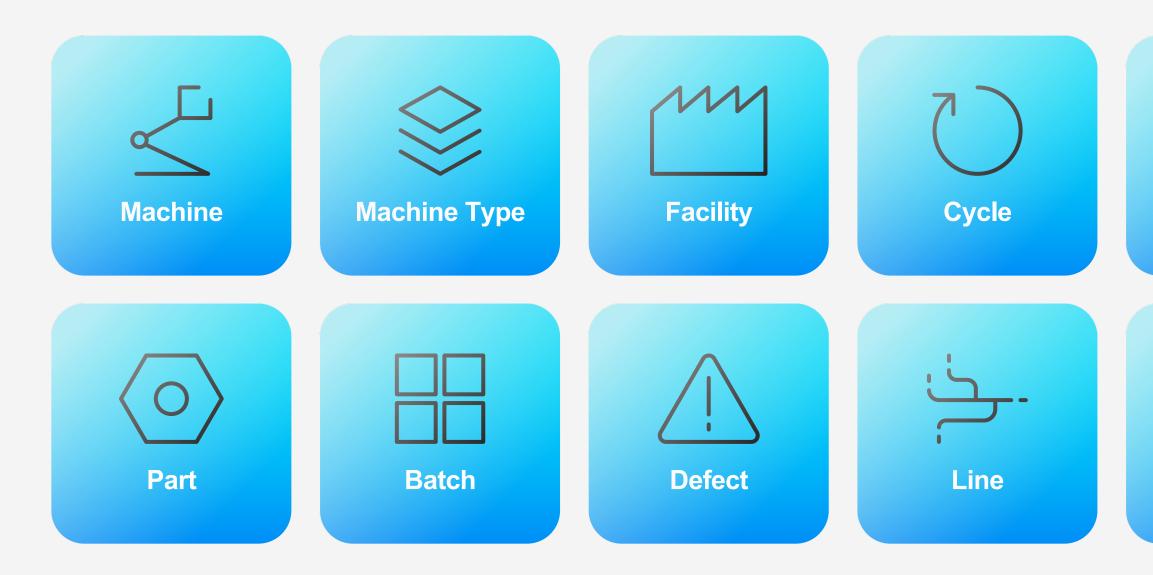
## Sight Machine Common Data Models for Manufacturing



## **Background and Presentation Overview**

- Sight Machine analyzes production by streaming plant floor data from all systems and sources
- Data is streamed into 4 Common Data Models. These models represent automated production in all industries
- This method is different. It's streaming, so it's real-time, which is necessary for plants otherwise plants can't react
- Also, the foundational unit that is used to represent production Data is different
- To represent plant activity, most experts start by building models of machines and processes. Sight Machine structures OT Data differently into basic, universal units. These rows of Data describe each value-added step done by every machine
- This approach yields standardized Data Foundation: all plant data structured into standardized structures with a high degree of flexibility as to data types and parameters incorporated
- Data Foundation is then graphed into representations of machines, lines and plants, which are further visualized and analyzed. Data Foundation enables expansive KPIs, analytics and AI/ML
- Sight Machine's architecture is **modular, transparent, and configurable at each level**. Clients and partners can access and modify: (a) raw data, (b) configuration, and (c) Transformed Data via API and SDK layers
- This presentation reviews Common Data Models and graphing methods used to build up higher-level models. It then highlights a few from hundreds of analytics currently offered with web services. After several slides, it is mostly pictures ©
- Connectivity, pre-processing, streaming and transformation are addressed elsewhere
- A summary architecture is provided last

## Things we want to understand in manufacturing





#### Downtime



#### Problem to be solved: when analyzing plant floor production, customary modeling approaches don't work

- Most manufacturing activities besides production itself are successfully analyzed with batch processing, existing software systems, and traditional modeling techniques. Areas where traditional methods work include Product lifecycle (PLM), business processes (ERP), physics-based simulation, Supply Chain (SCM)
- Analysis of actual plant floor production (OT Data) is different. Despite substantial investment in the last decade by both technology and industrial companies, traditional modeling techniques have not worked for plant floors
- Among the many challenges, one of the more fundamental is around representational units
- Because machines are often the representational unit we think of first, when analyzing production we usually model machines. Other representational units we might use include single sensors, larger data sources (e.g., historians, quality systems) lines, plants, and parts
- But manufacturing has many thousands of kinds of machines and hundreds of systems, and relationships among data sources are complex. This complexity is one reason traditional approaches fail
- For plant floors, we need a simpler approach with only a few elemental units that can be continuously generated and "built up" to represent all machines, lines, and plants

## What's needed are common building blocks

- We need to use building blocks that are common across every machine and process
- These building blocks should be constructed from the OT data as it is created, independent of the machine types and software systems that generated the data
- We can then stream and transform Data into standardized units, and assemble these units into higher-level conceptual templates. This way, we can relate every machine, process, and part with the same underlying, standardized elements
- These building blocks are Common Data Models for Production. With these models, mapped through stream processing, we can represent almost every activity in manufacturing with the same Data Foundation
- This approach is essential for scale. It enables analysis not just from the asset to enterprise level, but also across industries and Value Chains

## Manufacturing Common Data Models

To represent infinite machines, parts, processes, and plants, only a few Common Data Models are needed

