HUNTSMAN

Enriching lives through innovation

Process Health Monitoring & Parallel Coordinates

TrendLab 2025 – Cologne

Matthijs Geerse
Advanced Analytics Engineer

Huntsman's Global Business Scope

HUNTSMAN
Enriching lives through innovation




$6bn revenue

6,300 associates

60 facilities

25 countries

2024 Revenue

End Markets

Construction & Infrastructure

Industrial and other

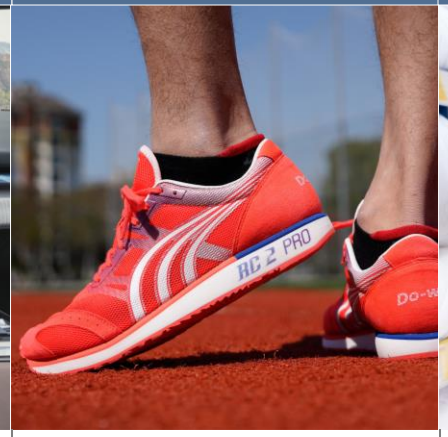
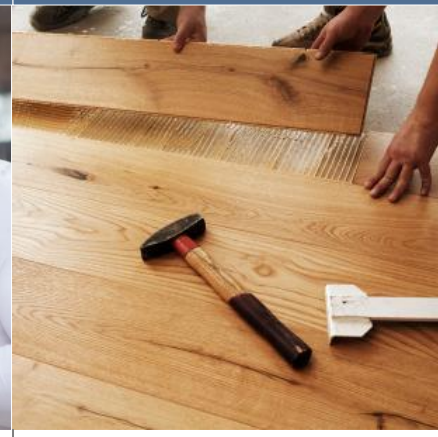
Automotive

Consumer

Aerospace

Our products help address customers' sustainability challenges

HUNTSMAN
Enriching lives through innovation

Insulation	Composite Wood Products	Automotive	Elastomers	Furniture & Bedding	Adhesives & Coatings
					
Energy saving thermal insulation containing TEROL® polyols with up to 60% recycled content Polyol formulated system with up to 20% recycled content or 30% bio-based content	Composite wood products utilizing scrap wood Wood composite resin with up to 25% bio-based content	Interior solutions with up to 25% CO_2 reduction potential compared with incumbent technology EV battery materials, supporting the drive toward electrification Lightweight composites, reducing fuel consumption and extending EVs drive range	Bio-based and recycled content Recyclable* footwear soles Recyclable* TPU core for flooring	Bio-based prepolymers with up to 17% bio content Rebond binders can be used to extend the life cycle of foams by enabling their recyclability	Low/ no solvent added adhesives and coatings Fast curing at ambient or low temperature, helping to reduce energy consumption

* Assuming end of life take-back programs and a recycling ecosystem are in place

Myself & TrendMiner at Huntsman

HUNTSMAN
Enriching lives through innovation

- Advanced Analytics Engineer
- Background in chemical engineering
- Global Excellence Team Digital Manufacturing
  - Process modeling
  - Data science
  - Digital portfolio
  - Process control

- Almost ten years of TrendMiner at Huntsman
- Deployed to six major production sites across three divisions
- Use cases ranging from real-time monitoring to root cause problem solving

