start scenario - Settings

S&OP

Productmix

Product	Amount	Percentage
Product A1	12	14.2857%.
Product A2	18	21.4286%.
Product B1	5	5.9524%.
Product B2	9	10.7143%.
Product C1	15	17.8571%.
Product C2	25	29.7619%.

Number of orders per day [random from poisson, with expected value]: 100

Randomness of generated orders: Poisson

Percentage rush orders: 5

Percentage orders with late due date: 5

Release

Release rule: PUSH

Capacity control

Overtime strategy: No Overtime

Leadtime offsetting

DeliveryTime strategy: Fixed

General delivery time: 10

Detailed lead time

Product	Lead Time
Product A1	7
Product A2	7
Product B1	7
Product B2	7
Product C1	7
Product C2	7

Start scenario - Configuration

Variability

Failures

Enable failures: ☐

Workstation	Down Time Min [hours]	Down Time Max [hours]	Up Time Min [hours]	Up Time Average [hours]
Cutting	0.25	8	100	200
Machining	0.25	4	50	900
Bending	0.25	8	200	800
Welding	0.06	8	1	100
Coating	0.25	8	100	600
Finishing	0.25	2	10	400
Assembling	0	0	100	400

Supplier lead time

Product	Material delivery time [days]	Material delivery performance [%]	Material delivery Variation on late [days]
Product A1	3	65	2
Product A2	2	65	2
Product B1	4	85	2
Product B2	3	75	2
Product C1	5	85	1
Product C2	3	95	1

Maintenance

Enable Maintenance: ☐

Workstation	Maintenance Duration [hours]	MaintenanceInterval [hours]
Cutting	0.5	96
Machining	8	2400
Bending	0.25	100
Welding	0	48
Coating	1	200
Finishing	0.5	40
Assembling	0	48

Rework

How to determine rework: Fixed Probability Per Machine

How much rework on general level [%]: 10

Rework per workstation [%]:

Workstation	Percentage Rework	Rework Destination	Rework Time Factor
Cutting	1	Current Station	1
Machining	1	First Station	1
Bending	1	First Station	1
Welding	5	First Station	1
Coating	1	First Station	1
Finishing	3	First Station	1
Assembling	7.5	First Station	1

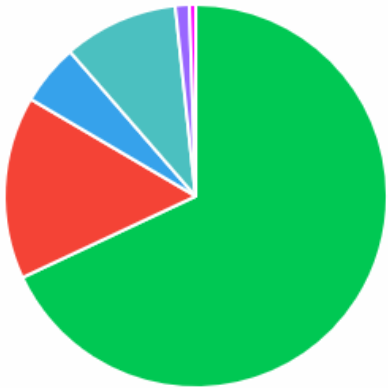
Operator sick

Probability Operator Sick [%]: 10

Start scenario - Results

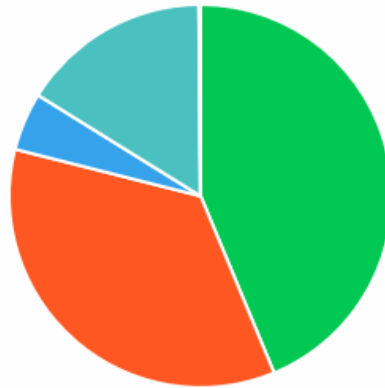
Cutting

Processing Idle Waiting for operator
Waiting for transporter Breakdown
Maintenance



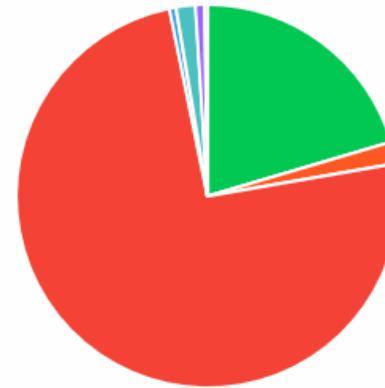
Machining

Processing Setup Waiting for operator
Waiting for transporter Maintenance
Breakdown



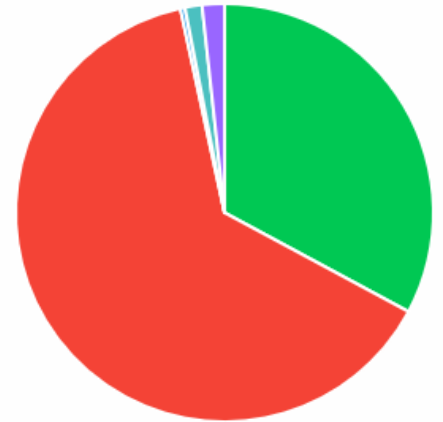
Bending

Processing Setup Idle
Waiting for operator Waiting for transporter
Breakdown Maintenance