- Building blocks are represented as rows in data tables
- Columnar values are parameters of interest, generated through real-time data transformations
- Columnar data combines and transforms data from any source:
  - Machines (hundreds of sensors each, thousands of different machines per enterprise)
  - Operator data (Excel, entries, digitized reports)
  - Adjacent systems (historians, ERP, MES, quality, etc.)
  - Environment (temperature, humidity)
  - Value chain (raw material, upstream supplier)
- The resulting information is now **Data Foundation**. It is continuously generated and standardized, and can be associated, combined, compared, and analyzed with all other standardized units of information
- Data Foundation enables broad application of analytical techniques from visualization and KPIs to data science and AI/ML. Data Foundation can also be joined with other information (finance, energy, logistics) in manufacturing enterprises

#### Data Foundation supports both real-time operational analysis and firm, or industry-level analytics

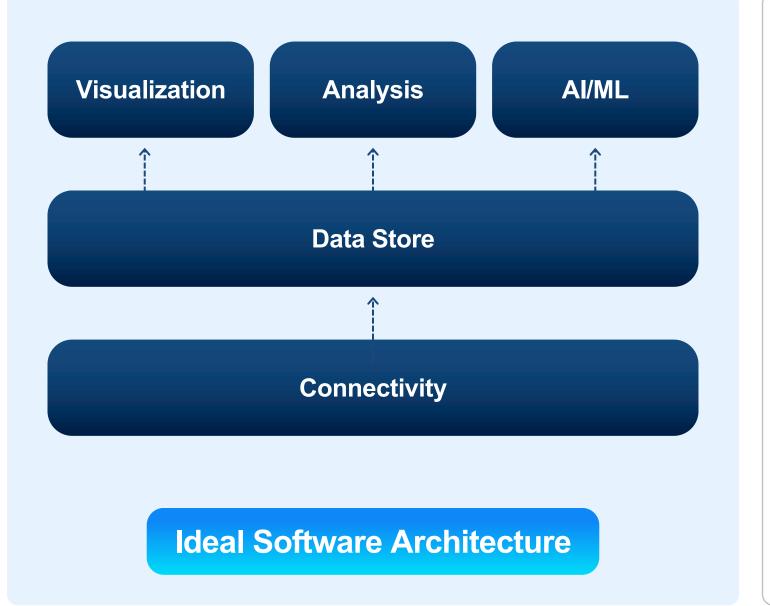
## This Background In Pictures



### Free-standing, single assets can be modeled by representing "the Machine." Manufacturing is different. Even simple products involve hundreds of machines



## The ideal software stack is logical, streamlined. Manufacturing software is accreted over decades, tailored, complex



Logistics*	Maintenance*	Management*
Environmental Systems	Tool Monitoring 🛛 🌆	Information Portal
Metrics (DTD, BTS)	Predictive 🛛 🌉	Energy/Building Mgmt 🛛 🌆
Shipping 🛛	Preventive 🛛 🌉	Cost Management
Container Tracking 🛛 🌉	Crisis 🛛 🌉	Policy Deployment 🛛 🌆
Lot Tracking 🛛 🌆	Reliability & Maintenance 🌆	Best Practice 🛛 🌆
Rack Tagging 🛛 🜆	Downtime Analysis 🛛 🌆	Timekeeping 🛛 🌆
Raw Mat Ordering & Inv 🌆	Fluid Tracking 🛛 🌉	Metrics for Workforce 🛛 🌉
Dock Inventory	Programmable Dev Supp	lssues Management 🛛 🌆
Schedule Optimization	Plant Design & Layout 🛛 🌆	Production Log 🛛 🌆
Inventory Control	Die Re-Chroming	Knowledge Management 🌆
Line Side Replenishment		Training [ 🌉
Part Consumption		
Production*	New Mfg Systems	Quality*
Production* Production Monitoring	New Mfg Systems Digital Twin Apps	Quality* Campaigns
Production Monitoring	Digital Twin Apps	Campaigns
Production Monitoring	Digital Twin Apps Device/Machine IoT Apps	Campaigns Shipping – Error Proofing
Production Monitoring Downtime Analysis Production Counts	Digital Twin Apps Device/Machine IoT Apps Predictive Maintenance 1	Campaigns Shipping – Error Proofing External Metrics
Production Monitoring Downtime Analysis Production Counts Constraint ID & Analysis	Digital Twin Apps Device/Machine IoT Apps Predictive Maintenance 1 Predictive Maintenance 2	Campaigns Shipping – Error Proofing External Metrics Internal Metrics
Production Monitoring Downtime Analysis Production Counts Constraint ID & Analysis Schedule Execution/	Digital Twin Apps Device/Machine IoT Apps Predictive Maintenance 1 Predictive Maintenance 2 Predictive Maintenance 3	Campaigns Shipping – Error Proofing External Metrics Internal Metrics Traceability
Production Monitoring Downtime Analysis Production Counts Constraint ID & Analysis Schedule Execution/ Hit to Hit	Digital Twin Apps Device/Machine IoT Apps Predictive Maintenance 1 Predictive Maintenance 2 Predictive Maintenance 3 Remote Monitoring	Campaigns Shipping – Error Proofing External Metrics Internal Metrics Traceability Error Proofing
Production Monitoring Downtime Analysis Production Counts Constraint ID & Analysis Schedule Execution/ Hit to Hit Process Control Boards	Digital Twin Apps Device/Machine IoT Apps Predictive Maintenance 1 Predictive Maintenance 2 Predictive Maintenance 3 Remote Monitoring Connected Worker 1	Campaigns Shipping – Error Proofing External Metrics Internal Metrics Traceability Error Proofing Defect Tracking
Production Monitoring Downtime Analysis Production Counts Constraint ID & Analysis Schedule Execution/ Hit to Hit Process Control Boards Dock Inventory	Digital Twin Apps Device/Machine IoT Apps Predictive Maintenance 1 Predictive Maintenance 2 Predictive Maintenance 3 Remote Monitoring Connected Worker 1 Connected Worker 2	Campaigns Shipping – Error Proofing External Metrics Internal Metrics Traceability Error Proofing Defect Tracking SPC
Production Monitoring Downtime Analysis Production Counts Constraint ID & Analysis Schedule Execution/ Hit to Hit Process Control Boards Dock Inventory Process Sheets	Digital Twin Apps Device/Machine IoT Apps Predictive Maintenance 1 Predictive Maintenance 2 Predictive Maintenance 3 Remote Monitoring Connected Worker 1 Connected Worker 2 Augmented Reality 1	CampaignsShipping – Error ProofingExternal MetricsInternal MetricsTraceabilityError ProofingDefect TrackingSPCRepair Bay Ol

