WACKER

CREATING TOMORROW`S SOLUTIONS

How Process Mining Complements Productivity Management at WACKER

Wacker Chemie at Process Mining Camp 2021

How often have you already had contact with Wacker products TODAY?

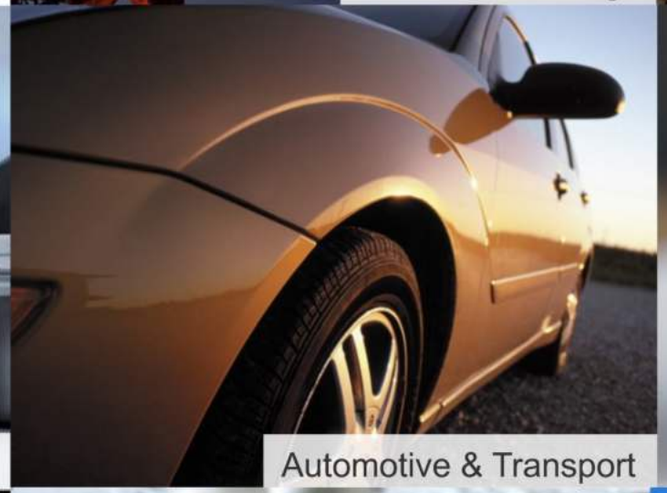

Sealants


Industrial Coatings


Textile, Leather & Nonwovens


Lithium-Ion Batteries


Electromobility


Automotive & Transport


Pharmaceuticals


Construction


Construction

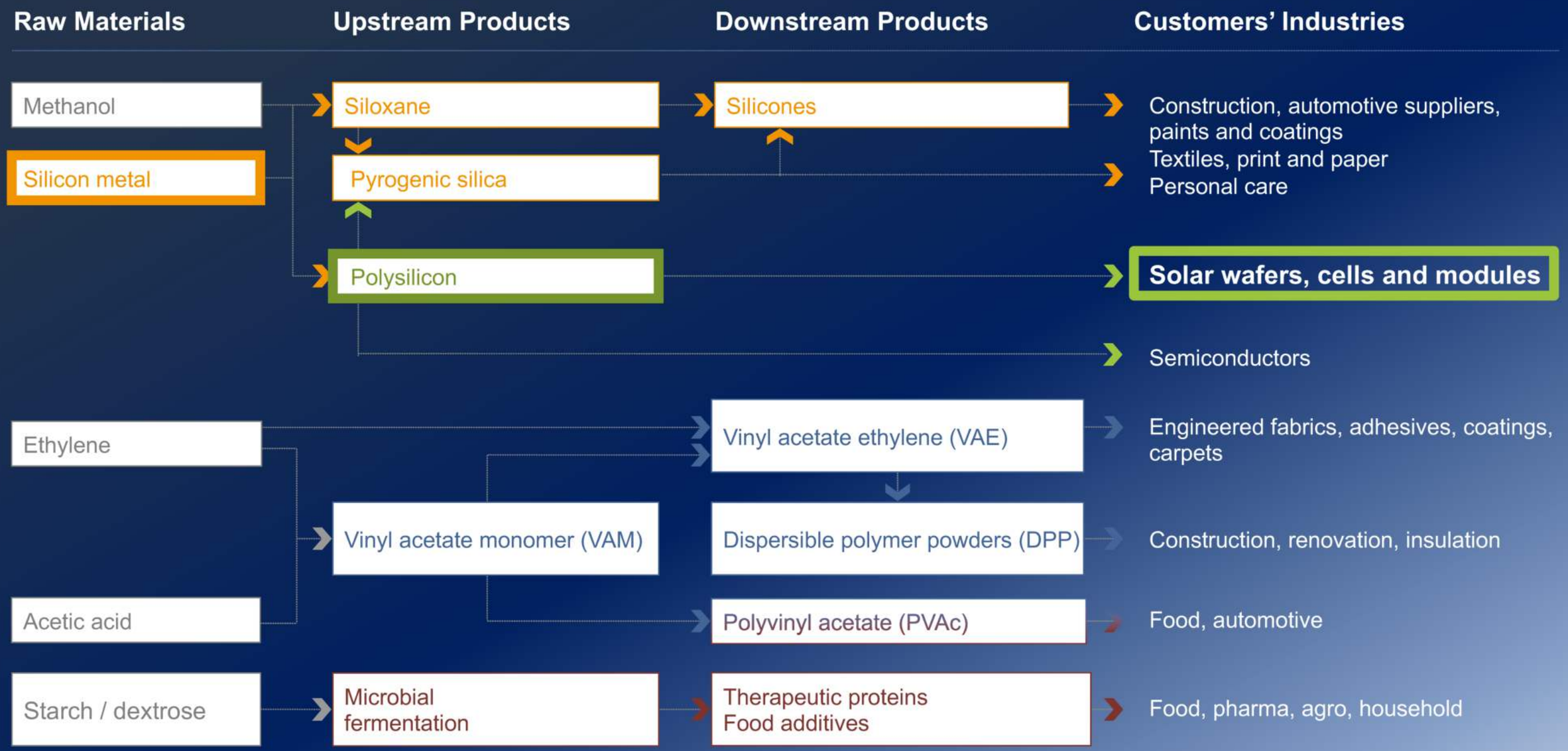

Gum


Agriculture


Food Supplements

DR. ALEXANDER WACKER

GESELLSCHAFT FÜR ELEKTROCHEMISCHE INDUSTRIE G.M.B.H.


Raw Materials
Upstream Products
Downstream Products
Customers' Industries
Methanol
Silicon metal
Siloxane
Pyrogenic silica
Polysilicon
Silicones
Construction, automotive suppliers, paints and coatings
Textiles, print and paper
Personal care
Solar wafers, cells and modules
Semiconductors
Ethylene
Acetic acid
Vinyl acetate monomer (VAM)
Vinyl acetate ethylene (VAE)
Dispersible polymer powders (DPP)
Polyvinyl acetate (PVAc)
Engineered fabrics, adhesives, coatings, carpets
Construction, renovation, insulation
Food, automotive
Starch / dextrose
Microbial fermentation
Therapeutic proteins
Food additives
Food, pharma, agro, household

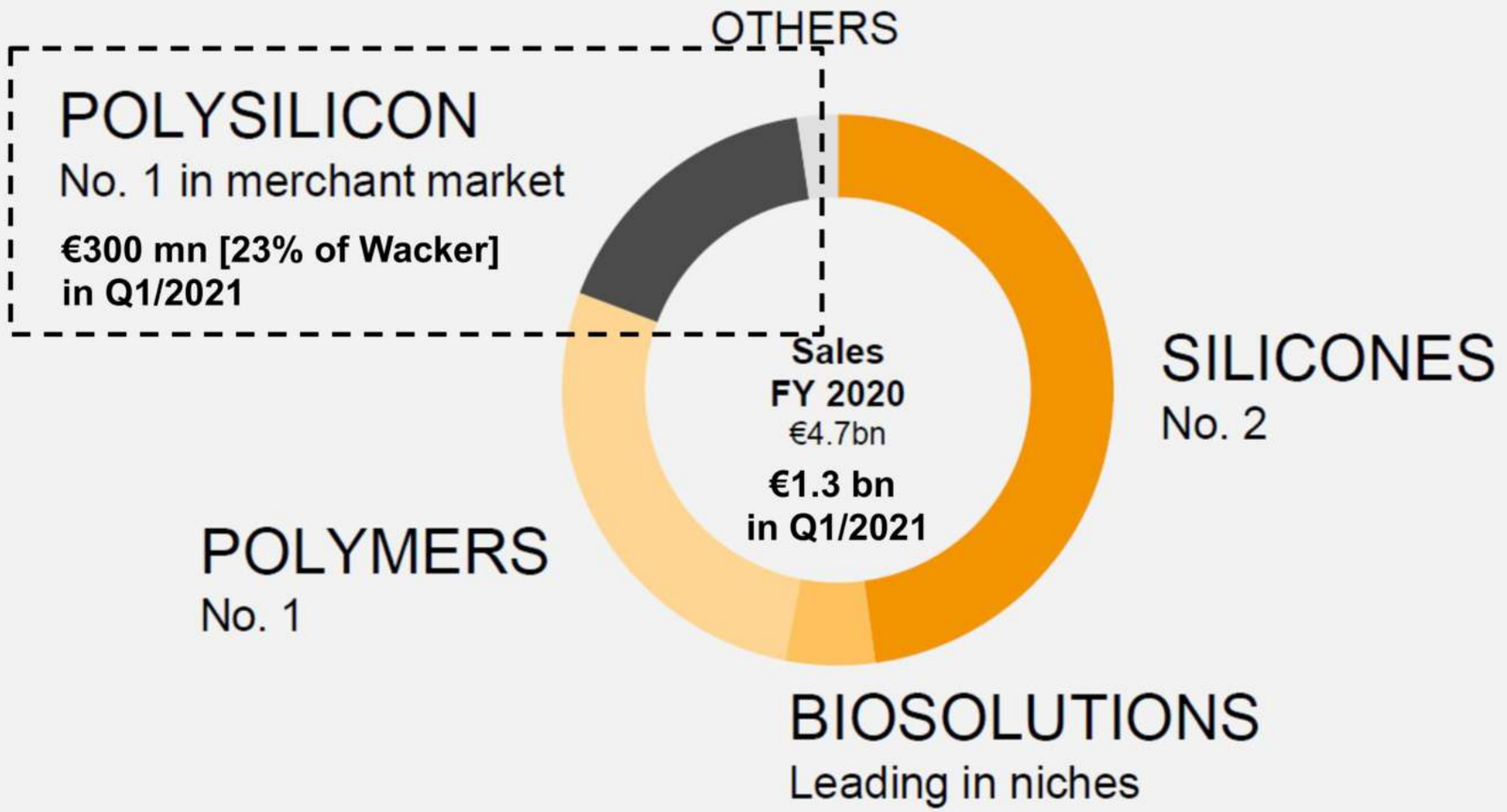
Our Search for Insights Led Us to…

… the Process Mining Camp in Eindhoven 2017

WACKER

CREATING TOMORROW'S SOLUTIONS

The Polysilicon Division

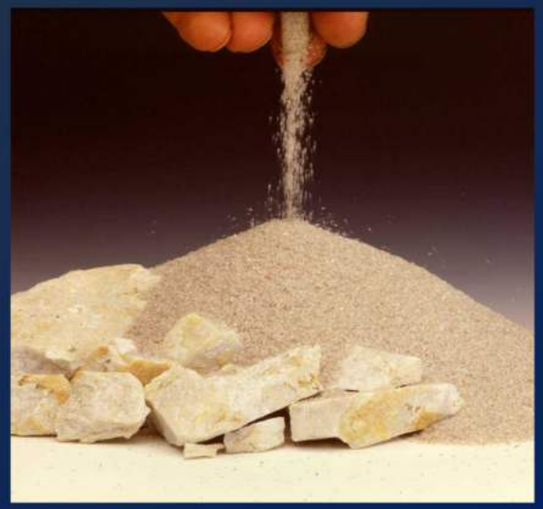

OTHERS
POLYSILICON
No. 1 in merchant market
€300 mn [23% of Wacker]
in Q1/2021
Sales
FY 2020
€4.7bn
€1.3 bn
in Q1/2021
SILICONES
No. 2
POLYMERS
No. 1
BIOSOLUTIONS
Leading in niches