HUNTSMAN

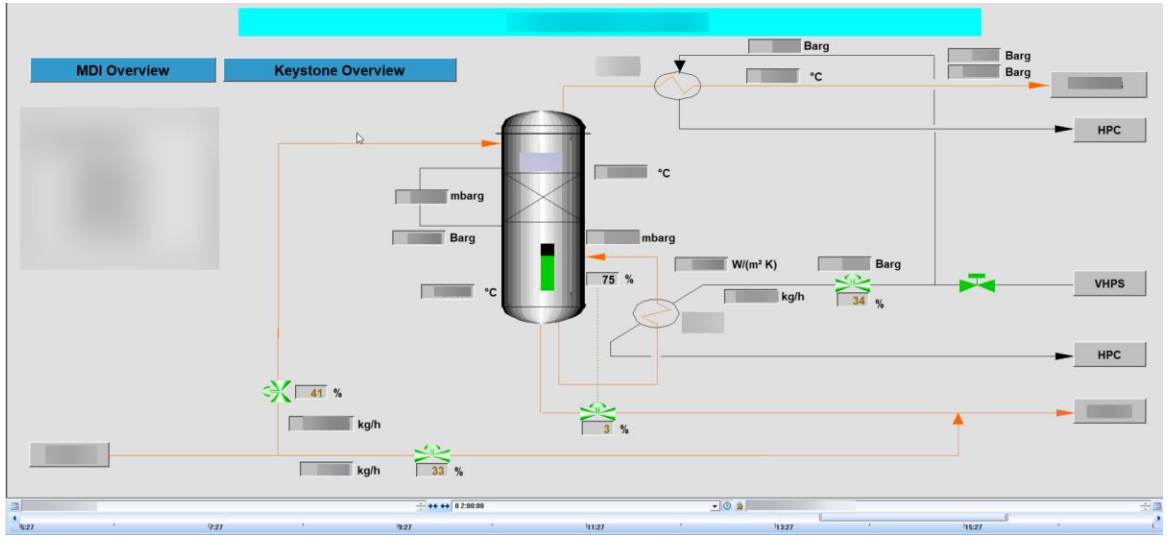
Enriching lives through innovation

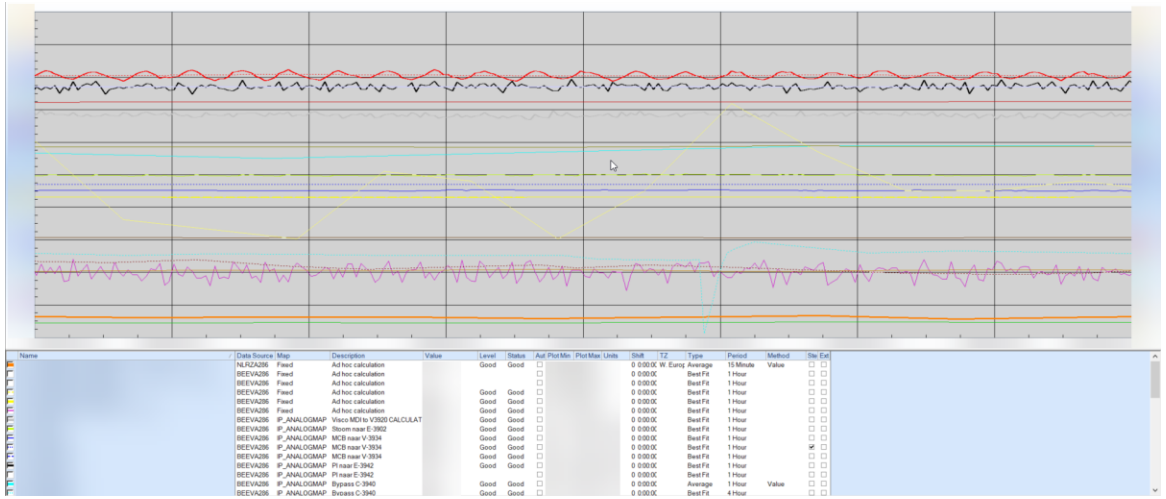
Process Health Monitoring

The Need for Health Monitoring

HUNTSMAN
Enriching lives through innovation

- Key reasons for health monitoring:
  - Prevent unplanned downtime
  - Ensure product quality
  - Predict necessary maintenance
- Historically the process health was assessed in Aspen Process Explorer and Excel sheets
- No common “source of truth” for process health
- Reactive rather than proactive
- Steep learning curve for new hires