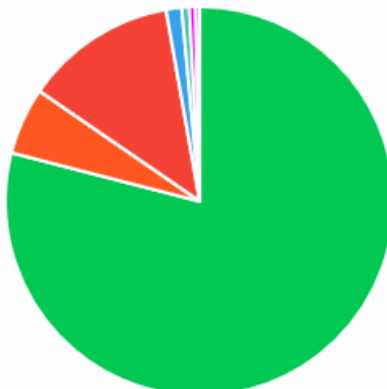
Welding

Processing Idle Waiting for operator
Waiting for transporter Breakdown



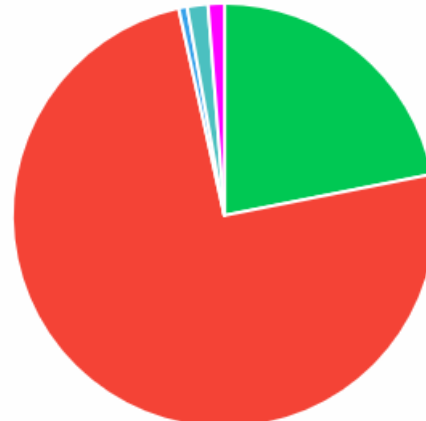
Coating

Processing Setup Idle
Waiting for operator Waiting for transporter
Maintenance Breakdown



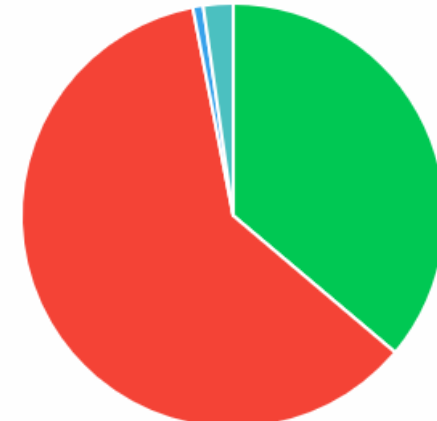
Finishing

Processing Idle Waiting for operator
Waiting for transporter Maintenance



Assembling

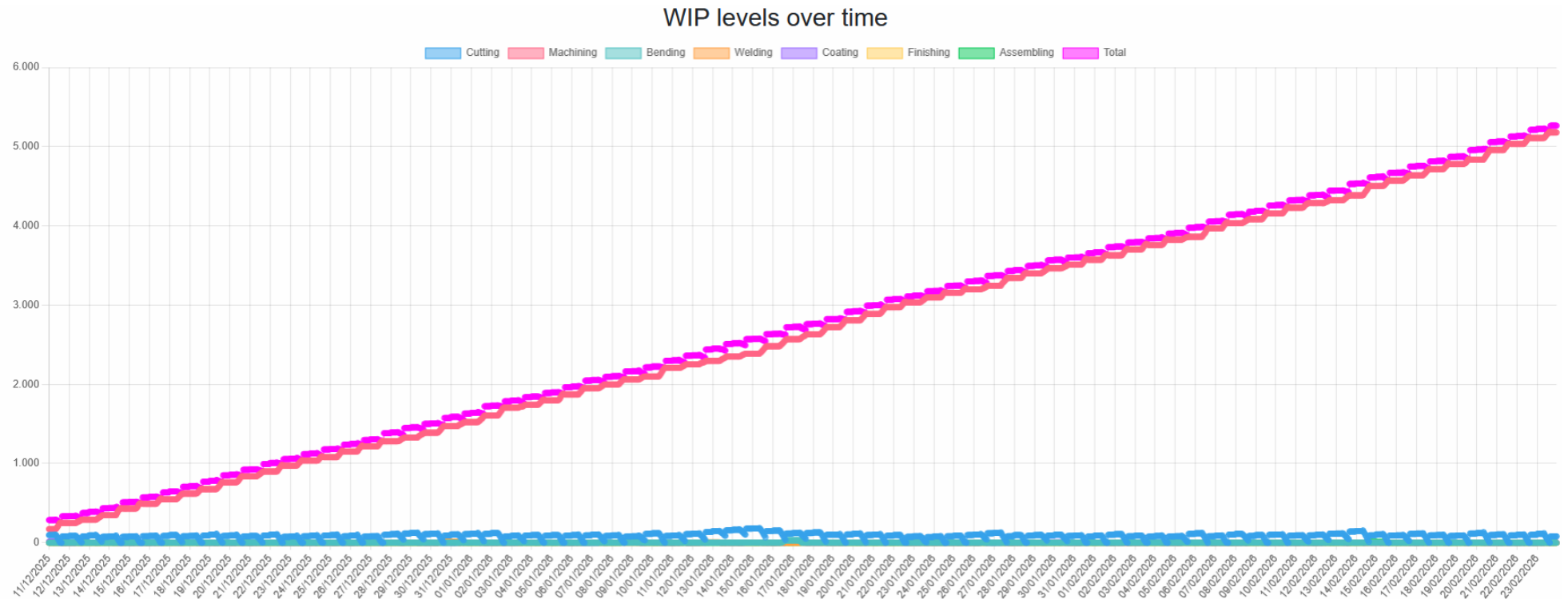
Processing Idle Waiting for operator
Waiting for transporter