Office Locations, Sites and Nameplate Capacities*

* in metric tons per year

United States

Silicon – 2nd Most Abundant Element in the Earth‘s Crust (26%)



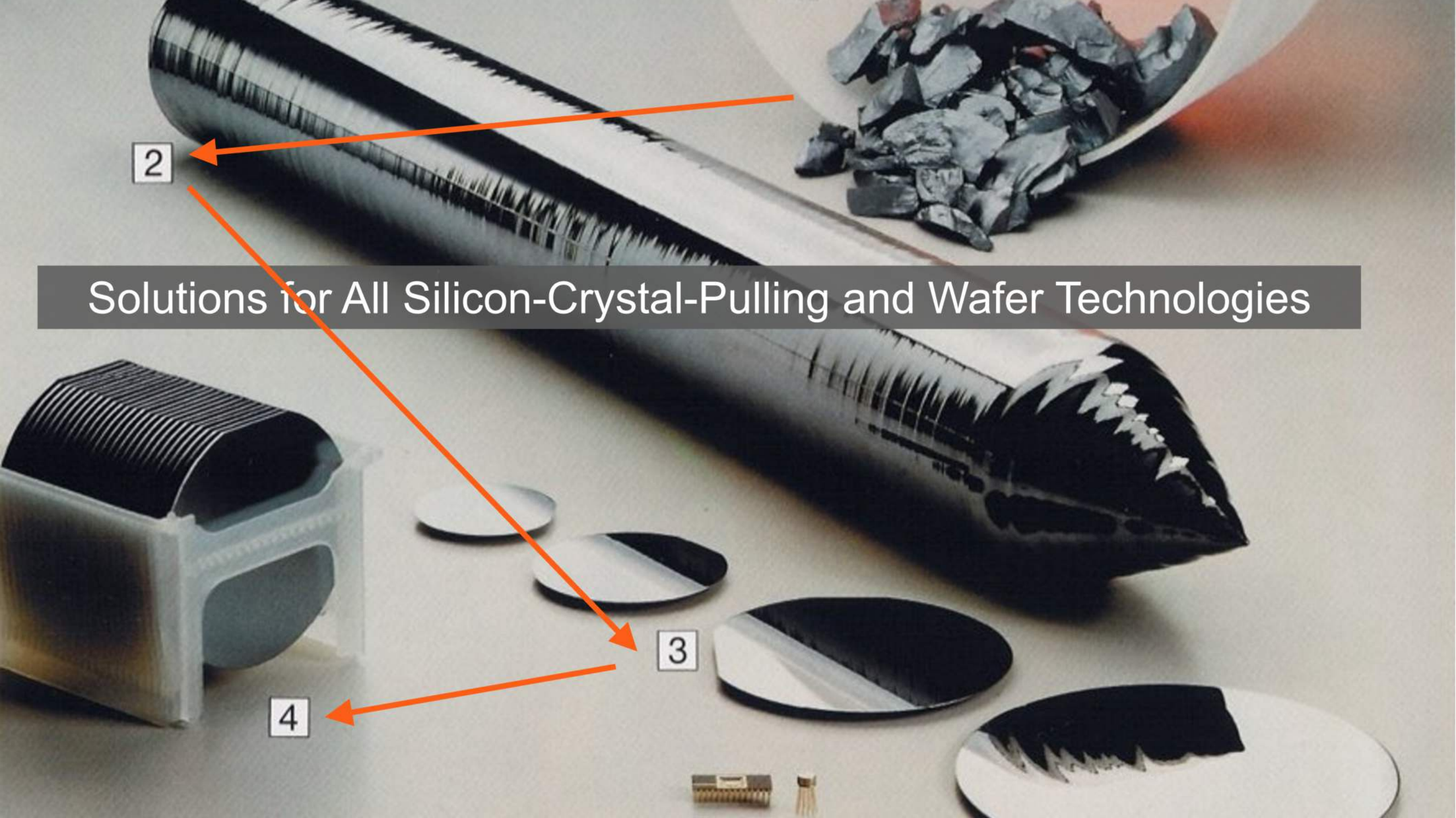
Quartz (SiO_2)

Si-Metal

Polysilicon

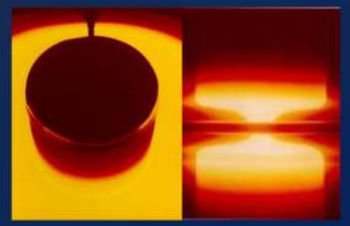

2
Solutions for All Silicon-Crystal-Pulling and Wafer Technologies
3
4

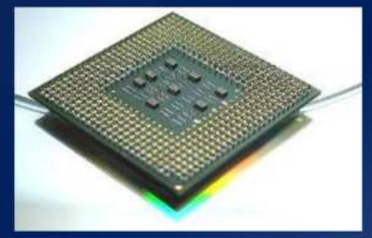
Solutions for All Silicon-Crystal-Pulling and Wafer Technologies


