



The IoT Inc Business Meetup Silicon Valley

Opening remarks and guest presentation

Join us onsite or online on April 7 at 6PM PST

Predictive Analytics
and the Industrial Internet
of Manufacturing Things

William Sobel
System Insights

IoT Inc. Meetup

Bruce Sinclair (Organizer): bruce@iot-inc.com

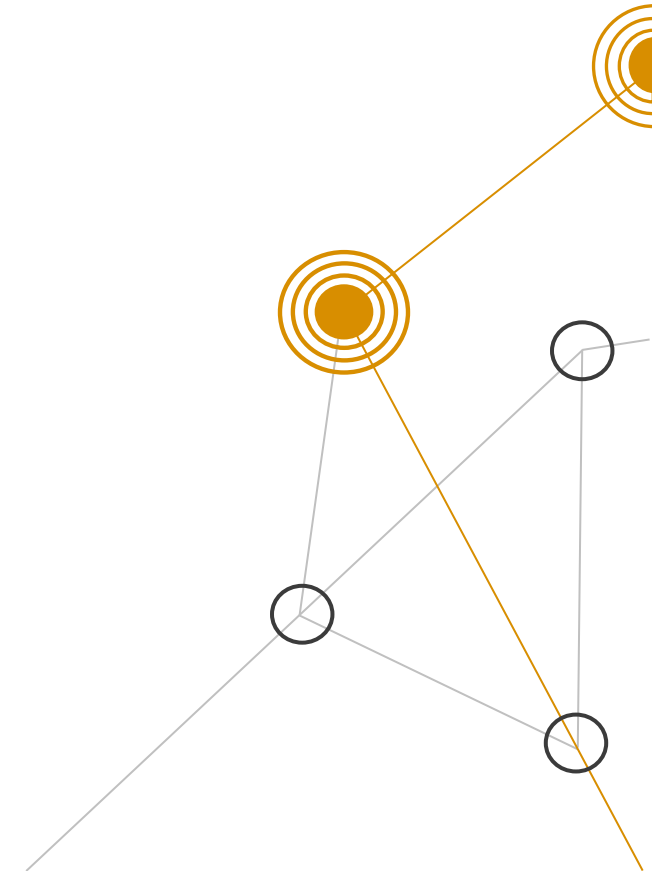


Target of Meetup

For business people selling products and services into IoT
but of course everyone else is welcome: techies, end-users, ...

Focus of presentations and discussions:

Business Models
Support
Marketing
Sales
Distribution
Finance
Post Sales
Pre Sales





Type of Products

All incremental value in an IoT product comes from transforming its data into useful information

- Trinity of value: model, app and analytics

Analytics transforms data into value

Past

Descriptive
Diagnostic

What happened?
Why did it happen?

Present

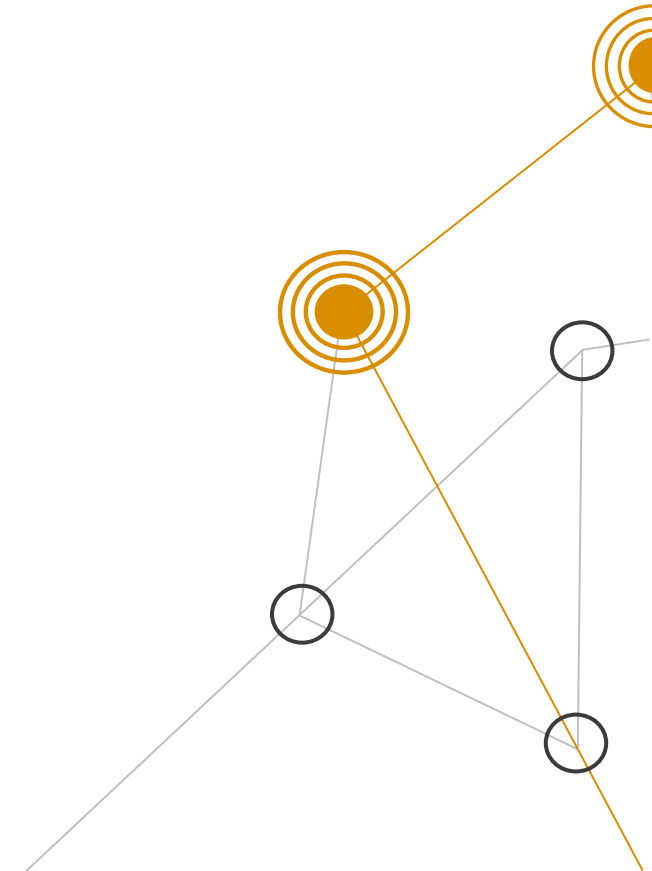
Rules Engine
RT Analysis

What is happening?

Future

Predictive
Prescriptive

What could happen?
What should happen?