#### **Typical Manufacturing Architecture**

#### The next challenge: Production data flows through manufacturing software

Production*	New Mfg Systems	Quality*	Logistics*	Maintenance*	Management*
Production Monitoring	Digital Twin Apps 🛛 🌉	Campaigns	Environmental Systems 🌆	Tool Monitoring 🛛 🌉	Information Portal
Downtime Analysis	Device/Machine IoT Apps	Shipping – Error Proofing	Metrics (DTD, BTS) 🛛 🌆	Predictive 🛛 🌉	Energy/Building Mgmt 🛛 🌆
Production Counts	Predictive Maintenance 1	External Metrics	Shipping 🛛 🌆	Preventive 🛛 🌆	Cost Management 🛛 🌆
Constraint ID & Analysis [	Predictive Maintenance 2	Internal Metrics	Container Tracking 🛛 🌆	Crisis 🛛 🌆	Policy Deployment 🛛 🌆
Schedule Execution/	Predictive Maintenance 3	Traceability	Lot Tracking 🛛 🌆	Reliability & Maintenance	Best Practice 🛛 🌆
Hit to Hit 🛛 🌅	Remote Monitoring	Error Proofing	Rack Tagging 🛛 🌆	Downtime Analysis 🛛 🌆	Timekeeping 🛛 🌉
Process Control Boards [	Connected Worker 1	Defect Tracking	Raw Mat Ordering & Inv 🌆	Fluid Tracking 🛛 🌆	Metrics for Workforce 🛛 🌉
Dock Inventory	Connected Worker 2	SPC 🛛	Dock Inventory	Programmable Dev Supp	lssues Management 🛛 🌆
Process Sheets	Augmented Reality 1	Repair Bay Ol 🛛 🌆	Schedule Optimization	Plant Design & Layout 🛛 🌆	Production Log
Manual Production Count	Augmented Reality 2	Quarantine 🛛 🌆	Inventory Control 🛛 🌆	Die Re-Chroming 🛛 🌆	Knowledge Management 🌉
Cycle Time Analysis	Supply Chain Analytics/Ops	Scrap & Reject Reporting	Line Side Replenishment 🌆		Training 🛛 🌉
Sequencing	Hot, Warm, Cold Data Lake	Birth History	Part Consumption		

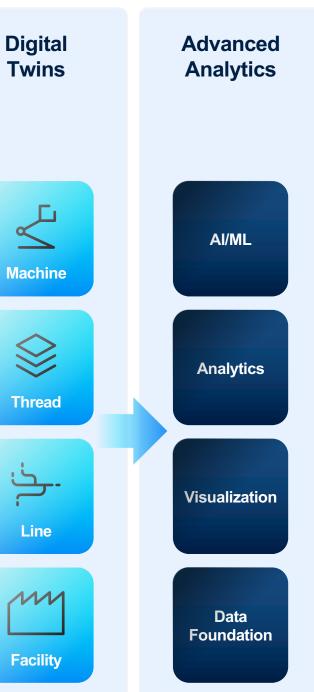






## How to standardize analysis? It's the data

Production* Production Monitoring Downtime Analysis Downtime Analysis Constraint ID & Analysis Schedule Execution/ Schedule Execution/ Hit to Hit Process Control Boards Dock Inventory Process Sheets Manual Production Count Count Cycle Time Analysis	New Mfg Systems Digital Twin Apps Device/Machine IoT Apps Predictive Maintenance 1 Predictive Maintenance 2 Predictive Maintenance 3 Remote Monitoring Connected Worker 1 Connected Worker 2 Augmented Reality 1 Augmented Reality 2 Supply Chain Analytics/Ops	External Metrics	Shipping Container Tracking Lot Tracking Rack Tagging Raw Mat Ordering & Inv Dock Inventory Schedule Optimization Inventory Control	Predictive       Preventive       Crisis       Reliability & Maintenance       Downtime Analysis       Fluid Tracking       Programmable Dev Supp       Plant Design & Layout       Die Re-Chroming	Cost Management	Streaming Data	Common Data Models	C T
Sequencing	Hot, Warm, Cold Data Lake	Birth History	Part Consumption				Cycle Cycle Part	
							Downtime Defect	ſ



## Common Data Models



## Cycle



**Cycle** characterizes discrete periods of machine activity. A cycle represents a unit of work by a machine.

Each row in a Sight Machine data table describes a single recurring unit of work by any machine. Examples of repetitive work done by machines are limitless and include pressing, cutting, filling, painting, and heating. **Cycle** creates a common thread across machines, lines, process areas, facilities, and industries