Start scenario - Results

WIP levels

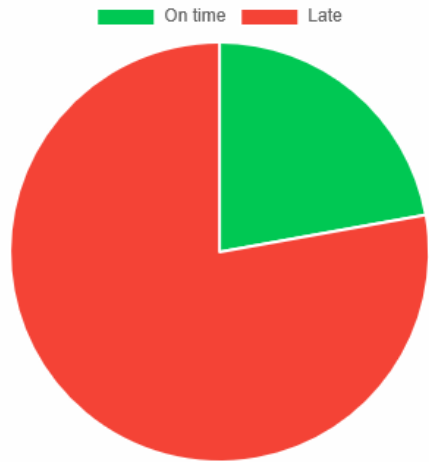
Workstation	Average	Max
Total	2719.16	5266
Cutting	86.14	186
Machining	2629.12	5190
Bending	0.64	31
Welding	0.52	12
Coating	1.65	16
Finishing	0.26	9
Assembling	0.83	22



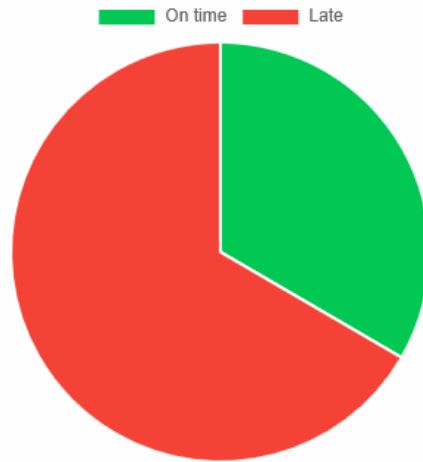
Start scenario - Results

Throughput	% Late	WIP	Production lead time	Delivery time
35.07	77.83% 91.9% inc WIP	avg: 2719.16 max: 5266	avg: 18 days, 10 hours 95%: 48 days, 17 hours max: 72 days, 23 hours	avg: 22 days, 7 hours 95%: 52 days, 6 hours max: 78 days, 7 hours