Coming Up

Next Meeting, Thursday, May 5, 2016

Mega Meetup2 will be in July

Presentation, recording of Meetup and announcements for today's meeting will be sent in one week to everyone who provided their email upon signup for this meeting or any other past Meetup

Send announcements to me: My email: bruce@iot-inc.com

Feel free to upload pictures and tweet with hashtag #iotbusiness

Reviews would be great!



We have Sponsors!

Gold



Bronze



Shelter



Sponsor spots still available!

Food & Drink is \$600 per meeting x 10 meetings a year = \$6,000

- Gold = \$2,000 and Bronze = \$500

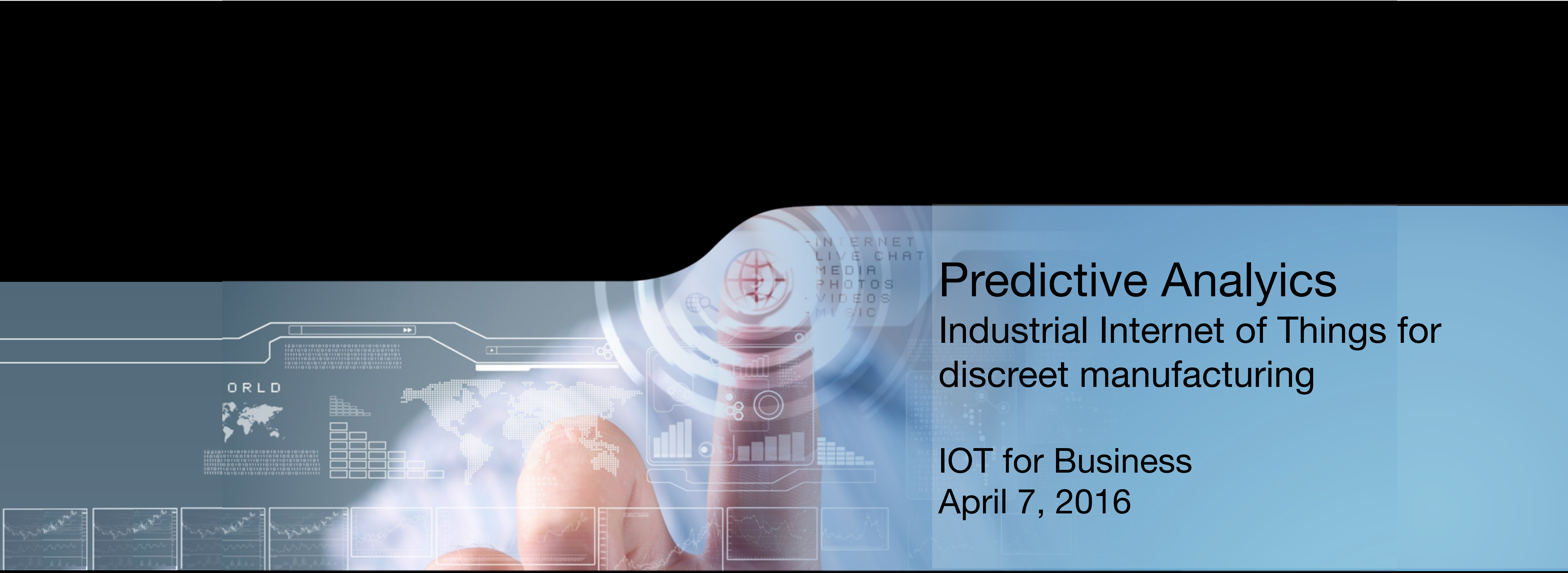
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Predictive Analytics