Our Approach to Implement Health Monitoring

HUNTSMAN
Enriching lives through innovation

- Experience with monitors and dashboards in Trendminer for batch processes
- Started developing health monitoring dashboards in 2022
- Defined six steps for full implementation on Rotterdam site

01 Involve all operations stakeholders

02 List tags and operating ranges for site areas

03 Define key variables for process health and product quality

04 Create monitors and trends for one area

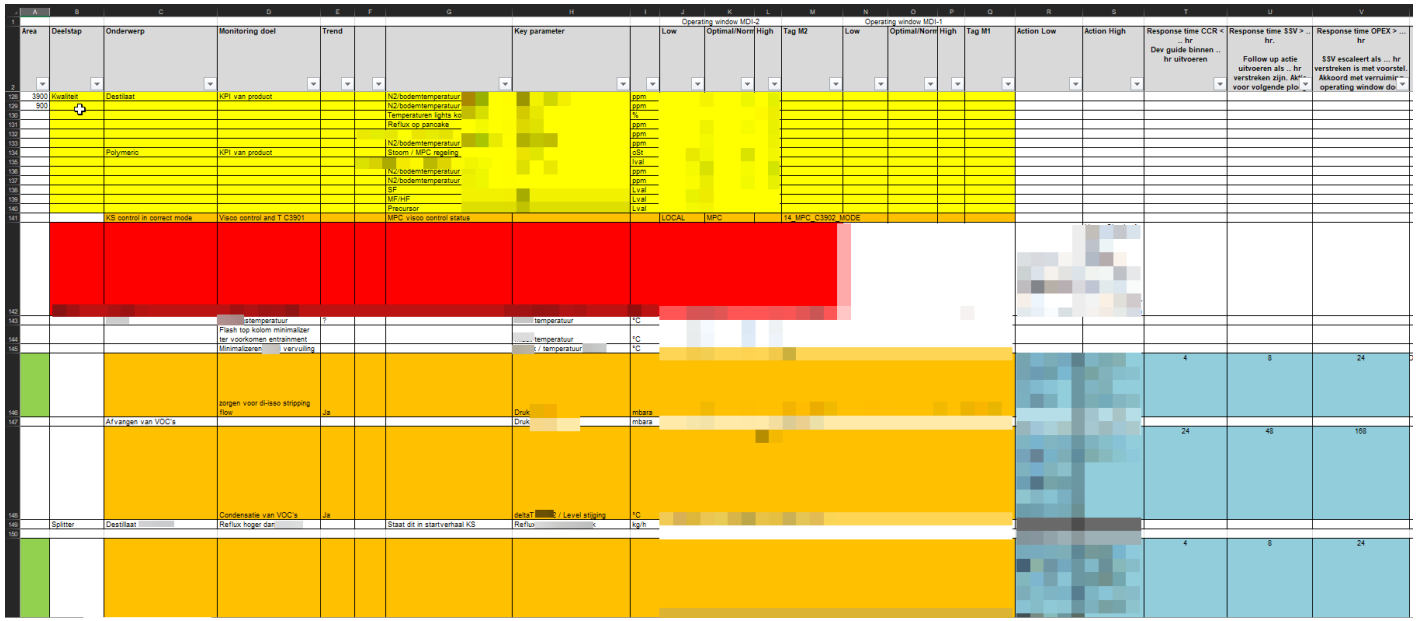
05 Review and design process to integrate in way of working