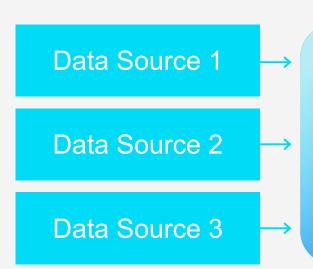
## **Cycle Data Model**

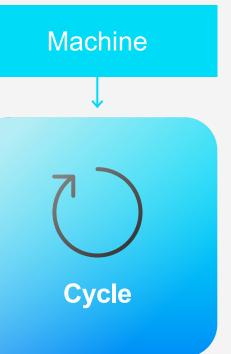
#### Unit of work

- Primarily identified by Machine + Time (sometimes Machine + Counter/Unique Identifier)
- Contains a shift, production day, and output

#### **Commonly includes:**

- Machine telemetry
- Running status
- Product/material information
- Energy use
- Quality/inspection data





Records from grouping/ aggregation by time, counter, status codes

## Example Cycle Data Table

INE		📿 DA	SHBOARDS 🧹 📊	II ANALYSIS ∨	DATA 🗸 🔣 CO	OKBOOKS								?
	7	Су	cle - BN_Diec	ast 1 12776 Rows F	Public									☆ ∠
el es	>													
ts n - Diecast 1	>	#	Machine	Cycle Start Time	Cycle End Time	Production Day	Cycle Time (Net) Seconds	Cycle Time (Gross) Seconds	Shift	Output	Aluminum Staging - Total Time	Aluminum Temperature °C	Cylinders	Die Temperatu
		1	Busan - Diecast 1	2021-03-06 09:03:55	2021-03-06 09:04:27	2021-03-06	32	32	Shift 2	1	5000	650.9	4	283
ve Range <b>' Days</b>	>	2	Busan - Diecast 1	2021-03-06 09:01:12	2021-03-06 09:02:17	2021-03-06	65	65	Shift 2	1	6000	653.1	4	288
Fields		3	Busan - Diecast 1	2021-03-06 08:58:29	2021-03-06 08:59:34	2021-03-06	65	65	Shift 2	1	5000	658.0	4	284
lected		4	Busan - Diecast 1	2021-03-06 08:57:59	2021-03-06 08:58:29	2021-03-06	30	30	Shift 2	1	5000	657.7	4	289
		5	Busan - Diecast 1	2021-03-06 08:57:25	2021-03-06 08:57:59	2021-03-06	34	34	Shift 2	1	6000	656.0	4	29
		6	Busan - Diecast 1	2021-03-06 08:56:52	2021-03-06 08:57:25	2021-03-06	33	33	Shift 2	1	6000	658.5	6	28
		7	Busan - Diecast 1	2021-03-06 08:56:21	2021-03-06 08:56:52	2021-03-06	31	31	Shift 2	1	6000	659.4	6	28
		8	Busan - Diecast 1	2021-03-06 08:55:56	2021-03-06 08:56:21	2021-03-06	25	25	Shift 2	1	5000	657.1	6	303
		9	Busan - Diecast 1	2021-03-06 08:53:12	2021-03-06 08:54:17	2021-03-06	65	65	Shift 2	1	5000	669.6	6	29
		10	Busan - Diecast 1	2021-03-06 08:52:39	2021-03-06 08:53:12	2021-03-06	33	33	Shift 2	1	6000	663.6	4	28
		11	Busan - Diecast 1	2021-03-06 08:49:55	2021-03-06 08:51:00	2021-03-06	65	65	Shift 2	1	6000	654.3	4	290
		12	Busan - Diecast 1	2021-03-06 08:49:24	2021-03-06 08:49:55	2021-03-06	31	31	Shift 2	1	5000	655.5	4	28
		13	Busan - Diecast 1	2021-03-06 08:48:53	2021-03-06 08:49:24	2021-03-06	31	31	Shift 2	1	5000	664.6	4	28
		14	Busan - Diecast 1	2021-03-06 08:48:19	2021-03-06 08:48:53	2021-03-06	34	34	Shift 2	1	6000	654.2	4	288
		15	Busan - Diecast 1	2021-03-06 08:45:39	2021-03-06 08:46:44	2021-03-06	65	65	Shift 2	1	5000	655.1	4	292
IPDATE		16	Busan - Diecast 1	2021-03-06 08:45:16	2021-03-06 08:45:39	2021-03-06	23	23	Shift 2	1	6000	655.0	4	29 <sup>.</sup>
		17	Busan - Diecast 1	2021-03-06 08:44:50	2021-03-06 08:45:16	2021-03-06	26	26	Shift 2	1	6000	659.8	4	288

### Downtime



**Downtime** describes instances and durations of non-productive, idle, or stop time for a machine

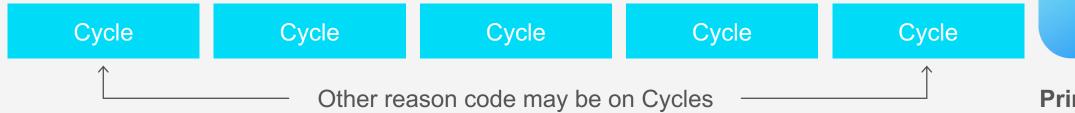
## **Downtime Data Model**

#### Track when a machine is down

- Start and end of downtime
- Reason code for downtime

#### Notes

- Split on shift, day boundaries, and reason code changes
- Commonly contains type, category, and reason code