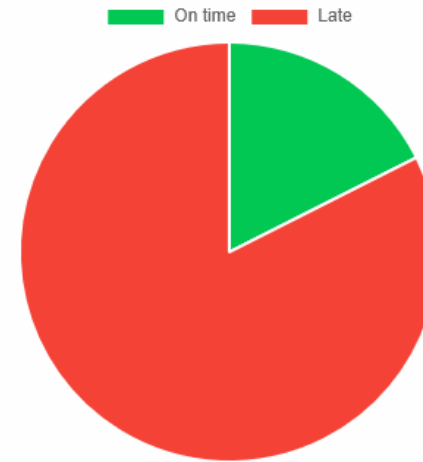
Total



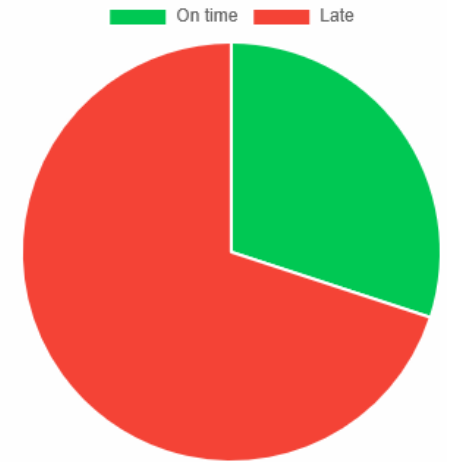
Product A1



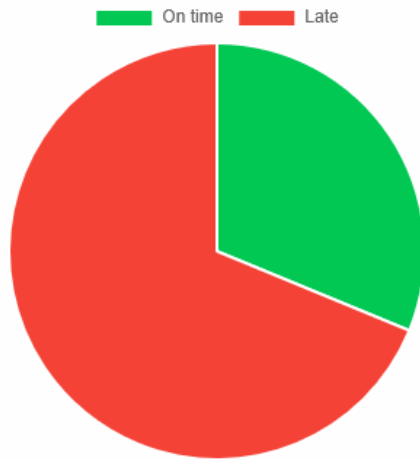
Product A2



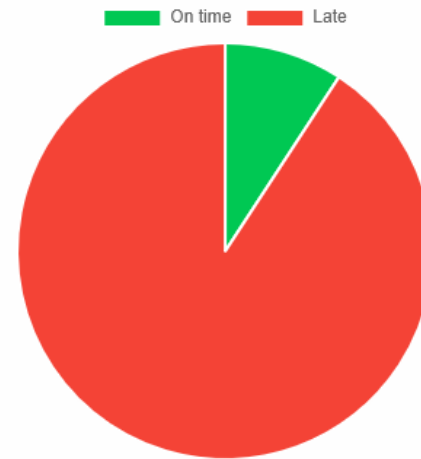
Product B1



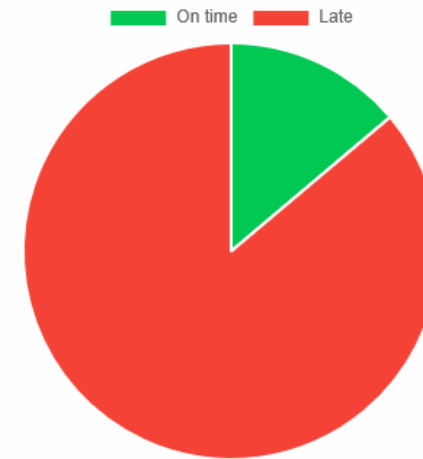
Product B2



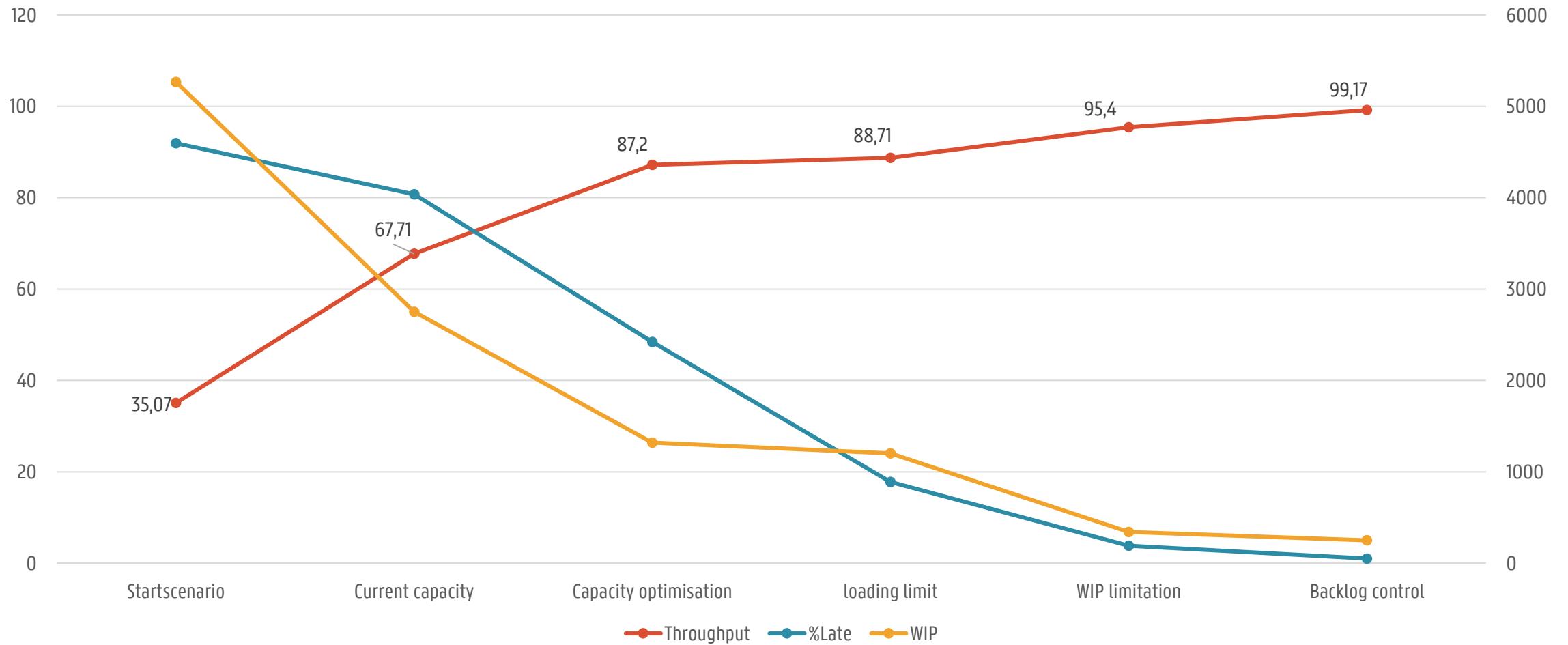