2
Solutions for All Silicon-Crystal-Pulling and Wafer Technologies
3
4

Polysilicon: Starting Point of the …

… Electronic
Value Chain

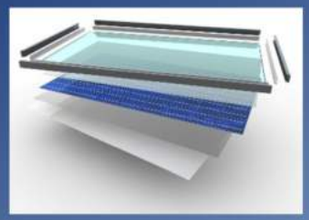



Polysilicon → **Ingot** → **Wafer** → **Device "Chip"** → **Electronics**

… Key Raw Material
for > 90% of all
Solar Systems

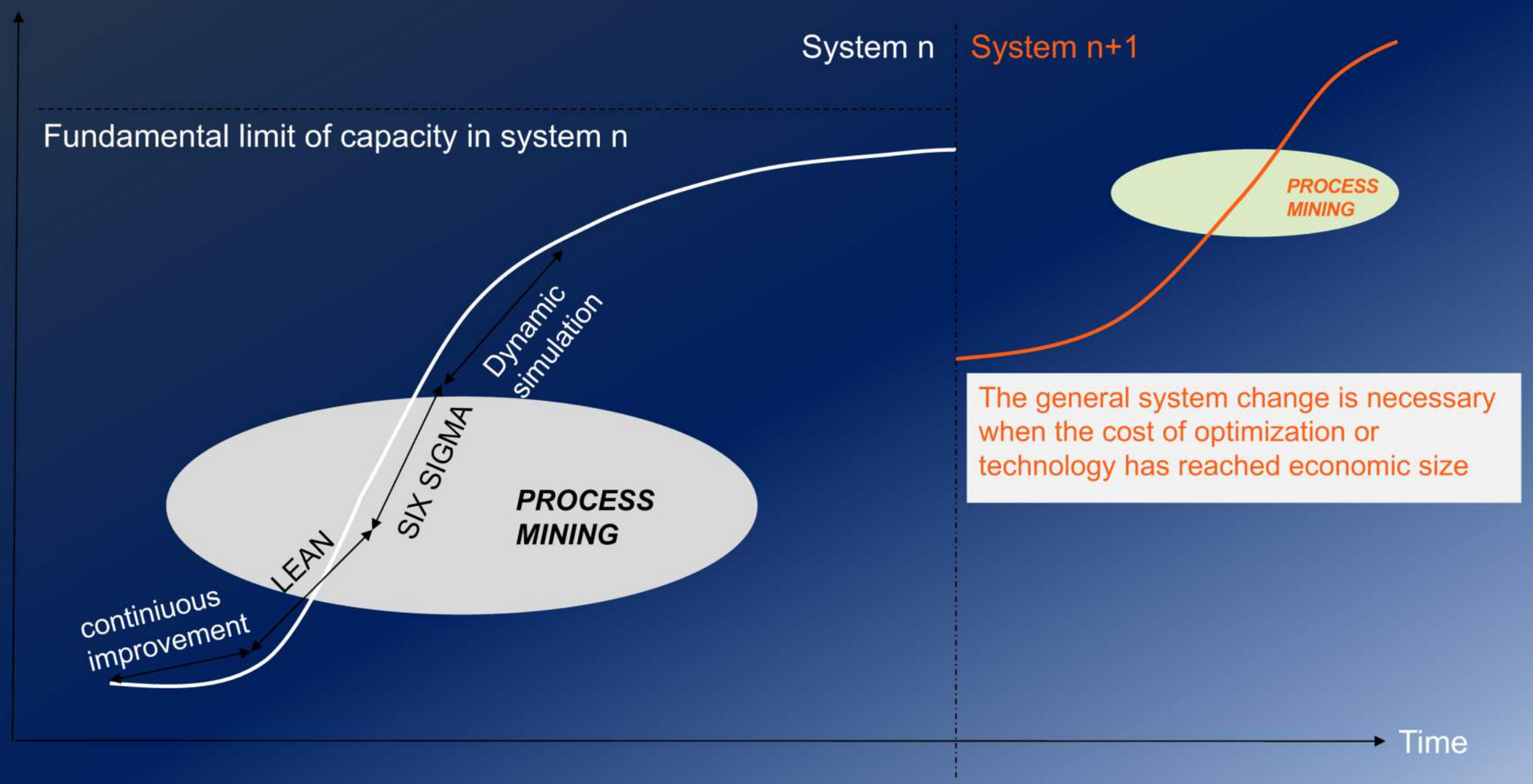







Ingot → **Wafer** → **Cell** → **Module** → **System**

Productivity Management

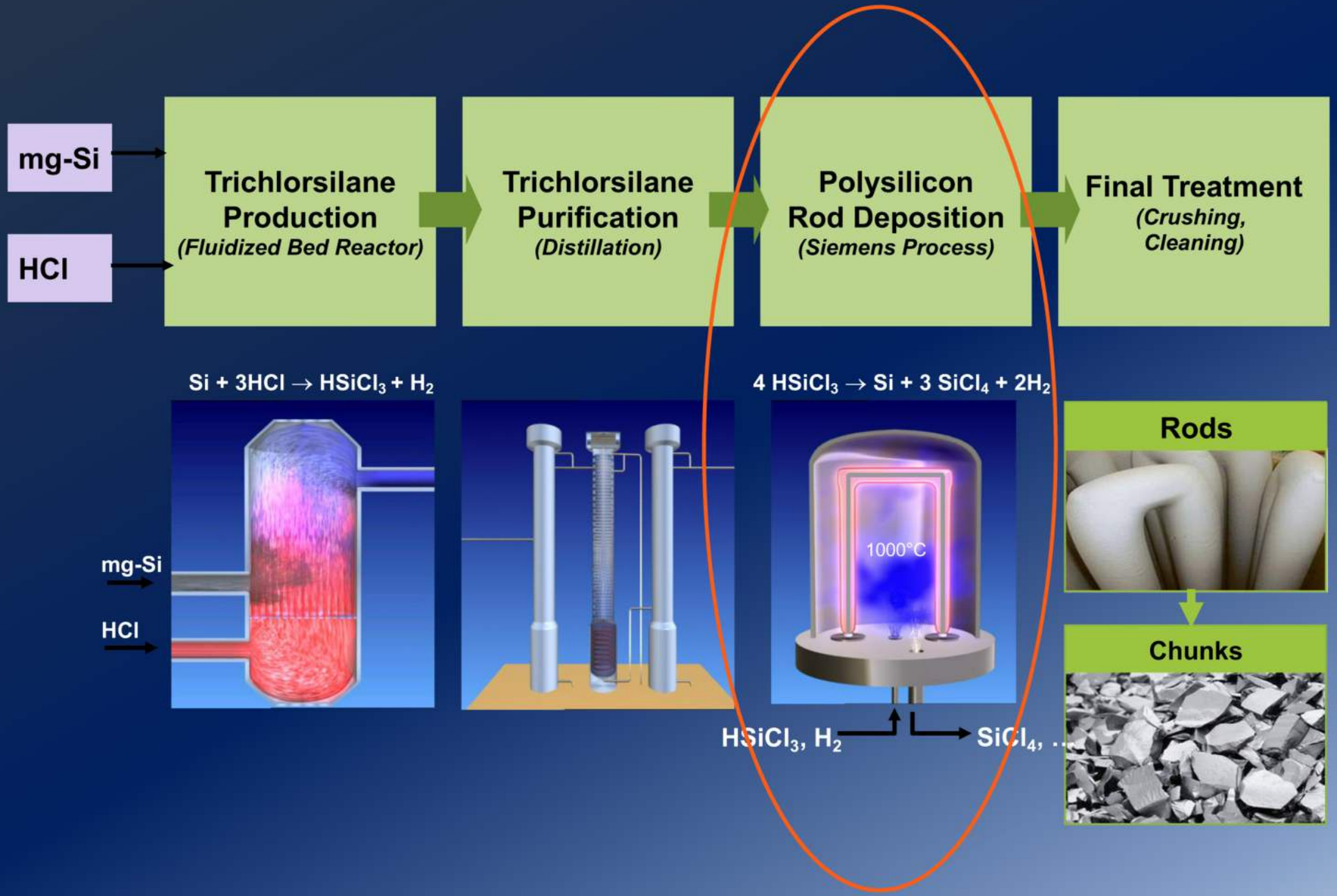


The general system change is necessary when the cost of optimization or technology has reached economic size

- First Example:

  Poly Deposition

Polysilicon Production Is a Four Step Purification Process

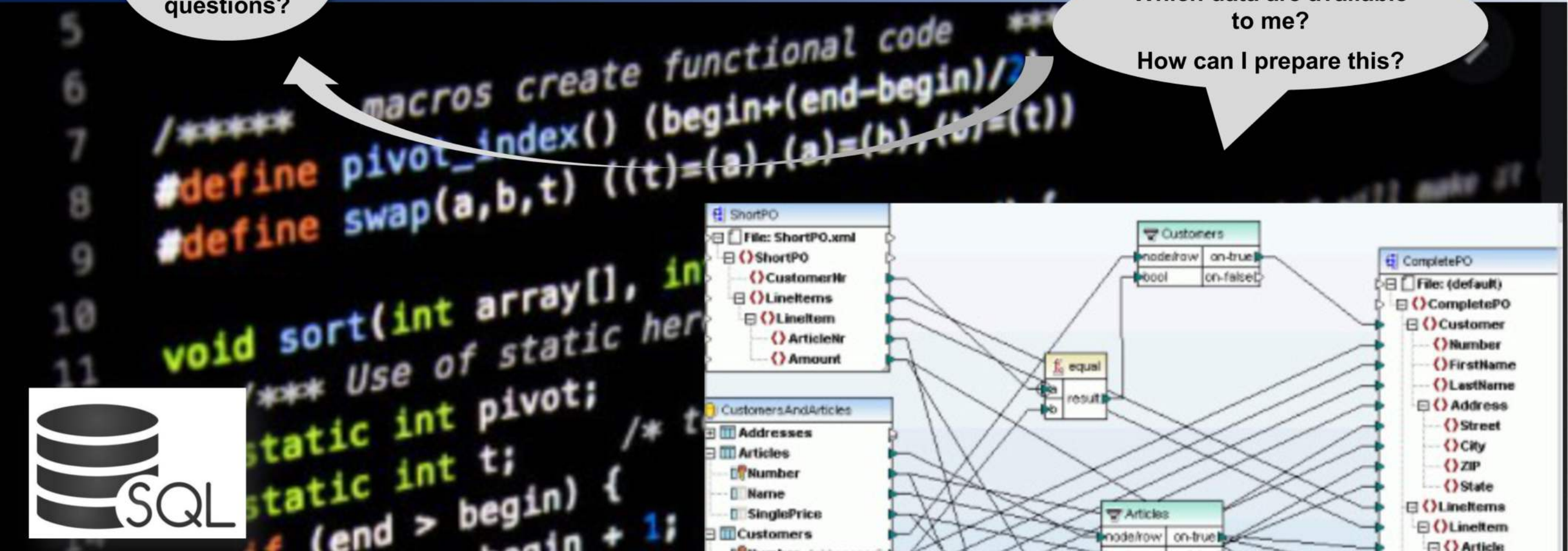


Define | Measure | Analyse | Improve | Control

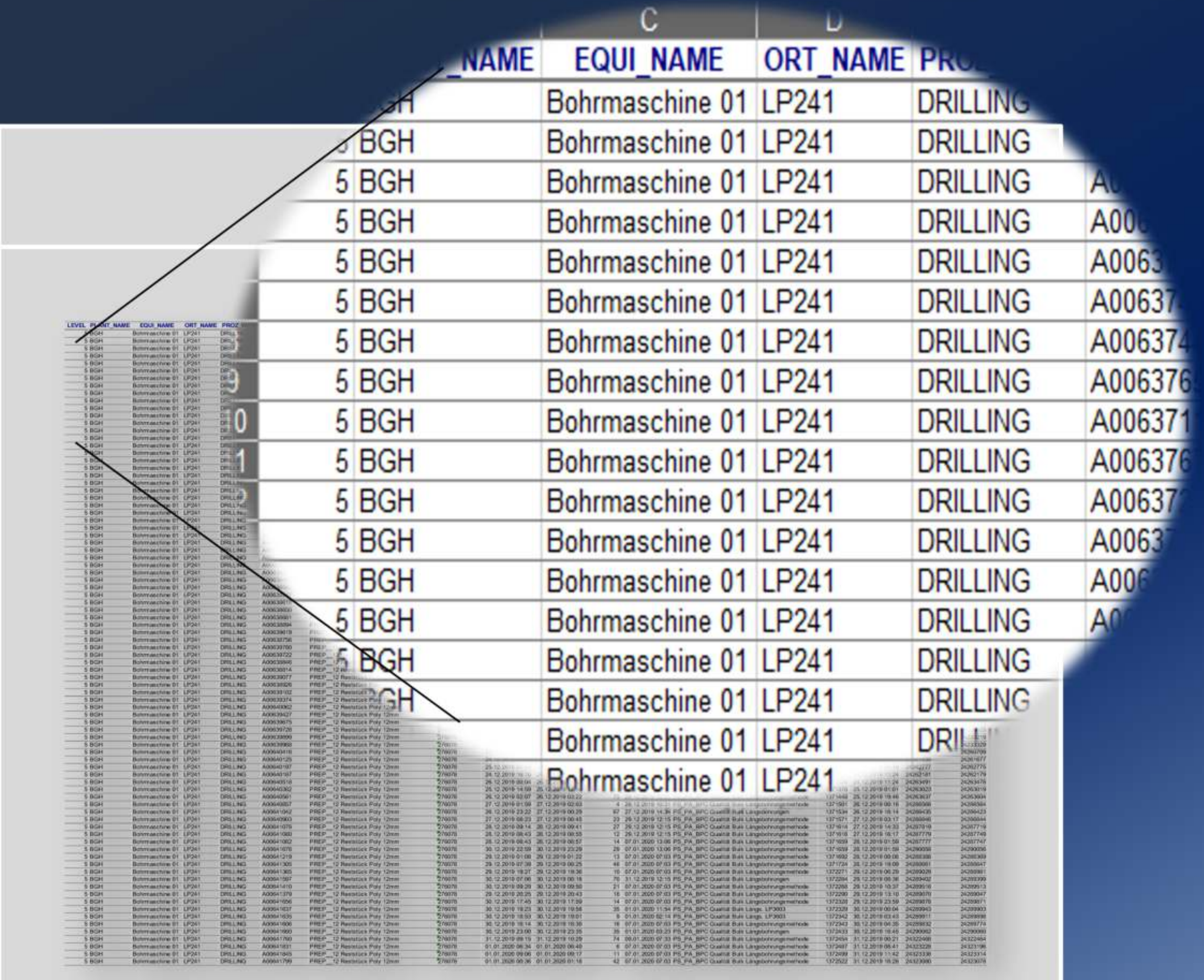
What are the questions?

Which data are available to me?

How can I prepare this?