#### Primary reason code on Downtime



## **Part and Batch**



**Part** provides traceability across production processes, facilities, and supply chains, and associates the process data with quality outcomes



multiple parts

#### Batch represent raw material, output grouping, and summary data, all of which are associated with

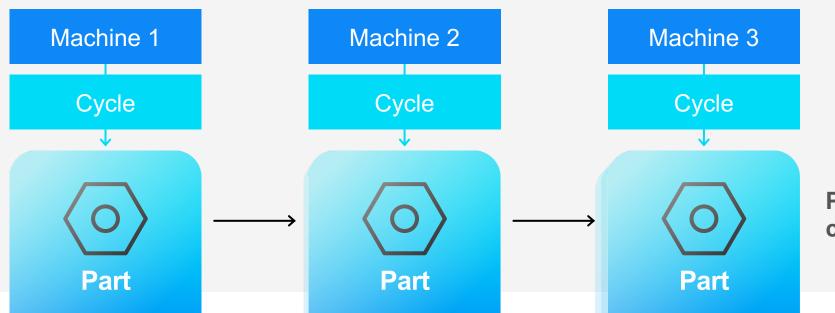
## Part and Batch Data Model

#### **Represents a Part/Batch as it moves down the line**

- Used for product traceability, identified by serial, or sometimes synthetic timestamp "serial"
- Will have multiple machines' data

#### **Contains**

- Cycles for all machines a part will/could touch
- Start time is from the first machine, end time is the most recent machine across many facilities as needed



#### Part grows as each cycle adds data

### Defect

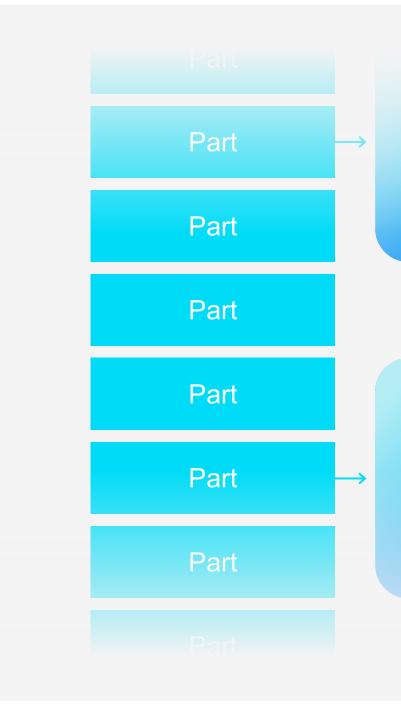


**Defect** represents non-conformant production output, in both single parts and batches

### **Defect Data Model**

## Track defect-specific information, associated with parts or batches

- Defect test time
- Category, type, and quantity







## **Configuring Common** Data Models Into Plants, Lines, Machines, KPIs





## Facility



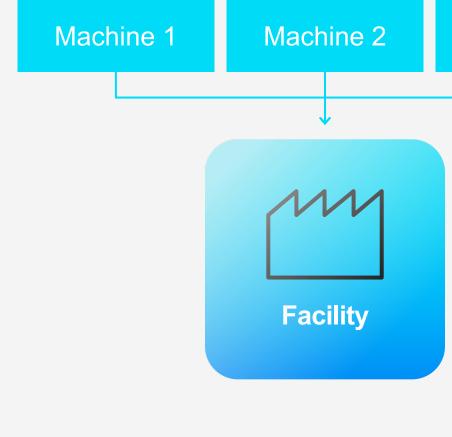
Facility defines the location, time zone, and shift schedule unique to each facility to determine when machines should be running, overall facility-wide KPIs, and shift performance analysis

## **Example Facility**

#### **Facility**

- Facility location (TZ-aware)
- Shift schedule
- Machine assignment

Config	uration	×	\$ {}	Q
14	<pre>"factory_id": "Discrete_P2_F2",</pre>			
15	"factory_partner": "Discrete_P2",			
16	"factory_location": "Discrete_F2",			
17	"factory_location_clean": "Ann Arbor Facility",			
18 -	"geo_location": {			
19	"lat": 37.799271,			
20	"lng": -122.4019282			
21	},			
22	"place_name": "221 N Main St, Ann Arbor, MI 48104, USA",			
23 -	"shift_events": [			
24 -	{			
25	"starttime": "2000-01-01 07:00:00.000000",			
26	"endtime": "2000-01-01 19:00:00.000000",			
27 -	"rrule": {			
28	"freq": "WEEKLY",			
29 -	"byday": [			
30	"SU",			
31	"MO",			
32	"TU",			
33	"WE",			
34 35	"TH", "FD"			
36	"FR", "SA"			
37	]			
38				
39	}, "exdates": [],			
40	"shiftid": "shift_1558055951922".			



## 2 Machine 3

## **Machine and Machine Type**



Machine is an instantiation of a machine type mapped to a facility location and shift schedule



Machine Type represents several of the exact same machine that can be modeled with the same schema (same sensors, etc.)