Product C1



Product C2



“Ideal” path



Getting started

Select your role

PLANVAR_Game Home Privacy Game

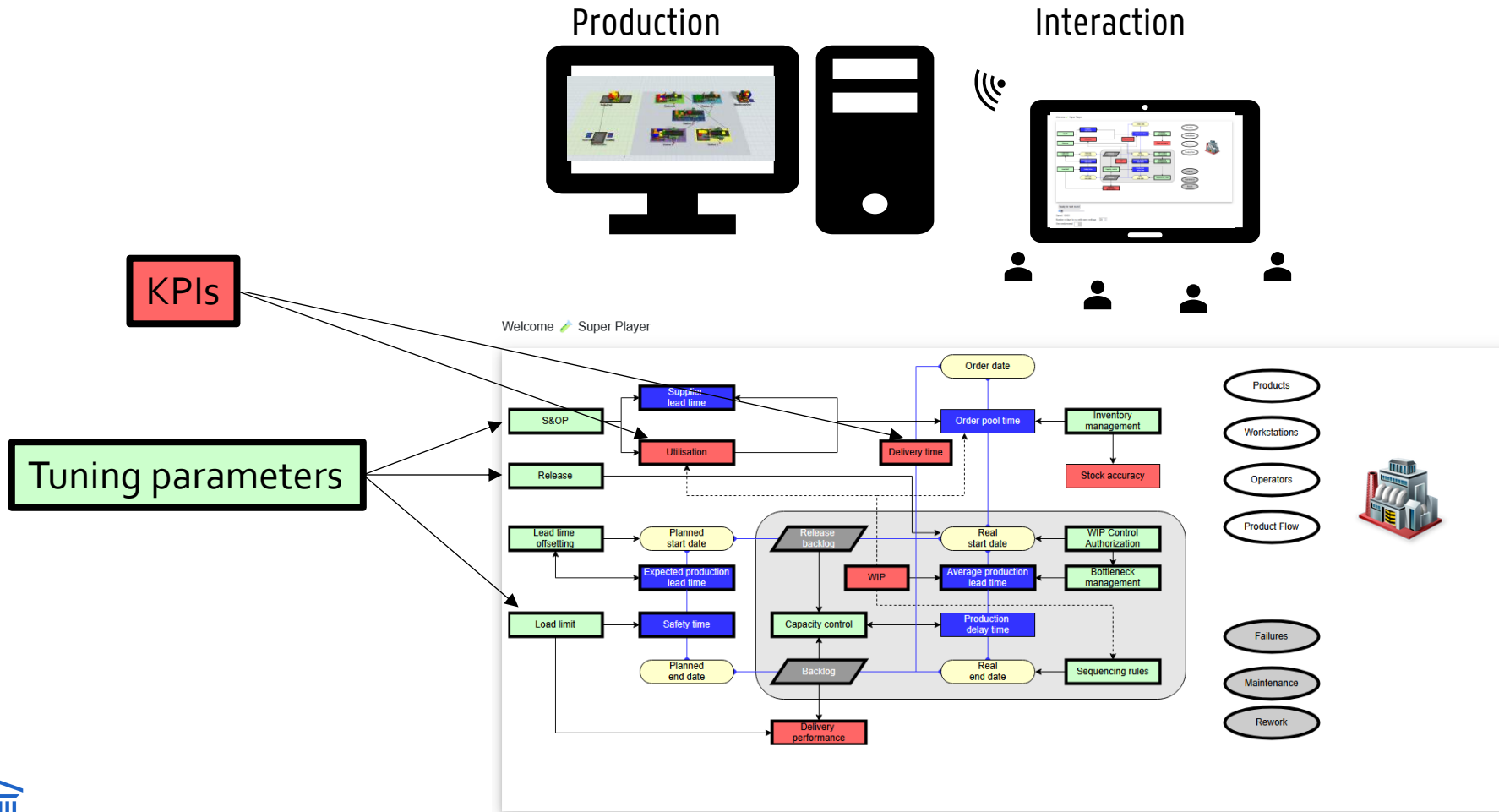
Register Login

Select your role in the game

- ☐  Configurator
 - ☐  Purchase/sales department
 - ☐  Scheduler
 - ☐  Machine operator
 - ☐  Super Player
- Confirm