06 Roll-out to all site areas

Defining Stakeholders and Key Parameters

HUNTSMAN
Enriching lives through innovation

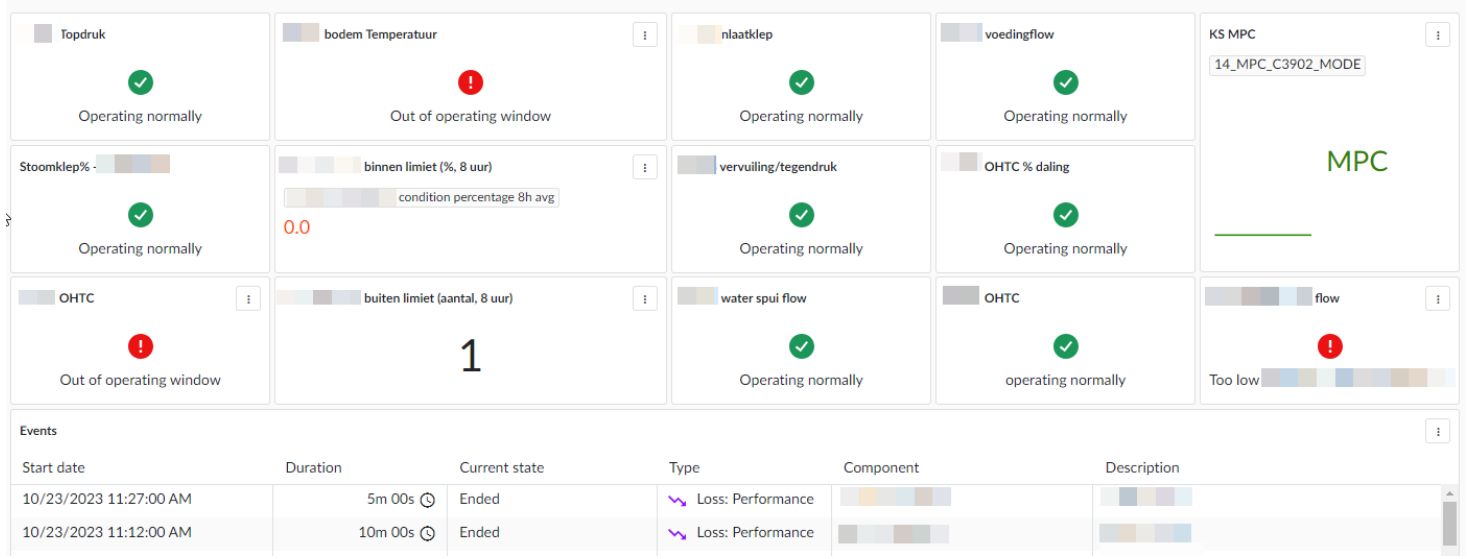
- Thorough process with many questions:
  - Who are our main stakeholders?
  - What are healthy operating conditions?
  - How quickly are we to respond?
  - What does our operating envelope look like?
  - What are acceptable deviations?
  - What quality parameters apply to which products?
- Very valuable and insightful discussions
- Can be applied directly in health monitoring dashboards



Setting up Monitors and Health Dashboards (1/2)

HUNTSMAN
Enriching lives through innovation

- Three levels of dashboards are defined:
  - P1 – traffic lights based on monitors
  - P2 – trends for monitored tags including applied limits
  - P3 – long term trends and indicators for RCPS (root cause problem solving)
- P1 dashboards are used as a starting point to indicate any health issues for specific areas
- Combination of TrendMiner tools:
  - Search, context items and monitoring (value based, operating area)
  - Tag builder (aggregations, formulas)



Setting up Monitors and Health Dashboards (2/2)

HUNTSMAN
Enriching lives through innovation

- P2 dashboards can be used to investigate any deviations found in P1 dashboards
- All P1 monitors have corresponding trends in P2 dashboards
- Easy to navigate using global timeframes
- P3 dashboards not realized yet – to focus on long term indicators

Integration of Health Monitoring in Way of Working

HUNTSMAN
Enriching lives through innovation

- Roughly the P1, P2 and P3 dashboards correspond to three disciplines:
  - Operators and shift supervisors (running the process – short term)
  - Process engineers and area teams (keep the process running – medium term)
  - Global Excellence Team (improve the process – long term)
- Each morning meeting the P1 dashboard is reviewed by the shifts
- Input from health monitoring dashboards is entered in shift logs
- Working process designed to escalate any process health issues