## **Example Machine Type**

#### Machine Type

- Data schema and tag metadata:
  - Internal name
  - UI naming
  - Function used to create
  - Output format

#### 

#### Configuration

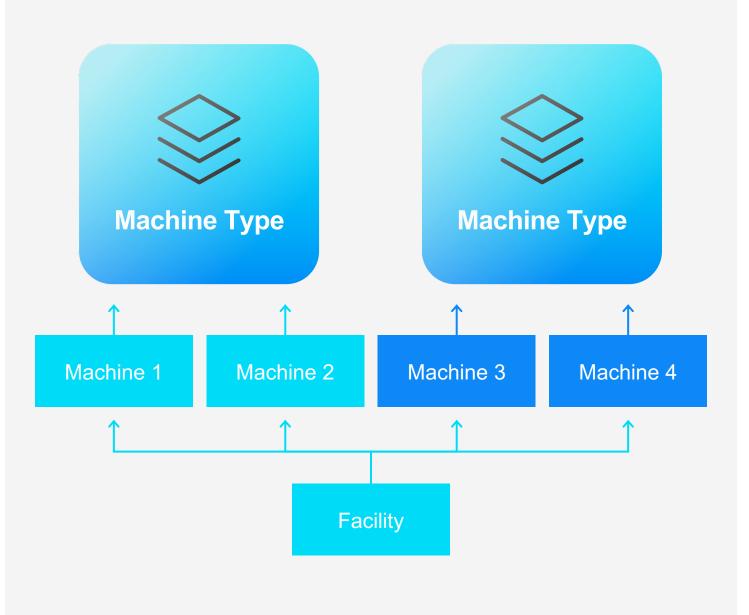
79 -	ł
80 -	"analytics": {
81 -	"columns": [
82 -	{
83	"name": "statsBM_Axial_Loadval",
84	"source_field": "val",
85	"stat_type": "Continuous",
86	"type": "float"
87	}
88	
89	},
90 -	"display": {
91	"title_prefix": "BM: Axial Load",
92	"ui hidden": false
93	},
94	"func": "last",
95	"in_timeline": false,
96	"round": 2,
97 -	
98	"sslog_types": [ "as"
99	], "title": "DM Aviel Lood"
100	"title": "BM_Axial_Load",
101	"unit": "",
102	"var": "Axial_Load_rl",
103	"variance": 0
104	},
105 🕶	{

#### \$ {} Q

#### **Example: Linking Machines to Facilities and shifts**

#### Link individual asset on the plant floor to the Machine Type

Assign Machine to Facility and shift schedule 





#### Line



Line defines the layout and sequence of a series of machines involved in the production process and allows for functionality like bottleneck detection, overall process OEE, traceability, and cross-asset analysis

## **Example Line**

#### **Configured line topology**

#### $\bullet \bullet \bullet$

{

```
"obj": {
 "factory_location": "Atlanta Facility",
 "factory_partner": "Continuous_P1",
 "id": "9741d96e2d68d3ddd6e1d98e",
 "line_topology": {
   "F1_Paper_Mill_Line_PM1": {},
   "F1_Paper_Mill_PM1_Broke": {
     "F1_Paper_Mill_PM1_White_Water": {}
   },
   "F1_Paper_Mill_PM1_Calender_Stacks": {
     "F1_Paper_Mill_PM1_Reel": {}
   },
   "F1_Paper_Mill_PM1_Dryer_Section": {
     "F1_Paper_Mill_PM1_Calender_Stacks": {}
   },
   "F1_Paper_Mill_PM1_Forming_Section": {
     "F1_Paper_Mill_PM1_Press_Section": {}
   },
   "F1_Paper_Mill_PM1_Headbox": {
     "F1_Paper_Mill_PM1_Forming_Section": {}
   },
   "F1_Paper_Mill_PM1_Lab_Tests": {
     "F1_Paper_Mill_PM1_Production_Status": {}
   },
   "F1_Paper_Mill_PM1_Press_Section": {
     "F1_Paper_Mill_PM1_Broke": {}
   },
```

## Time-based offsets to analyze machine interactions

15	3 Machines		11
Q	Search		REFI
0	F1 Pulp Mill 11 Machines	~	≡ OFF:
0	F2 Pulp Mill 11 Machines	~	=
$\odot$	F3 Pulp Mill 11 Machines	~	Ξ
0	F1 PM1 14 Machines	~	≡
0	F2 PM1 14 Machines	~	
0	F3 PM1 14 Machines	~	
0	F1 PM2 14 Machines	~	=
	F2 PM2		

Ū
i
SET HH : MM (i)
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
APPLY

## KPI



KPI represents key performance indicators unique to each facility's process and goals. KPIs are formulas calculated dynamically at runtime

## **Example KPI**

#### **Formula configuration**

Dynamic run-time calculation 

#### { "obj": { "dependencies": [ { "aggregate": "sum", "name": "gross\_cycle\_time" }, "aggregate": "sum", "name": "net\_cycle\_time" ], "display\_name": "Availability", "formula": "((net\_cycle\_time)/(gross\_cycle\_time)\*100 if gross\_cycle\_time>0 else None)", "id": "f86e11dabd1a00112444ce2e", "model": "line", "name": "availability" }, "type": "KPI" },

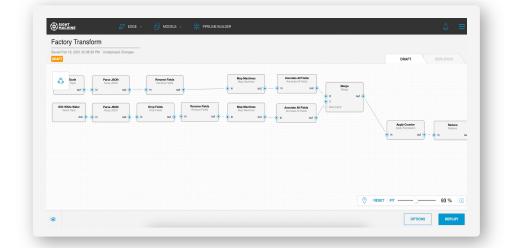
## Real-time Applications



### To drive outcomes, manufacturers require real-time insight

For real-time analysis, stream-processing data into **Common Data Models is the ideal approach** 