and the Industrial Internet of Manufacturing Things

William Sobel
System Insights



Predictive Analytics Industrial Internet of Things for discreet manufacturing

IOT for Business
April 7, 2016

VIMANA | by System
Insights

Berkeley, CA | Chennai, India

William Sobel
Chief Strategy Officer
System Insights

MTConnect Chief Architect

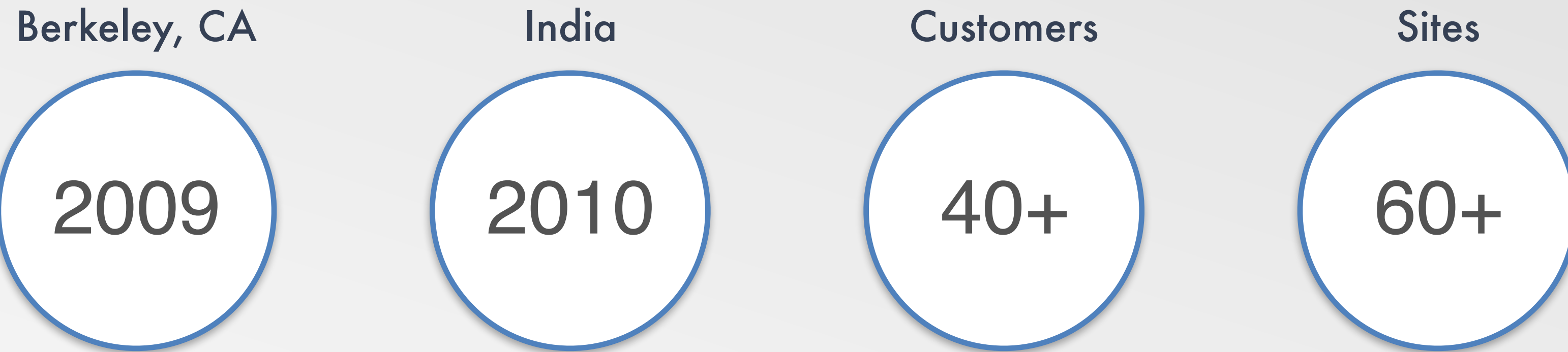
About Myself...

- Chief Strategy Officer – System Insights
- Chief Architect of the MTConnect Standard for the last 9 years
- Chair of the MTConnect Technical Steering Committee
 - Original Author of the Standard
- Co-Chair IIC Industrial Analytics Task Group

- My Background
 - Financial Systems Architecture
 - Real-Time Analytics
 - Distributed Architecture & Fault Tolerance