Roll-out to all site areas

HUNTSMAN
Enriching lives through innovation

- Health monitoring dashboards set up for all Rotterdam upstream areas
- Significant amount of work – but working well once fully set up
- Navigation dashboard for quick access
- Next steps:
  - Scale approach to other sites
  - Investigate how context items can be used more efficiently
  - Include downstream areas

P0 Overview Dashboard		
Area 200	P1_200	P2_200
	P1_2200	P2_2200
Area 300	P1_300	P2_300
	P1_2300	P2_2300
Area 400	P1_400	P2_400
	P1_2400	P2_2400
Area 500	P1_500	P2_500
	P1_2500	P2_2500
Area 600	P1_600	P2_600
	P1_2600	P2_2600
Area 700	P1_2700	P2_2700
Area 800	P1_2800	P2_2800
Area 900	P1_900	P2_900
	P1_2900	P2_2900
Keystone	P1_3900_Keystone	P2_3900_Keystone

HUNTSMAN

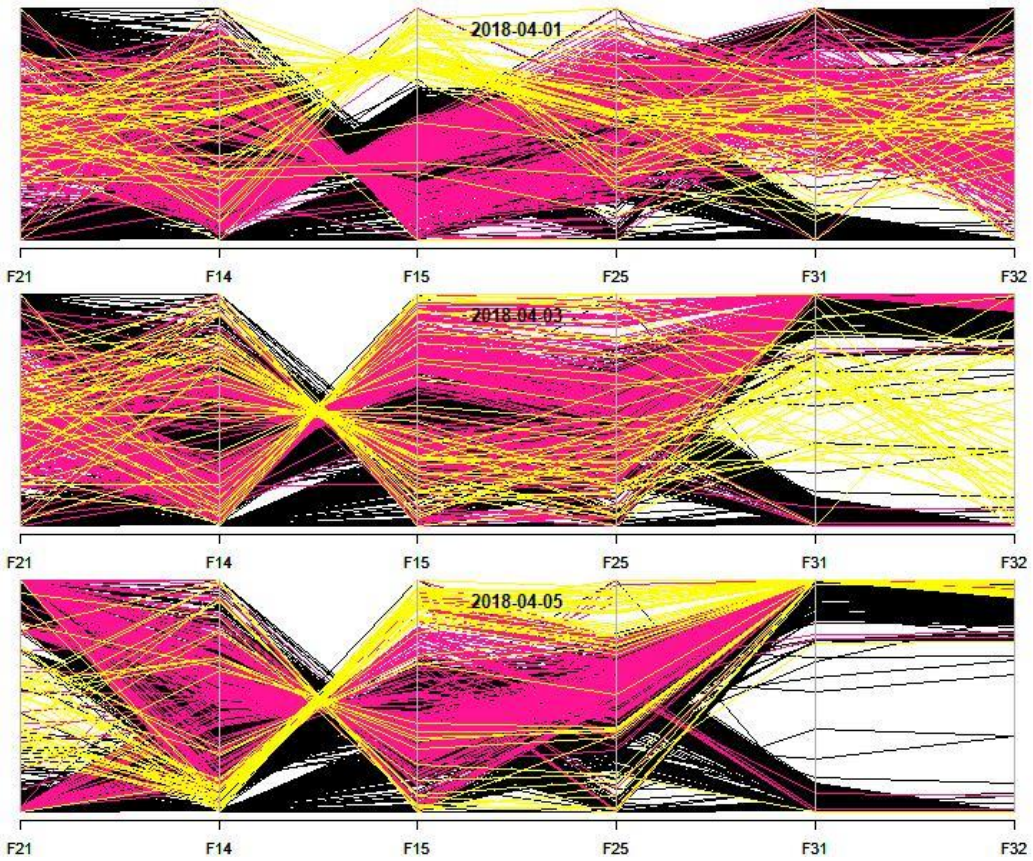
Enriching lives through innovation

Event Analytics with parallel coordinates

Event Analytics – Parallel Coordinates

HUNTSMAN
Enriching lives through innovation

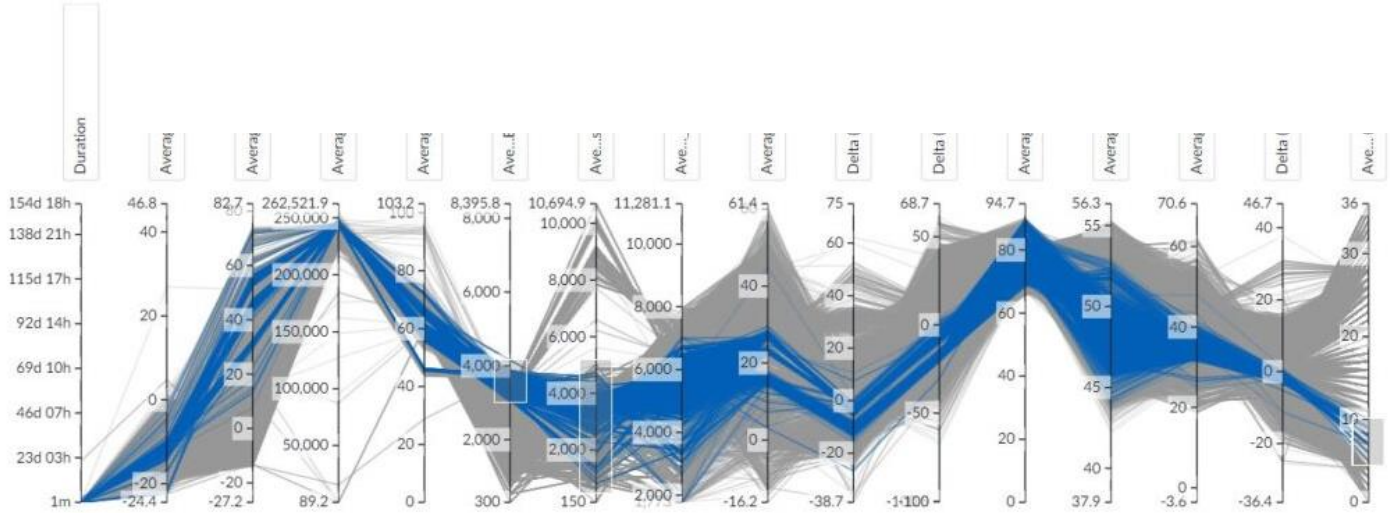
- Experiments with parallel coordinates in R
- Powerful visualization technique, however:
  - User needs coding skills
  - No flexibility to reorder and flip axis
  - Static time series data
- Huntsman advocating for this to be included in TrendMiner
  - Several sessions and design iterations with TrendMiner product team
- Three use cases:
  - Crystallizer performance
  - Batch deviation analysis
  - Low production analysis