Define | **Measure** | **Analyse** | Improve | Control

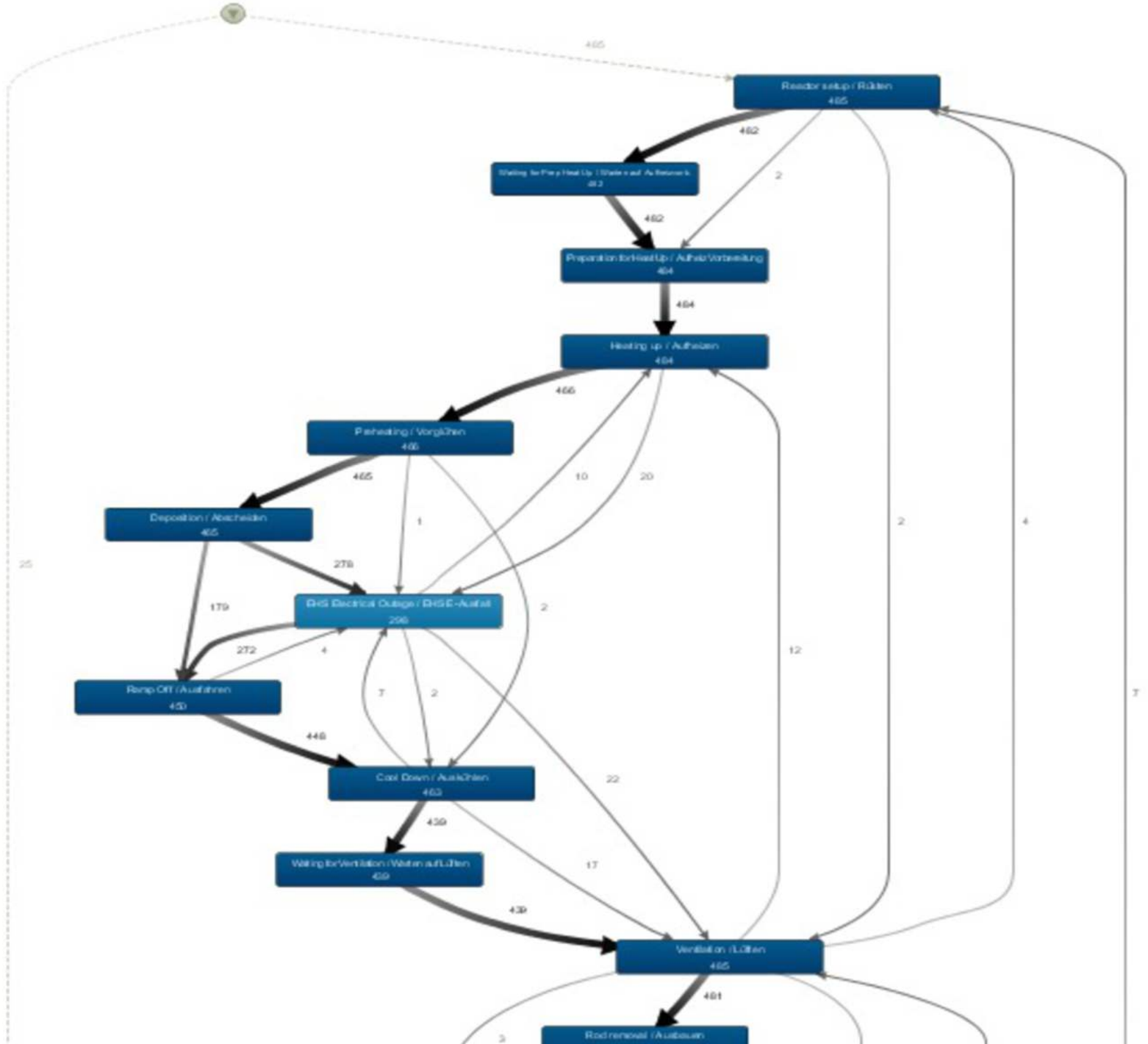


How can I condense the data?

PSTPT A_d Stab (T A) Poly	PSTPT A12z Stab Mono gezogen (T A)	PT A ROH Roh Poly T A	PT AMI_06z T A Mono Impfling 6mm gezoge	PT AP_RE Roh Poly T A Rest
22263	739490			
	82902		7984	7984
		1		
		7		
	11051		5794	5820
		11		
		11		
		273		
	27781		10914	

How are the connections?

New View on Process: PROCESS MAP

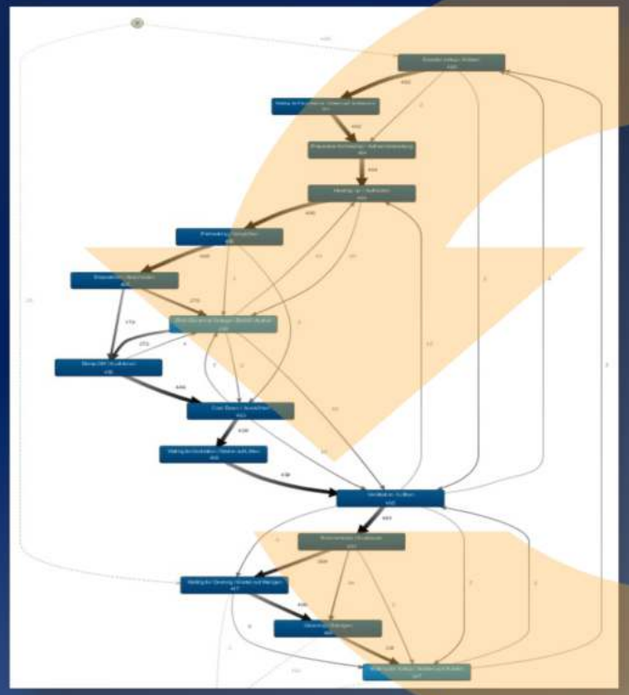


Define ✓ → Measure ✓ → Analyse → Improve → Control

(1) Data basis fixed

(2) Transparency with mining

(3) Detailed analyses using statistics



Different Disciplines Needed for a Process Mining Project

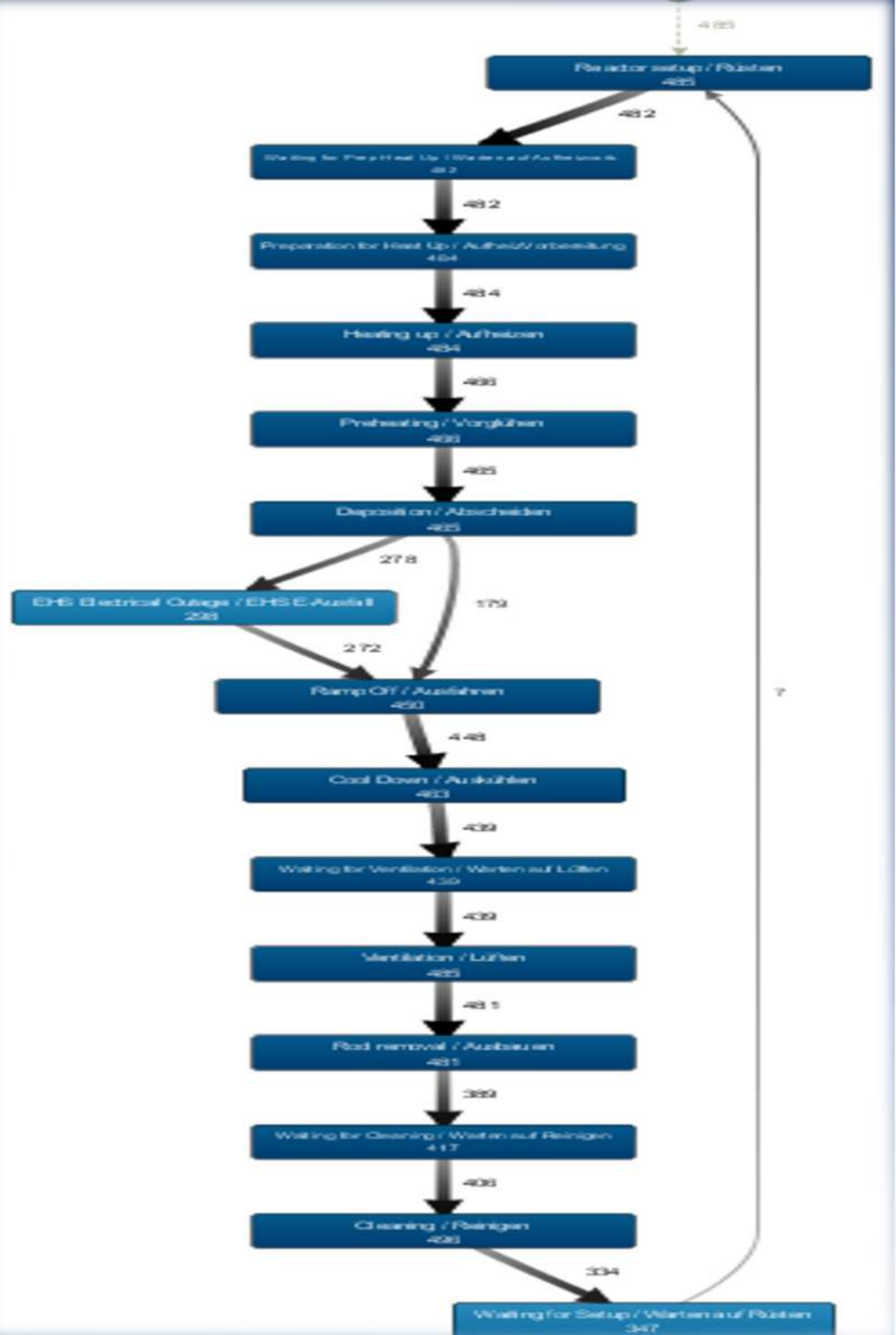
Polysilicon Deposition Process

Task:

Where do the different outputs of the individual **Deposition halls** come from?

Situation:

The 16 main process steps of all systems worldwide are selected from the DB over 24 months and analyzed with process mining

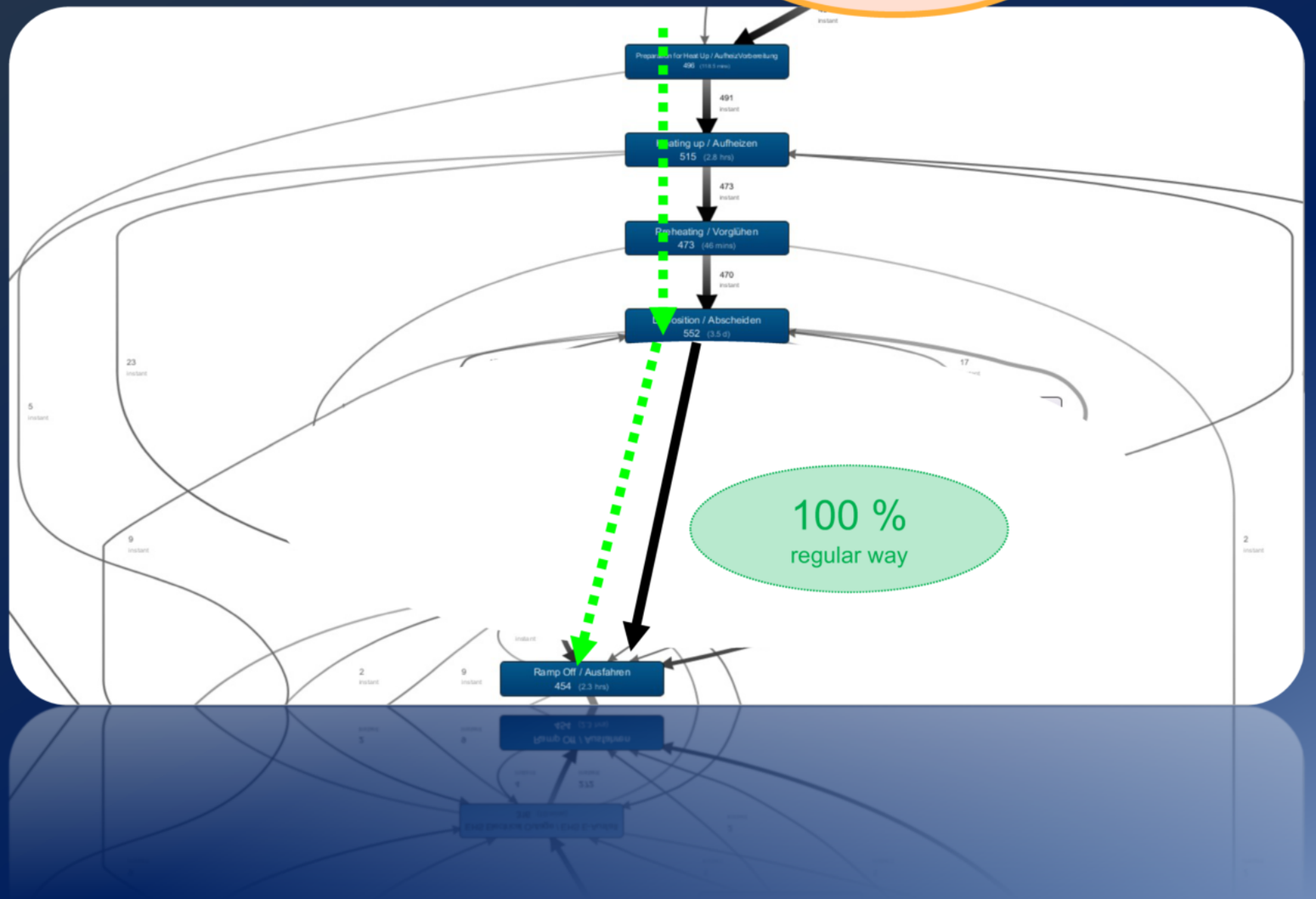


Extraordinary process:

„Regular process sequence “

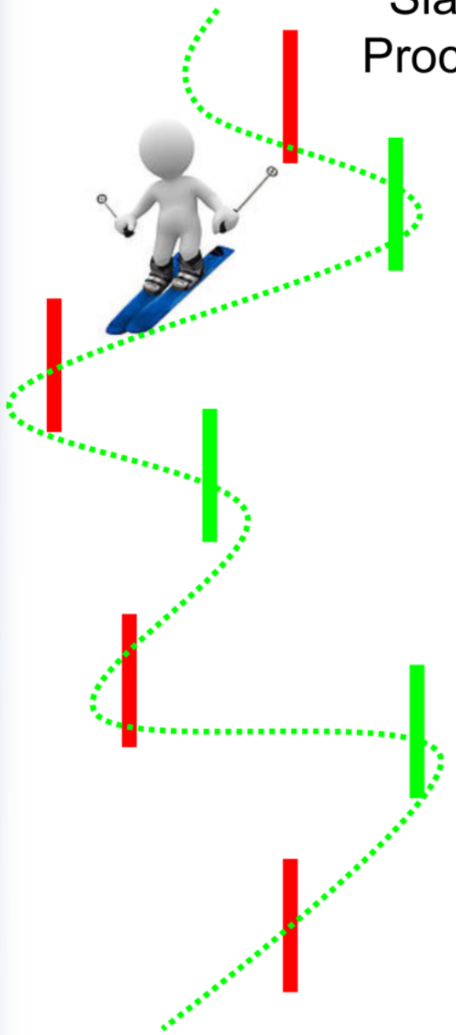
Deposition Process

552 Starts = 100 %



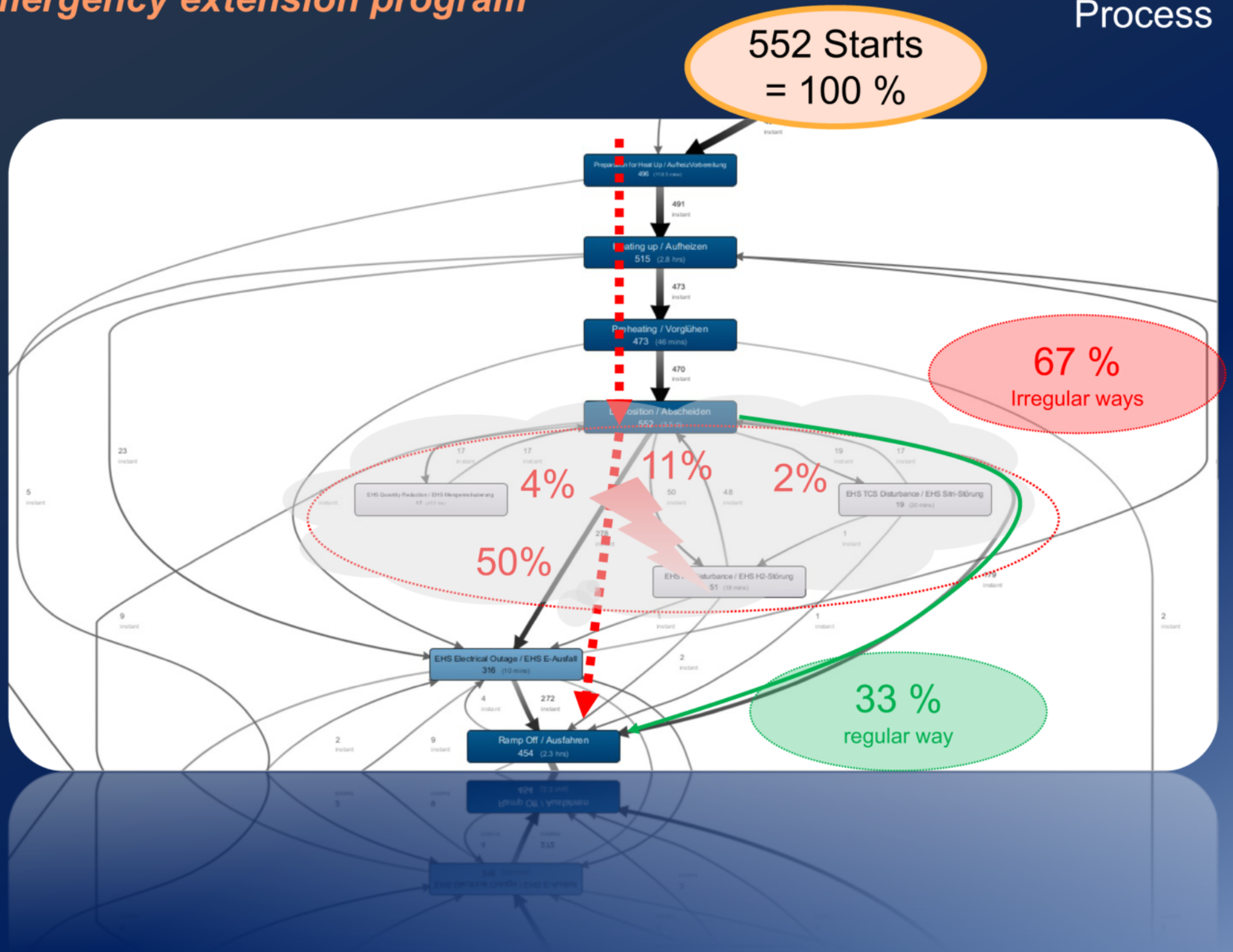
100 %
regular way

Slalom Process

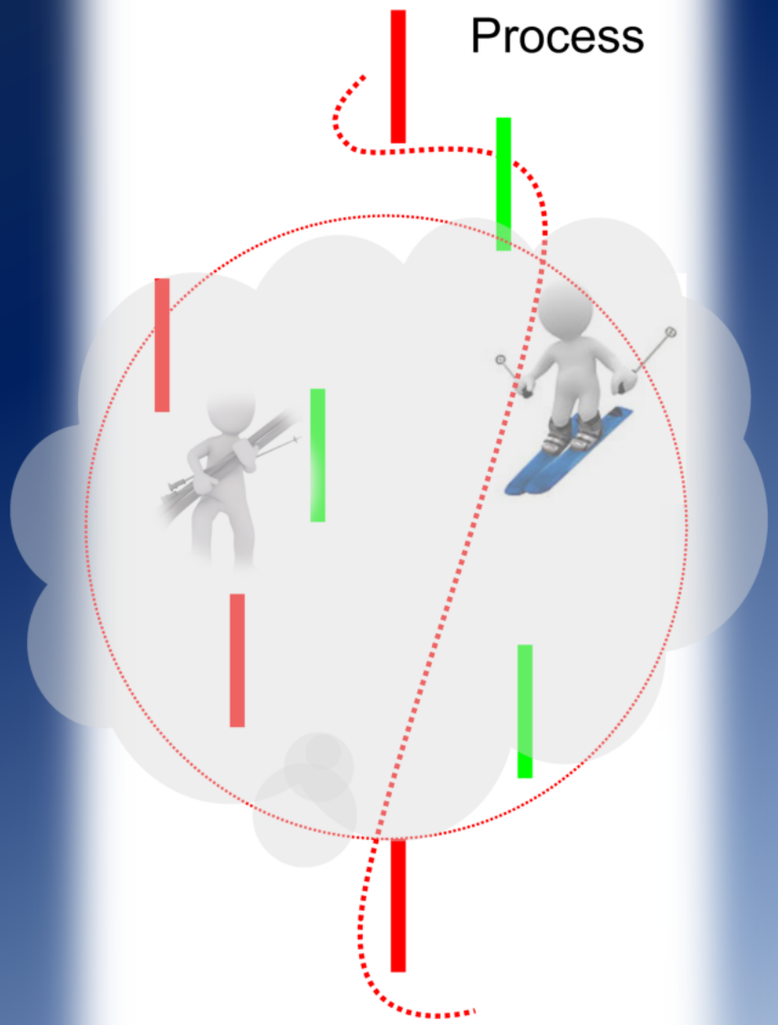


Extraordinary process:
Process is shorten by
„Emergency extension program “

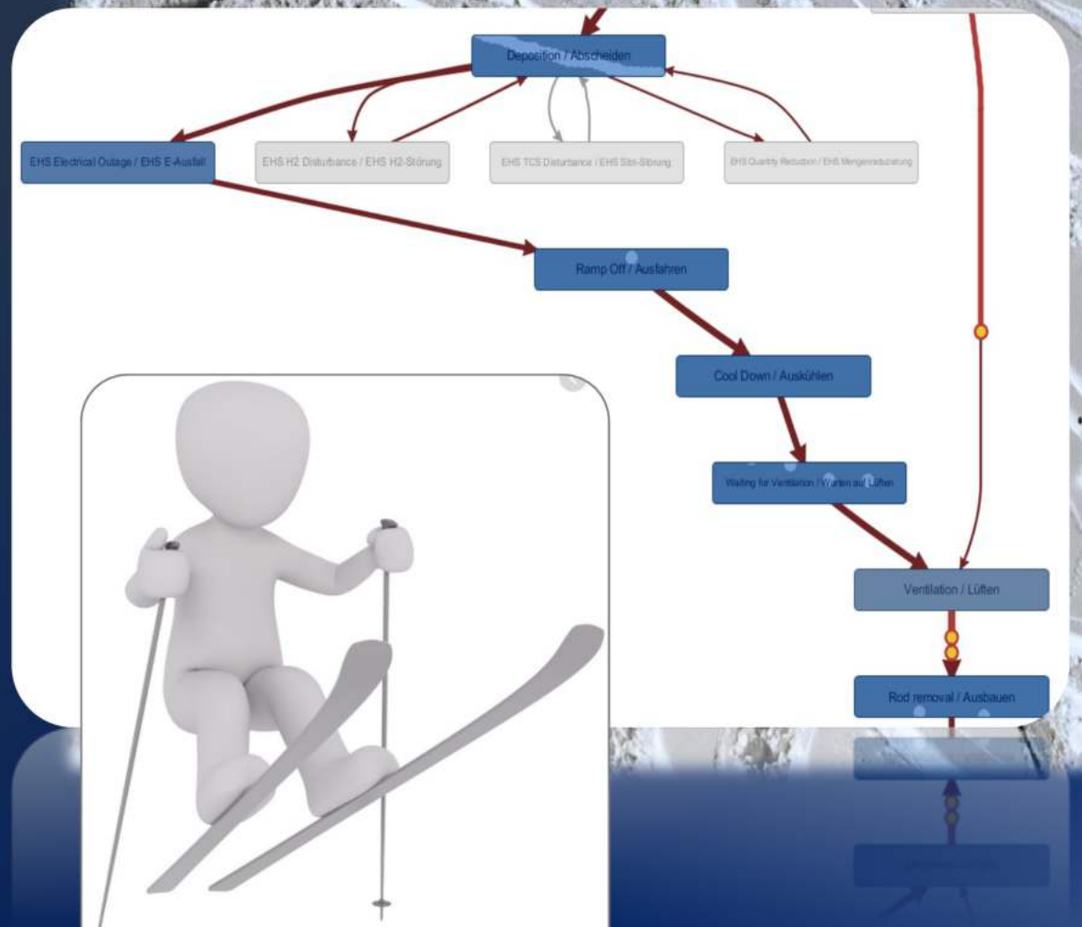
Deposition Process



Slalom Process



By Following And Comparing The Tracks, Significant Successes Could Be Achieved



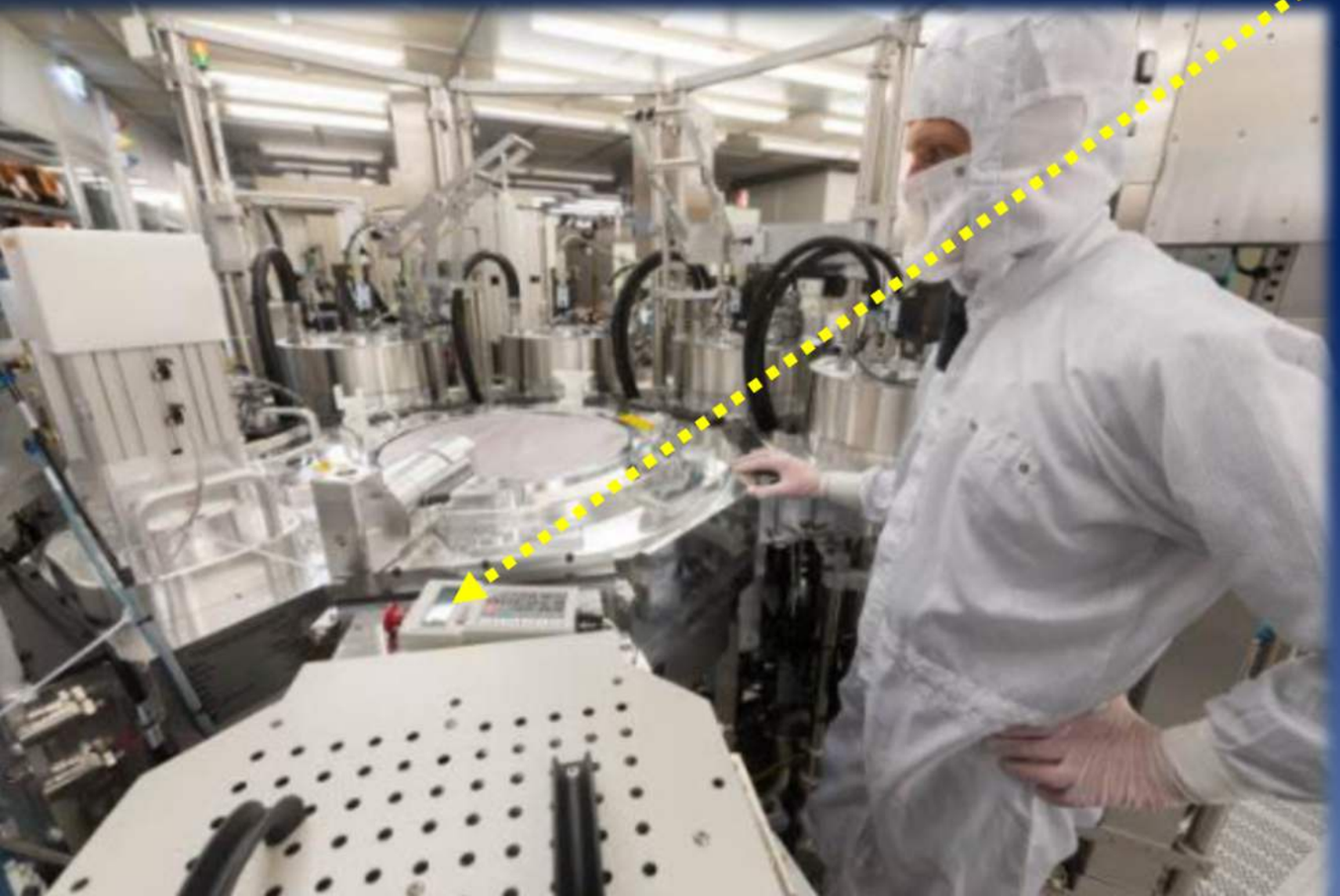
Result:

Saving 1 hour of process time in all 214 systems results in annual savings of ***17 M€ per annum***

- Second Example:

  Physical Analytics of Polysilicon

Polysilicon Physical Analytics



Task:

The higher quality requirements must be carried out with the same measuring equipment in the same time.

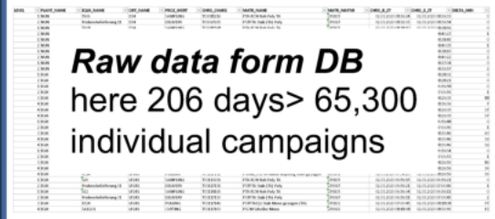
Situation:

55 analysts work on an average of 250 samples on 97 measuring devices in 5 shifts

1. Collect and compress data

2. Analysis of the entire area

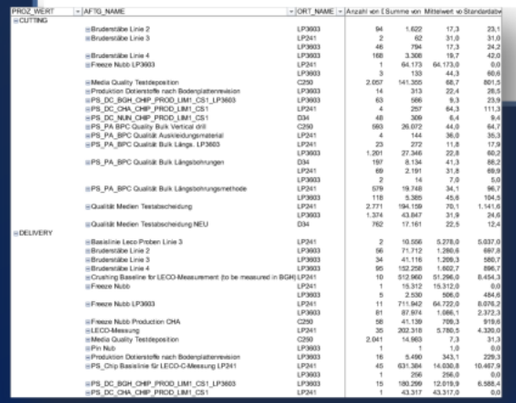
3. Synthesis of potentials



Raw data form DB
here 206 days> 65,300
individual campaigns

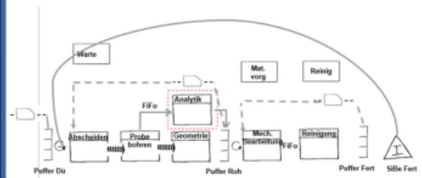
+

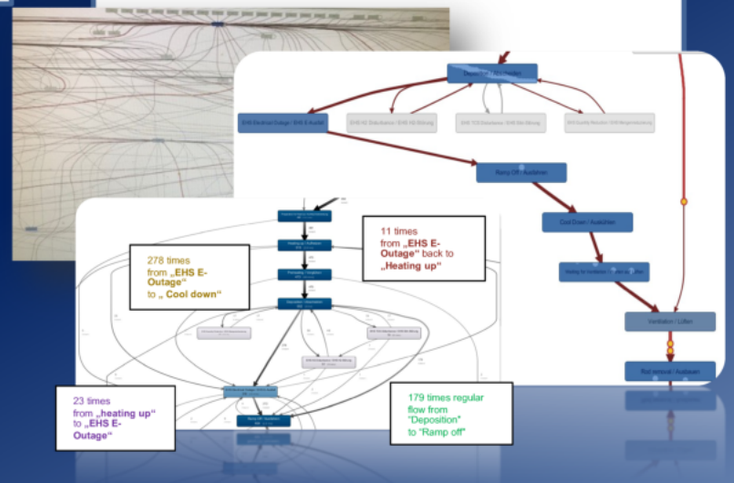
WSA manual activity
handwriting every single process



using SixSigma tools such as ...

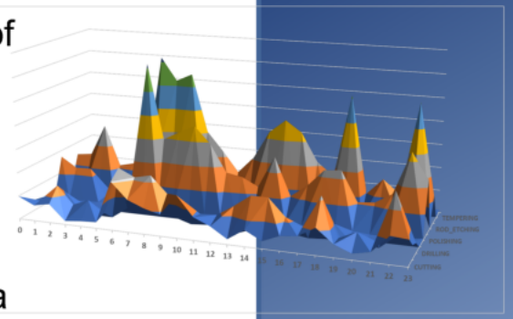
Work step analysis WSA
Value stream analysis VSA
 # Process Mining / Simulation