Sight Machine's **Pipeline as a Service** is a configurable stream-processing product that continuously transforms operational data into Data Foundation. The screen at the right is one of our browser-based tools for configuring pipelines

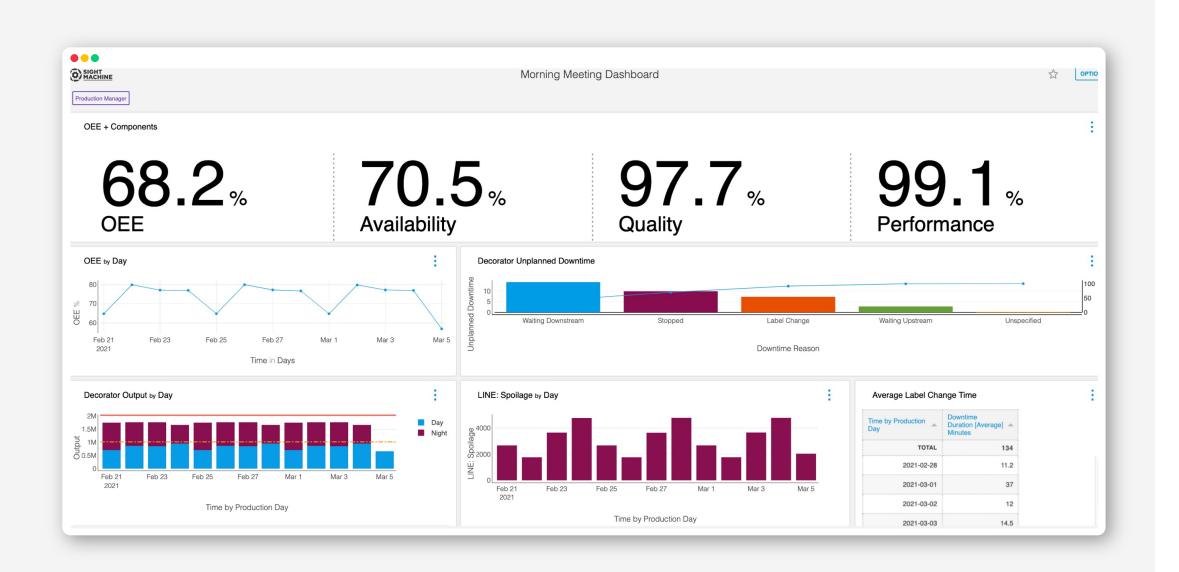


- Factories frequently add and change data. In this environment, robust pipeline management tools are essential. Sight Machine has management tools for modifying data sources, systematically changing configurations across pipelines, dynamically provisioning cloud services, and generating new analytics
- With a standardized Data Foundation, a wide array of analytics can be applied from visualization and KPIs to data science and AI/ML
- Data Foundation can be supplied to other systems (through API and SDK layers) such as Supply Chain Control Towers, CMMS, S&OP, etc.

## Visibility and KPIs

Data Foundation supports continuous visibility into operations. Data can be visualized and analyzed through Sight Machine and other leading applications such as Power BI, Tableau, Looker

An example of a series of visualizations and analytics used to run a plant



### **Data Foundation supports advanced analysis**

Sight Machine has built dozens of analytics into its platform to query Data Foundation

#### **Example:** Line **Productivity** This

"bottleneck detector" shows by SKU where problems arise in multiple lines. Takt time for each step is updated and shown in a heatmap of blocked and starved steps. The analytic uses machine and line models to continuously optimize production. The client achieved a 15% efficiency lift at one of its best plants

	📿 DASHBOARD	s v III ANALY	YSIS v	Data 🗸 🗐	🗓 сооквоокз							
= V	Bottleneck	Analysis										
Live Data Last 7 Days	<ul> <li>Board SKU</li> <li>102-3000A</li> <li>102-2200A</li> <li>110-2820H</li> <li>181-0002A</li> <li>181-0002A</li> <li>181-0000B</li> <li>180-0000B</li> <li>102-3001A</li> </ul>	2021-02-2 2021-02-2 2021-02-2 2021-02-2 2021-02-2 2021-02-2 2021-02-2		Information	Date End 2021-03-05 23: 2021-03-05 22: 2021-03-05 22: 2021-03-05 23: 2021-03-05 23: 2021-03-05 23: 2021-03-05 23:	16:18 35:30 17:25 56:39 12:22 47:41	This dashboard highlights the stations in bottleneck is the highlighted row in the t average throughput difference is the hig	n the line where the able next to the line	e visualization.	To increase thr	oughput, target	the places v
	Nagoya - Pick & Pick & Piaco 1 - Stago 1 25.65	Nagoya - Pick & Place 1 - Stage 2 15.32	Nagoya - Pick & Place 1 - Stage 3 23.44	Nagoya - Pick & Place 1 - Stage 4 13.18	Nagoya - Pick & Piace 1 - Stage 5 23.31	Nagoya Pick & Piace 1 - Stage 6 27.07	Machine 25 Nagoya - Pick & Place 1 - Stage 1 Nagoya - Pick & Place 1 - Stage 2 20 Nagoya - Pick & Place 1 - Stage 3 Nagoya - Pick & Place 1 - Stage 4 Nagoya - Pick & Place 1 - Stage 5 15 Nagoya - Pick & Place 1 - Stage 6	<b>102-30</b> 0 <b>Cycle Count</b> 2166 2166 2167 2167 2169 2171	00A Max CT (s) 30.00 18.00 27.00 16.00 27.00 30.00	Min CT (s) 24.00 13.00 21.00 11.00 21.00 25.00	Avg. CT (s) 26.65 15.32 23.44 13.18 23.31 27.07	Tgt? *
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#### **Dynamic Recipes and Operator Co-Pilot: Continuous guidance for optimization**