Use Case #1 – Crystallizer Performance

HUNTSMAN
Enriching lives through innovation

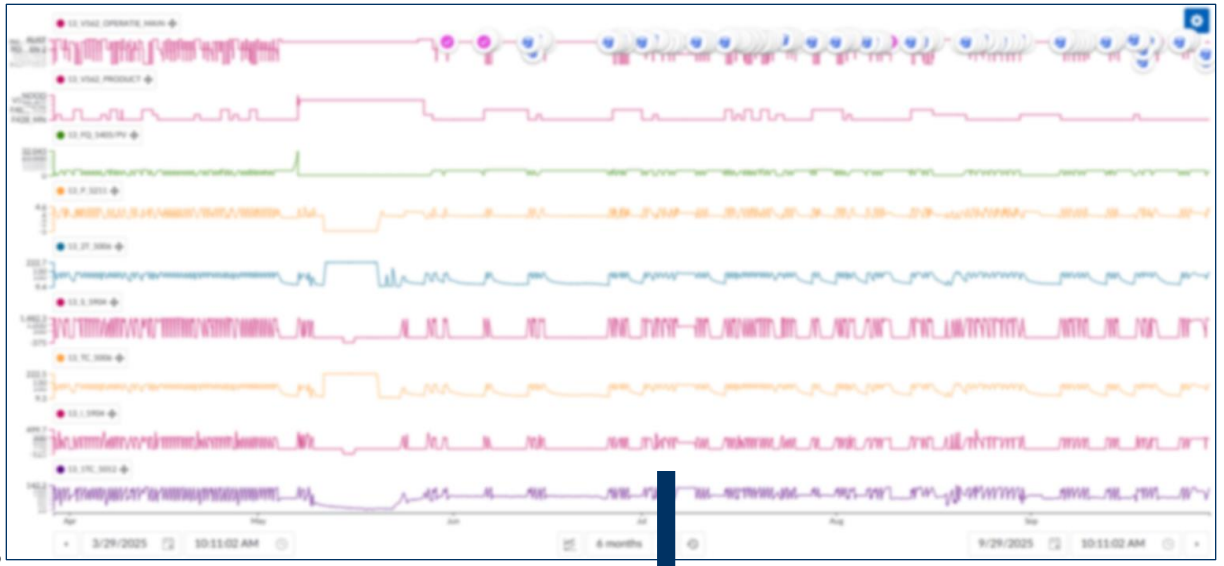
- Lean Six Sigma investigation for underperformance one of the crystallizers
- Selection mechanisms useful to identify how parameters influence each other – visually
- Found that low or high recycle settings have impact on product quality, and how they work through in product quality
- Investigation still on-going – parallel coordinates useful to identify key parameters