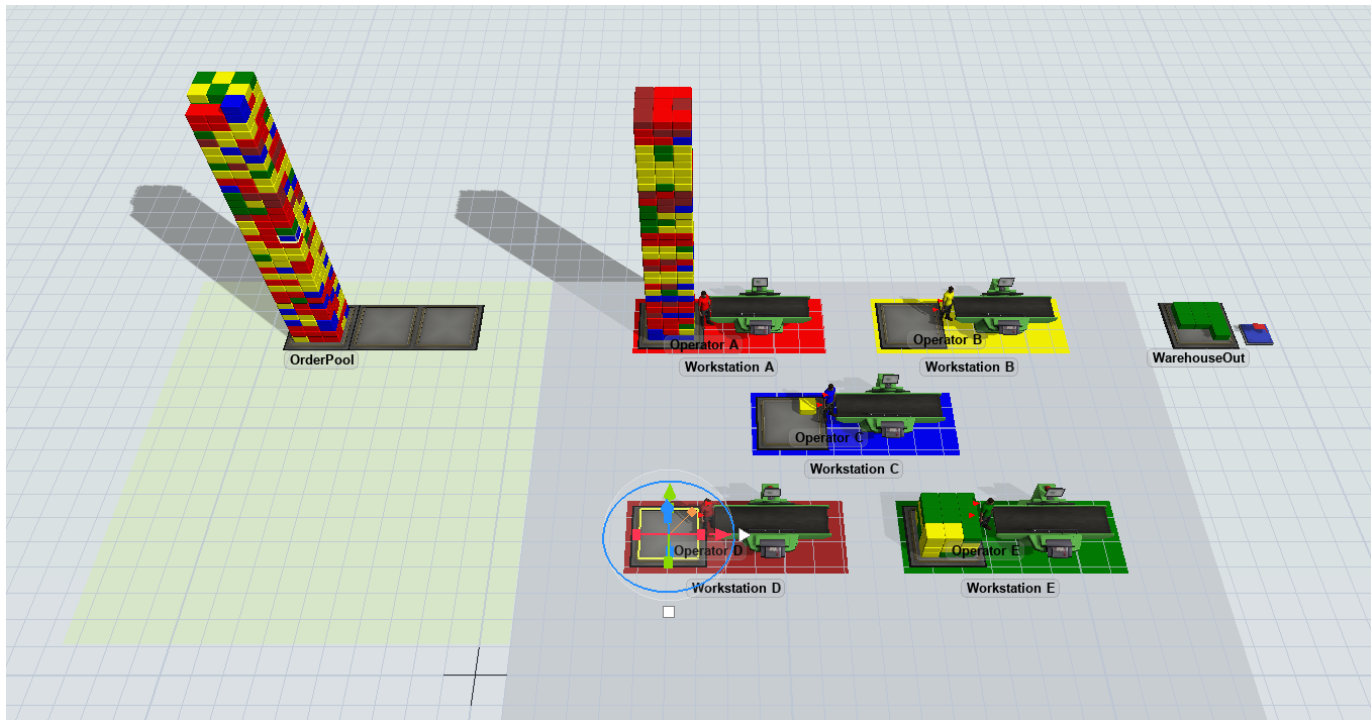
Getting started

Make decisions



Getting started

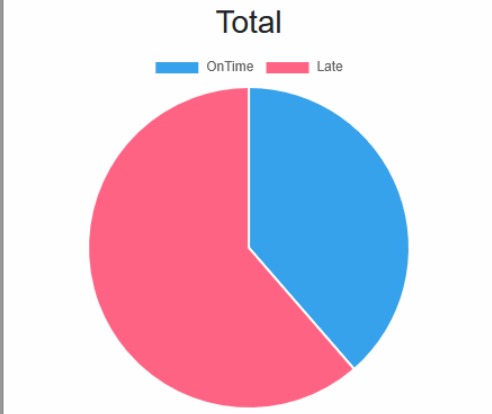
Analyse results and discuss further improvements with the team