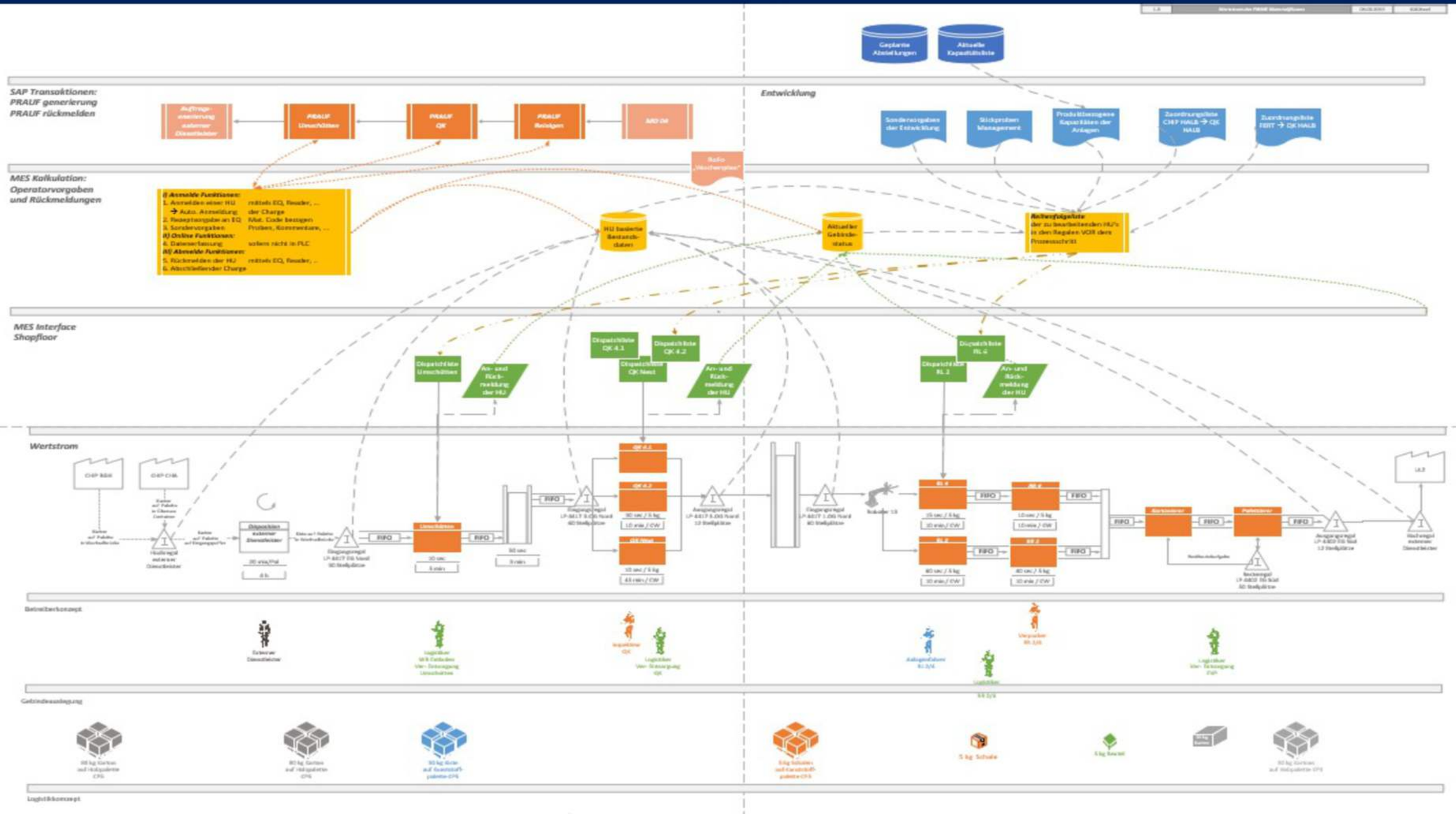


Visualization of the current state
and deriving potentials
through the outside view of OE-PM
under consideration of
dimensions:

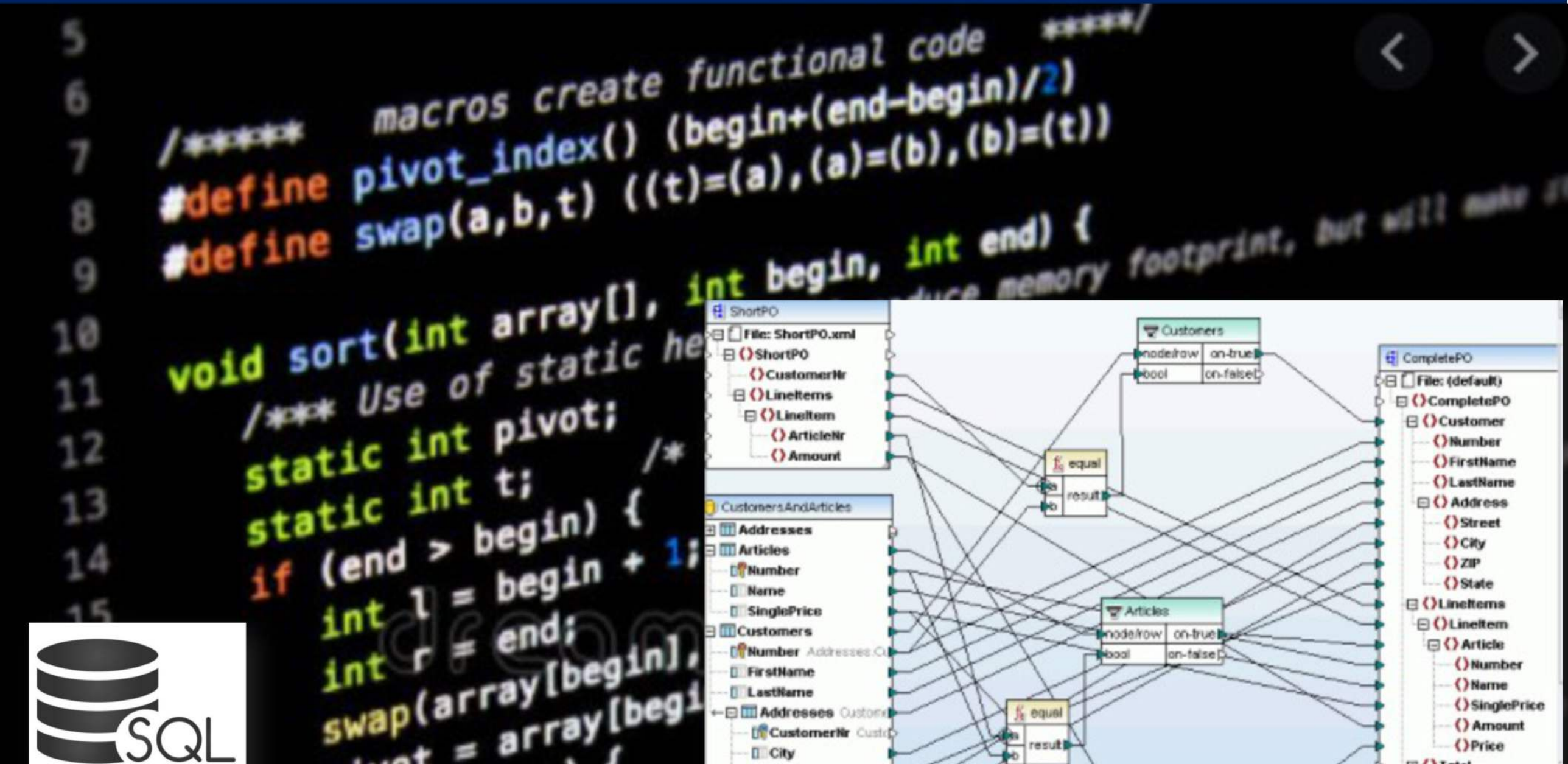
a) Time
b) Location
c) Manufacturing area
d) Qualification



0. Value Stream Analysis for the global understanding



1.1. Database selection



1.2. Data results and additional joins

2	NUN	ProbenAnlieferung 11	D34	DELIVERY	T03097934	PSTPTA Stab (TA) Poly	276097	02.03.2020 08:38:59	02.03.2020 08:40:27	1
1	NUN	T917	D34	SAMPLING	T03081599	PTA ROH Roh Poly TA	276105	02.03.2020 08:38:19	02.03.2020 08:38:45	0
2	NUN	ProbenAnlieferung 11	D34	DELIVERY	T03097933	PSTPTA Stab (TA) Poly	276097	02.03.2020 08:38:45	02.03.2020 08:40:05	1
1	NUN	T907	D34	SAMPLING	T03081221	PTA ROH Roh Poly TA	276105	02.03.2020 08:37:53	02.03.2020 08:38:15	0
2	NUN	ProbenAnlieferung 11	D34	DELIVERY	T03097932	PSTPTA Stab (TA) Poly	276097	02.03.2020 08:38:15	02.03.2020 08:40:22	2
1	NUN	T903	D34	SAMPLING	T03081218	PTA ROH Roh Poly TA	276105	02.03.2020 08:37:24	02.03.2020 08:37:34	0
2	NUN	ProbenAnlieferung 11	D34	DELIVERY	T03097524	PSTPTA Stab (TA) Poly	276097	02.03.2020 08:37:34	02.03.2020 08:39:57	2
1	BGH	912	LP241	SAMPLING	T03114195	PTA ROH Roh Poly TA	276105	02.03.2020 08:27:55	02.03.2020 08:28:02	0
2	BGH	ProbenAnlieferung 01	LP241	DELIVERY	T03117133	PSTPTA Stab (TA) Poly	276097	02.03.2020 08:28:02	02.03.2020 08:28:21	0
1	BGH	933	LP241	SAMPLING	T03114196	PTA ROH Roh Poly TA	276105	02.03.2020 06:59:51	02.03.2020 06:59:58	0
2	BGH	ProbenAnlieferung 01	LP241	DELIVERY	T03117134	PSTPTA Stab (TA) Poly	276097	02.03.2020 06:59:58	02.03.2020 07:00:59	1
3	BGH	F719	LP241	PULLING	T03117158	PSTPTA12z Stab Mono gezogen (TA)	276102	02.03.2020 07:00:59	02.03.2020 08:29:05	88