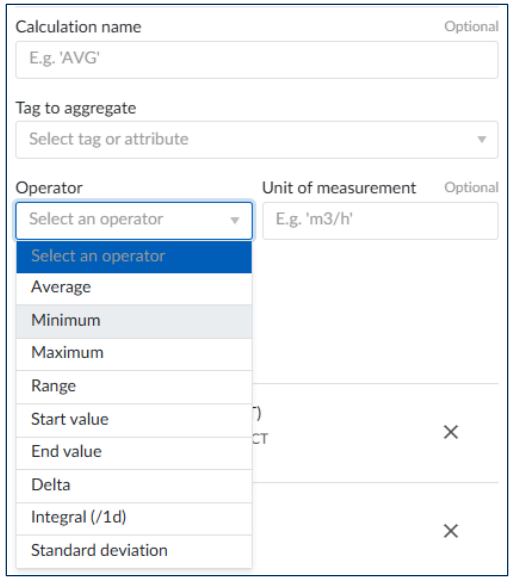


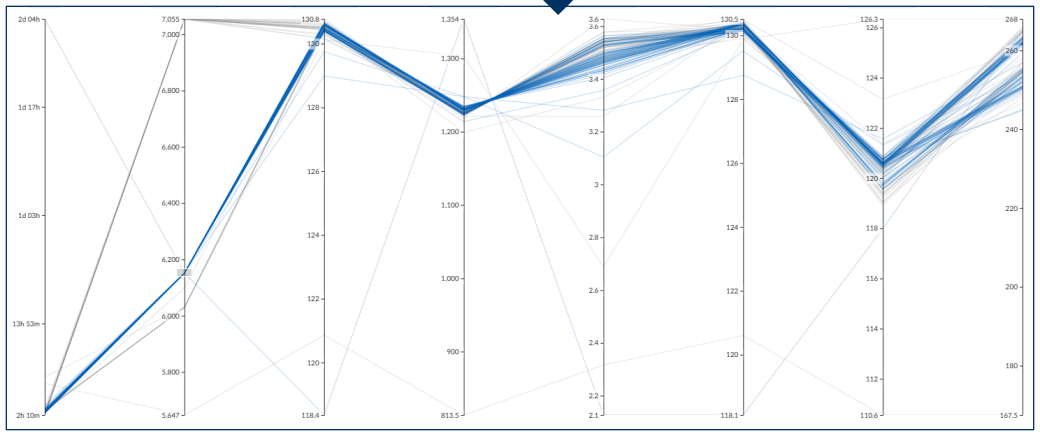
Use Case #2 – Batch Analysis

HUNTSMAN
Enriching lives through innovation

- Tags for batch step and product allow quick deep analysis of batch performance
- Comparative analysis of similar batches is much easier
- Duration of batch steps is part of the search mechanism
- Parallel coordinates allows to quickly validate theories, e.g.:
  - Temperature was higher at start of batch production, leading to lower quality
  - Longer batch step times require more heat input
- Calculation operators very useful and saves lots of time spent in tools like Minitab



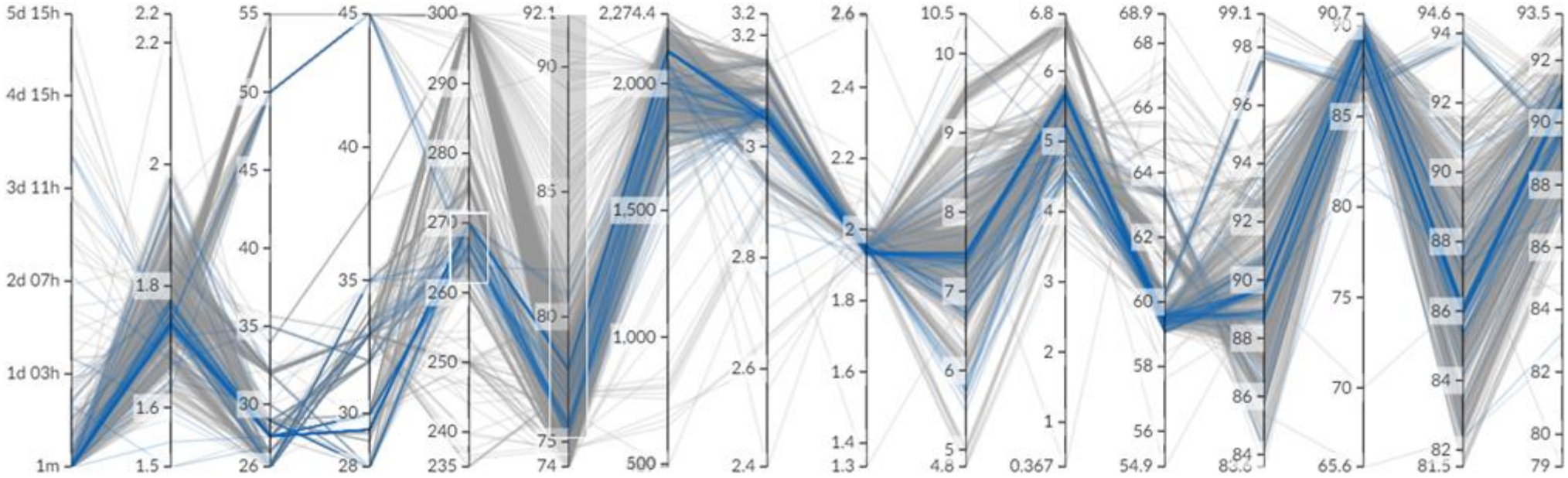




Use Case #3 – Producing at lower rates

HUNTSMAN
Enriching lives through innovation

- Production issue regarding product colour at lower production rates
- Parallel coordinates allows to easily compare historical values at similar production rates
- Filtering can tell which setpoints were used previously to get into the right specifications
- Changing valve setting helped improve the product colour



HUNTSMAN

Enriching lives through innovation

Thank you!

Any questions?