- **Dynamic Recipes** are another example of advanced analysis. This analytic sets optimal settings for complex arrays of assets by analyzing all previous production runs and optimizing based on goals set by the process engineer. The **Operator Co-Pilot** advises the engineer of any variations from ideal settings
- **Example: Energy and Emissions** The screens below show a real-time Dynamic Recipe for minimizing SO<sub>2</sub> emissions in a chemicals process at a given temperature, and a Co-Pilot advising of variations that need to be corrected

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⊖ outcomes ()	36 RECIPES	# Runs 🔺 # Records 🔺	20-514R1 1.kademe fark basınç ölçer proses değeri (mba	rg] [Konvertör (20-514R1 Convertor)] Score 💌	RECIPE DATA	LEVERS OUTCOMES
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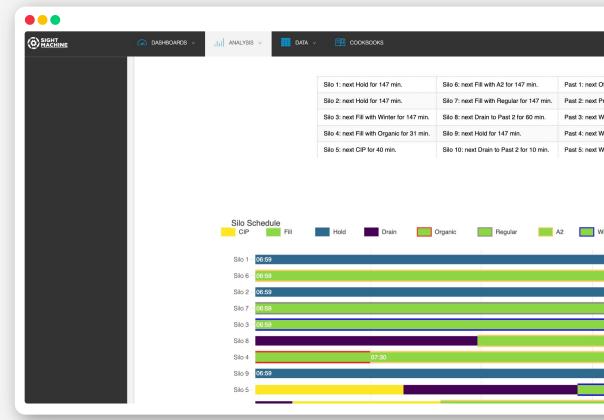
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## AI/ML

#### Sight Machine has applied many AI/ML techniques to Data Foundation

#### **Example: Dynamic Optimization of**

**Assets** Milk supplies and product mix are ever-changing in dairies. How best to use critical assets, like pasteurizers? This model uses genetic algorithms to schedule optimal asset use. The model adjusts every 30 minutes to reflect dynamic changes in supply and demand



Manufacturing Data Foundation provides abundant opportunities for AI/ML models Representative AI/ML use cases are listed here



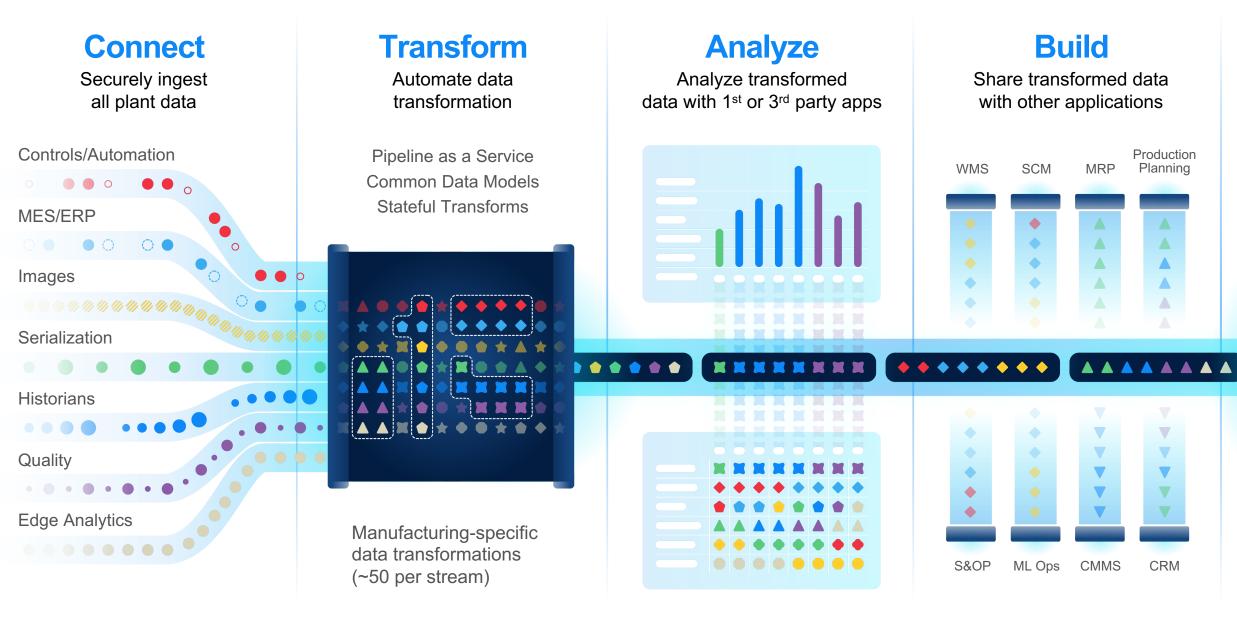
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## Architecture



### **Sight Machine Architecture**

Each layer is open and modular: transformed Data supports 3<sup>rd</sup> party products and services



OT Data is now transformed and ITready

#### **Results**

Make data useful for all stakeholders

- Operations Leadership
- Process Engineers
- Operators
- ✓ IT Managers
- ✓ Data Scientists
- Supply Chain
- ✓ Sustainability
- Connected Machines Sales Teams
- ✓ Planning

# Thank you