WIP



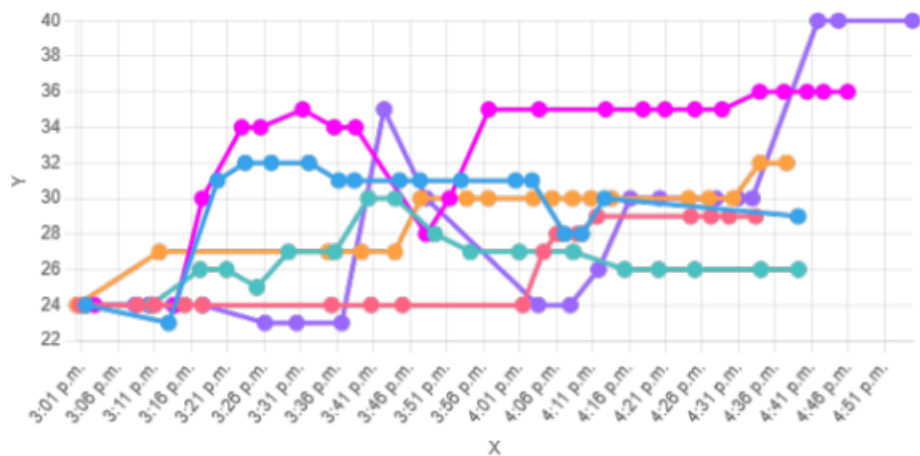
Finished products



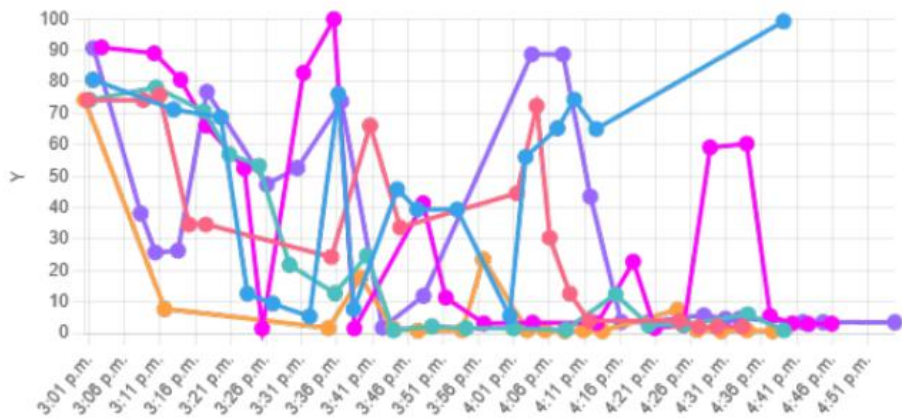
Gamification

Resources

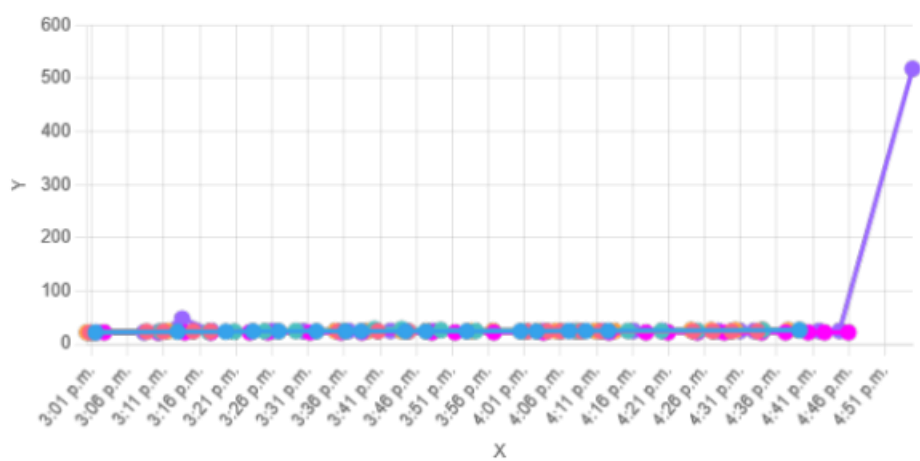
Operators



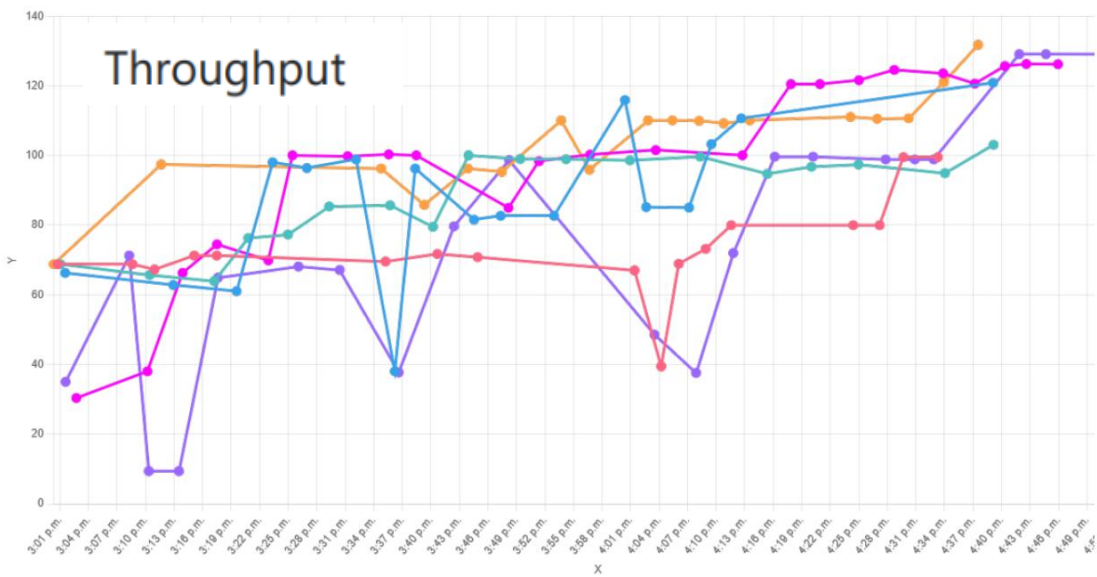
Late inc WIP



Machines



Throughput



Conclusions



Conclusions

Lessons Learned

- Planning framework seems overwhelming at the start, but the step-by-step approach works good
 - Participants are positively surprised that the impact of their choices is that visual and logical
 - The gamification aspect clearly motivates the groups
 - A lot of (interaction between) principles can be illustrated on one company case
-
- There are some “cheat codes” (more resources, longer lead times) → not easy to find a suitable “cost function”
 - The very bad start situation gives big improvements on first actions, but marginal gains in the end
 - Too complex for quick learning $\leftrightarrow$ Not complex enough for a company analysis

