

# Smart scheduling recommender system for process-centric production planning in medium sized enterprises (SRS-4-MSE)

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## Agenda

- Context & challenges
- Conceptual design
- Application & value add

## Context & challenges

- In the Swiss mechanical and electrical engineering industries (MEM), usually ERP modules for scheduling processes based on **heuristics** are applied in the production planning, and often are already **limiting** the production performance in the background
- Production **data** sets nowadays are widely available in ERP/MES (often not yet fully capitalized on), e.g.:

$$A = (a, p, w, n, se, Dm1, Dm2, Ds1, Ds2, set, \dots, tm, ts, cm)$$

*a* Production order number [#]

*p* Product number [#]

*w* Machine number [#]

*n* Lot size of production order *a* [#]

*se* Effective sequence number in production order *a* [#]

*set* Tool set number [#]

*Dm* Time stamp for start (1) and end (2) of machining for product order *a* on machine *w* [dd.mm.yyyy hh:mm:ss.s]

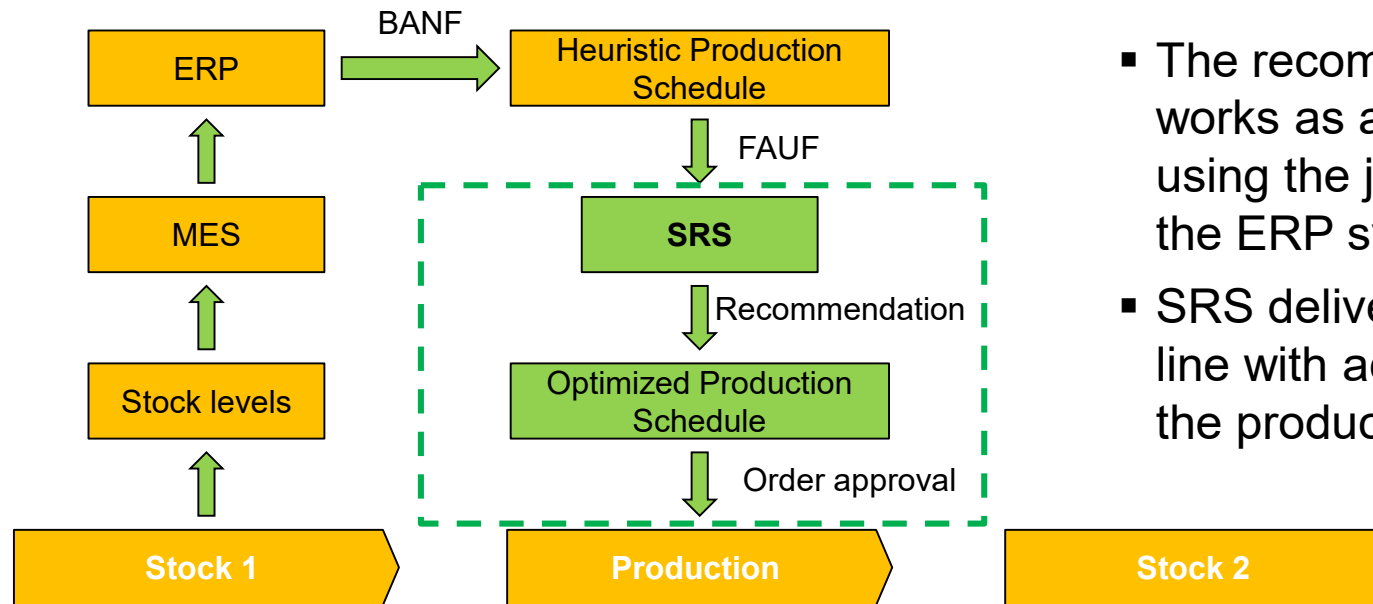
*Ds* Time stamp for start (1) and end (2) of setup for product order *a* on machine *w* [dd.mm.yyyy hh:mm:ss.s]

*tm* Machining time for product *p* on machine *w* [s]

*ts* Setup time for tool for production order *a* on machine *w* [s]

*cm* Machine capacity for product *p* on machine *w* [#s]

## Conceptual solution design



- The recommender system SRS works as an assistant system is using the job order list received from the ERP system
- SRS delivers a production forecast in line with actual capacity limitations of the production system

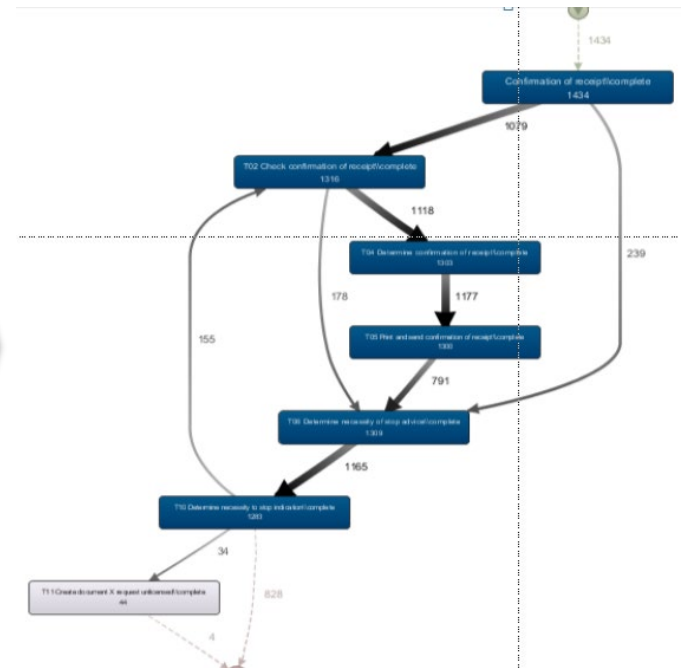
- ▶ The result of this optimization is a process-centric and capacity-optimized production schedule returned to the ERP planning table for final approval by the scheduler
- ▶ Digital twins are virtual models of processes, products and/or services connecting the real world with real data in the virtual rim