Raw data from DB

here 206 days> 65,300 individual campaigns

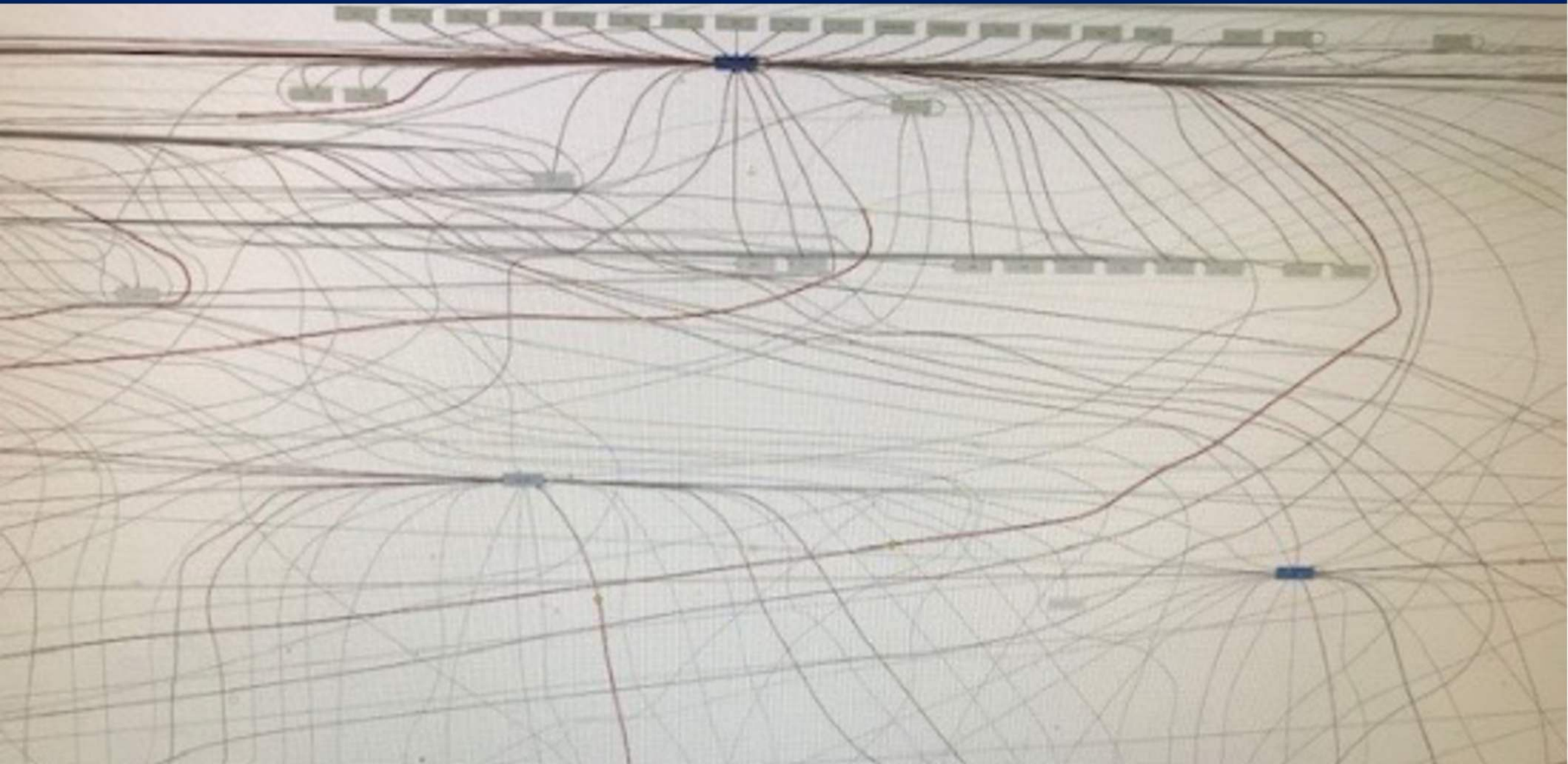
+

Bereich	Labor	Teilbereich	Tätigkeit	Prozessaufwand	igkeit	ozessaufwa	ssaufwand	Gleichzeitigkeit	ozessaufwa	zessaufwa	ozessaufwa	ozessaufwa
				[min]		[min]	[min]		[min]	[min]	[min]	[min]
Testabscheidung				**646**		**21**	**21**		**641,7**	**30,8**	**656,5**	**62,6**
		Abscheidung	Chargenwechsel	12	1,00	12	12	1,00	9,0	9,0	21,9	21,9
			Abscheidevorgang	6	1,00	6	6	1,00	630,0	19,1	630,0	36,1
			Kontrollgang	4	1,00	4	4	1,00	2,7	2,7	4,6	4,6
Vorbereitung gebohrte				**24**		**12**	**12**		**0**	**0**	**17,1**	**2,9**
Proben	241	Probenätze	Proben anlegen	2	1,00	2	2	1,00			0,9	0,9
			Proben anschleifen	5	1,00	5	5	1,00				

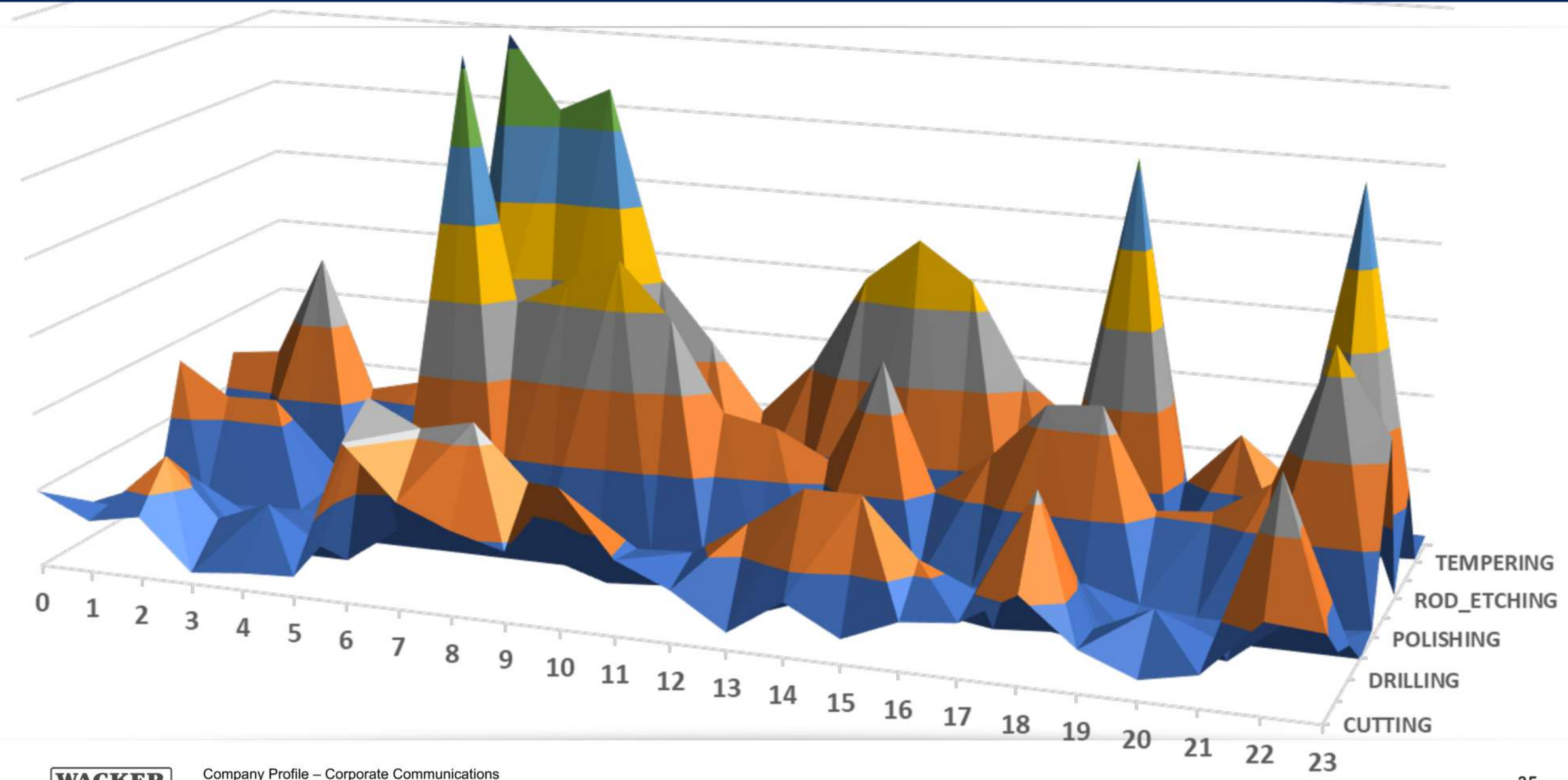
WSA manual activity

handwriting every single process

2. Process Mining



3.1. Visualization of Current and Alternative Situations



Result:

Due to the redistribution of the work between the work areas and the scheduling,
5 workers could be moved to other production areas!

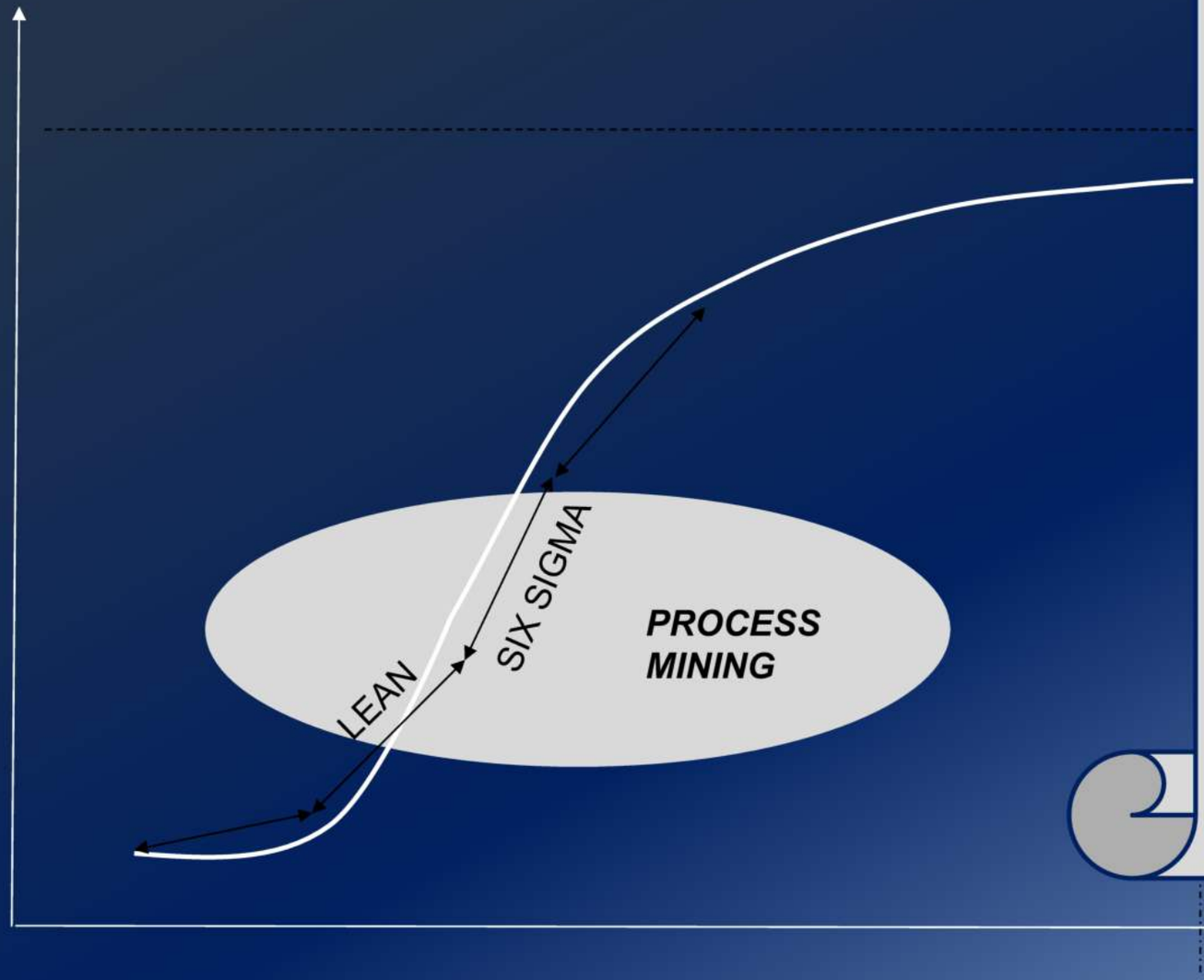
400 T€ per annum

3.2. Quantification of the measure

Other projects that are in progress or planned

1. Poly cleaning input material delivery behaviour from BGH, NUN and CHA
2. Rod removal allocation status in the different sites and deposition halls
3. Rod carriers movement cluster of each ASL
4. HU based lot-tracking from ASL‘s and ABL through Poly cleaning shop floor
5. Box on pallets move-status from decanting to quality control
6. Process-carrier mining between QK and cleaning equipments RL2 / 4
7. Improvements of Warehouse activities and workflows / on-site transportation CHA
8. Workflow improvements workshop and equipment cleaning CHA
9. Reactor rebuilt optimizations CSR/Conversion on all sites

Productivity Management



Summery of …

Process Mining
at Wacker
in productivity management

is

- ***located as one tool in development and improvement cycles***

and

- ***gives a <u>Value-adding Contribution</u> in combination with the SixSigma and Reporting applications***

SUMMARY

1. Very interesting and profitable addition

2. Does not replace the task definition

3. Data preparation needs to be taken into account

4. Visualization is an excellent aid in developing improvement ideas

5. Process mining does not replace experience

6. Social competence needed for person-related evaluations

Thank you for your attention.