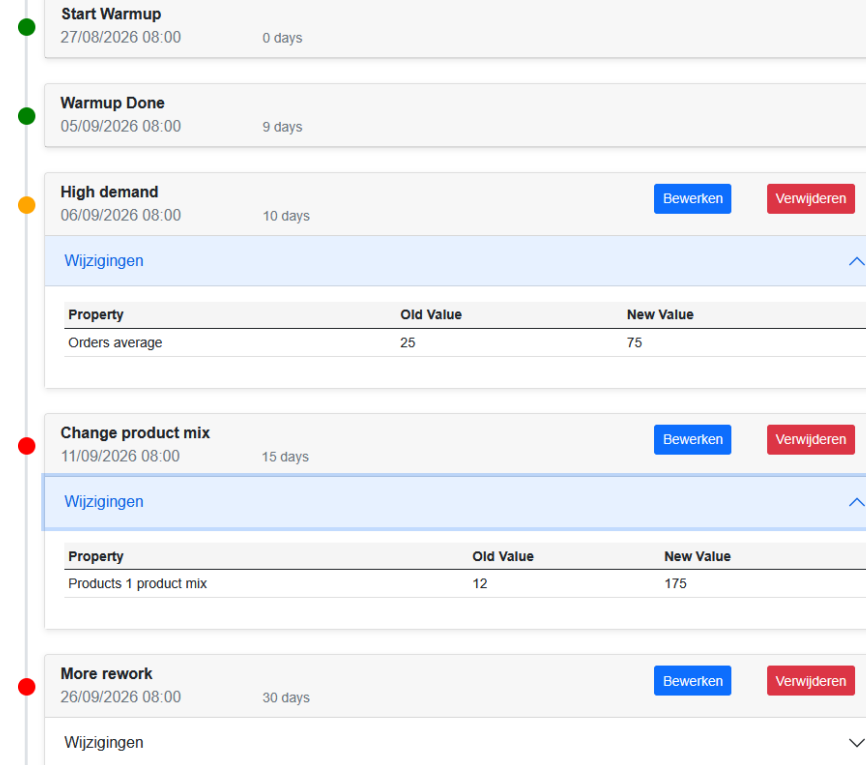
Conclusions

Future work | SCENARIO

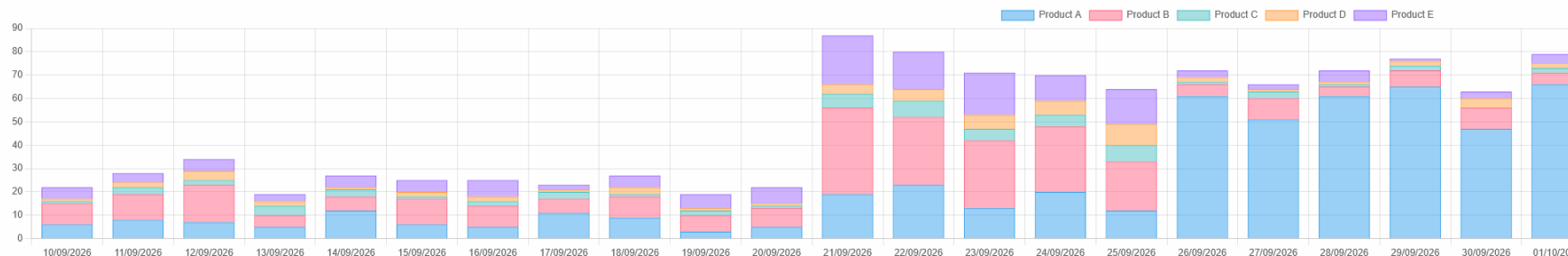
More realistic scenarios to assess (or capture) planning and scheduling knowledge and skills.

- Event based
- Generative AI support

Event Timeline

[Nieuw Event](#)

Created products per day



Conclusions

Future work | ANALYSIS

How to evolve towards an analysis tool for industry?

Sandbox environment to support production managers and schedulers to

1. See the impact of their choices in advance
2. Get an overview of “best” choices they can make and why



THANK YOU FOR YOUR ATTENTION!



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