# Process Mining algorithms for the analysis of existing event logs

Case ID	Event ID	dd-MM-yyyy:HH.mm	Activity	Resource	Costs
1	35654423	30-12-2010:11.02	register request	Pete	50
1	35654424	31-12-2010:10.06	examine thoroughly	Sue	400
1	35654425	05-01-2011:15.12	check ticket	Mike	100
1	35654426	06-01-2011:11.18	decide	Sara	200
1	35654427	07-01-2011:14.24	reject request	Pete	200
2	35654483	30-12-2010:11.32	register request	Mike	50
2	35654485	30-12-2010:12.12	check ticket	Mike	100
2	35654487	30-12-2010:14.16	examine casually	Sean	400
2	35654488	05-01-2011:11.22	decide	Sara	200
2	35654489	08-01-2011:12.05	pay compensation	Ellen	200
3	35654521	30-12-2010:14.32	register request	Pete	50
3	35654522	30-12-2010:15.06	examine casually	Mike	400
3	35654524	30-12-2010:16.34	check ticket	Ellen	100
3	35654525	06-01-2011:09.18	decide	Sara	200
3	35654526	06-01-2011:12.18	reinitiate request	Sara	200

Event logs:

- Case ID
- Time stamp
- Activity
- Attributes



- Existing event logs from ERP and/or MES are used for the offline process mining analysis
- Process mining algorithms deliver the granular and linked production process data, e.g. sequences, capacities, lead times
- Process-centric scheduling is combining process mining and process forecasting in a recommender system, e.g. based on the digital twin

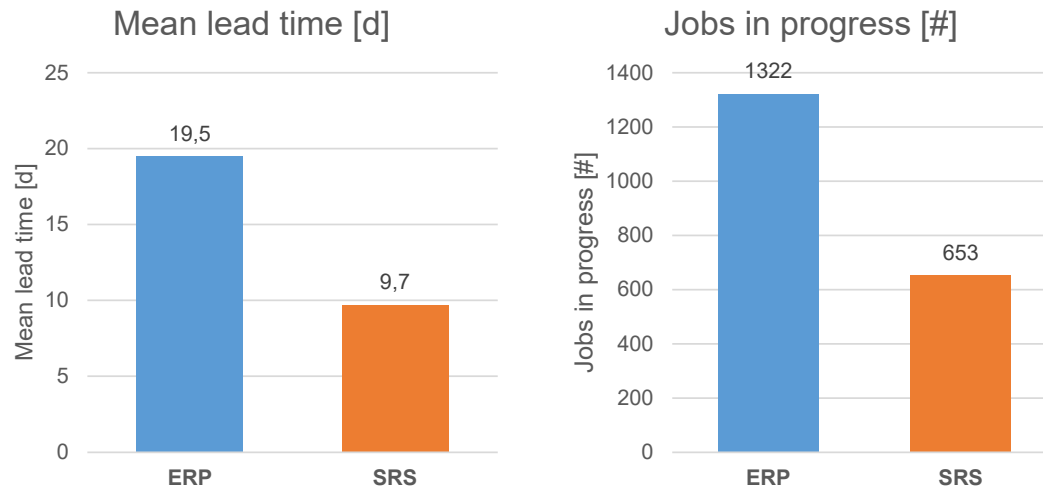
Source: Process Mining Freeware Disco (Demo-Version Sandbox); www.fluxion.com.

## Application & value add: data set for prove of concept (PoC)

Production process KPIs	Dataset
Events, data logs [#]	332'276
Cases, work orders [#]	44'324
Activities [#]	90
Av. # of activities/case [#]	5.5
Process variants [#]	6'158

- Powerful combination of process mining and process simulation algorithms
  - The core of the smart recommender system (SRS) is the process-centric digital twins using current product process data, and current machine capacity data
- The analyzed MEM company's operates by **MTS** (> 95%)
  - The production data set does reflect the existing job order of the SAP planning table, based on the stock level driven SAP demand forecast
  - The data set was collected over a production period of 22 months with:
    - 332'276 production event records
    - 44'324 production orders and
    - 90 different capacity positions
    - 5.5 activities per case on average
  - 6'158 different product processes have been identified with process mining analysis performed with "**Discovery**" from [www.fluxicon.com](http://www.fluxicon.com)

## Application & value add: achieved process improvements



- Proof-of-concept with significant improved average lead times at the constant machine capacity utilization, e.g. based on the ERP scheduling process:
  - Average lead time of 19.5 days per job down to 9.7 days per job (reduction by 50.2%)
  - 1'322 Jobs in progress (reduction by 50.6%) down to 653 Jobs in progress down to (reduction by 50.6%)

- ▶ Enabler for optimization of the scheduling process supported by the assistant system SRS to reduce lead times with the application of the digital twin as a precise model of the production system
- ▶ The smart scheduling recommender system SRS delivers the relevant elements for process-centric production planning, scheduling and forecasting by effectively and efficiently assisting schedulers handling complex production processes

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Source: IBE, FHNW (2021)