System Insights

The predictive analytics platform
for manufacturing intelligence



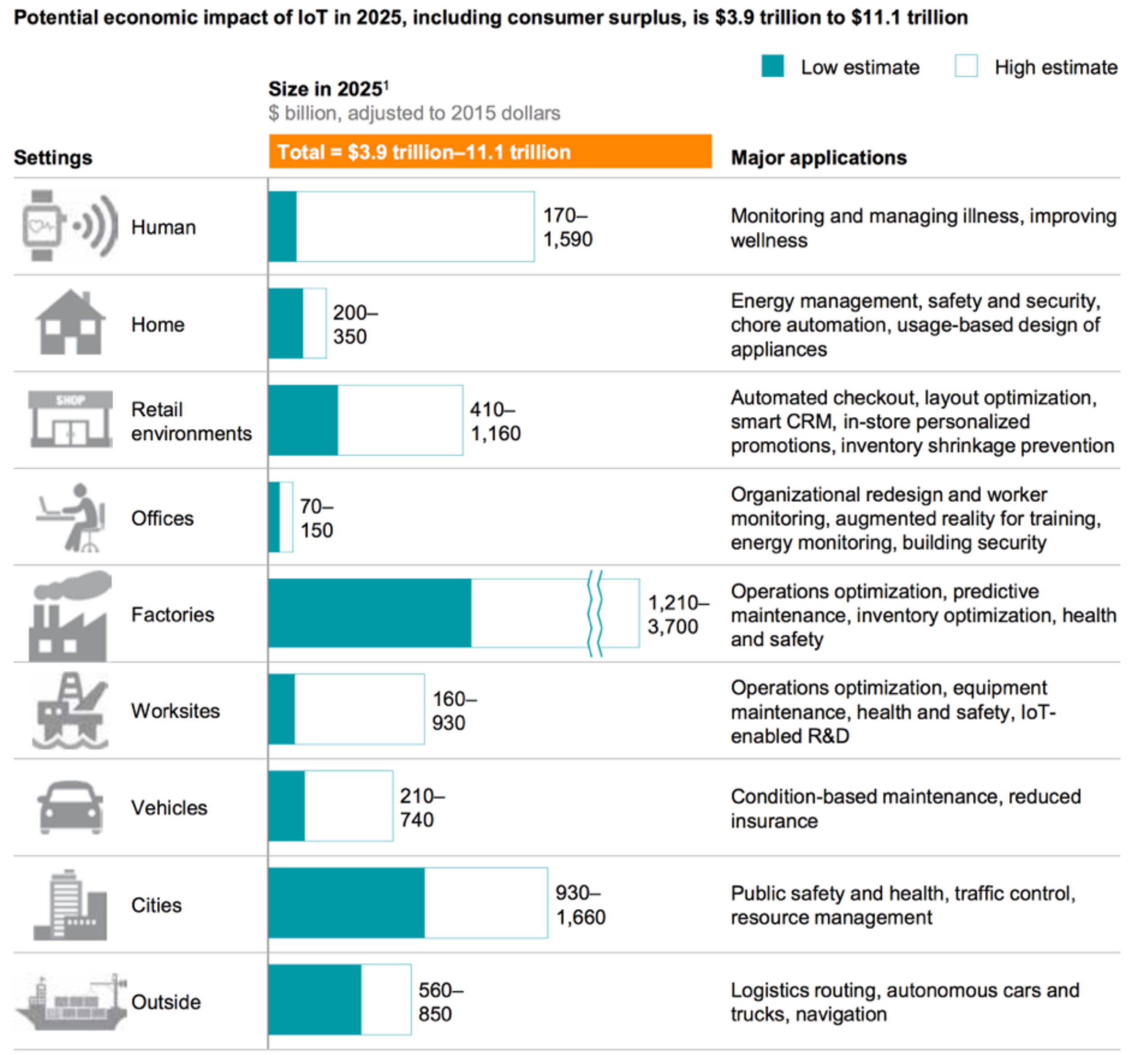
IIOT for Manufacturing

Industrial Internet of Things

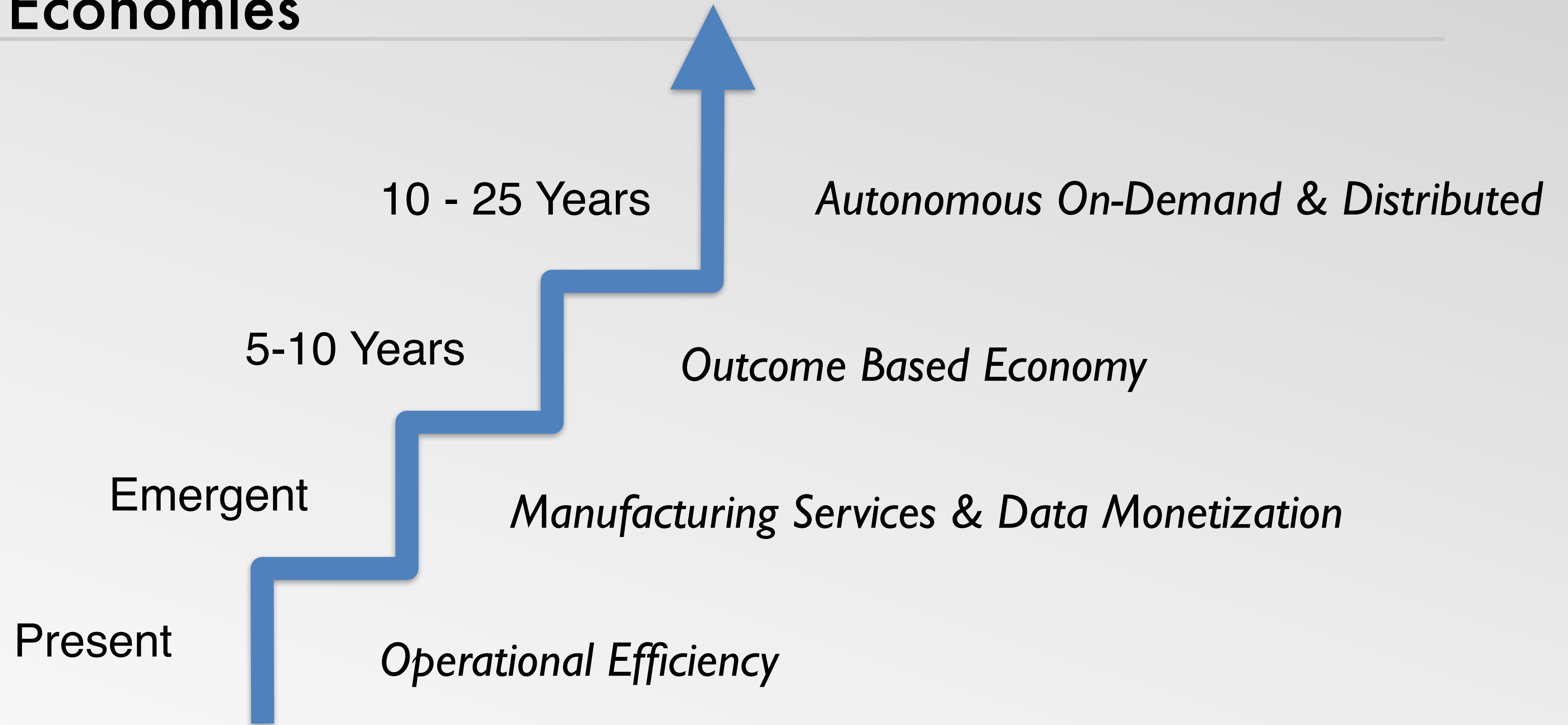
Internet of Things

- Industrial vs. Everything Else
 - Highest potential Impact
 - \$1.2 - 3.7T
- Areas
 - Operations Optimization
 - Predictive Maintenance
 - Inventory Optimization
 - Health and Safety

McKinsey Global Institute
 THE INTERNET OF THINGS: MAPPING THE VALUE
 BEYOND THE HYPE
 JUNE 2015

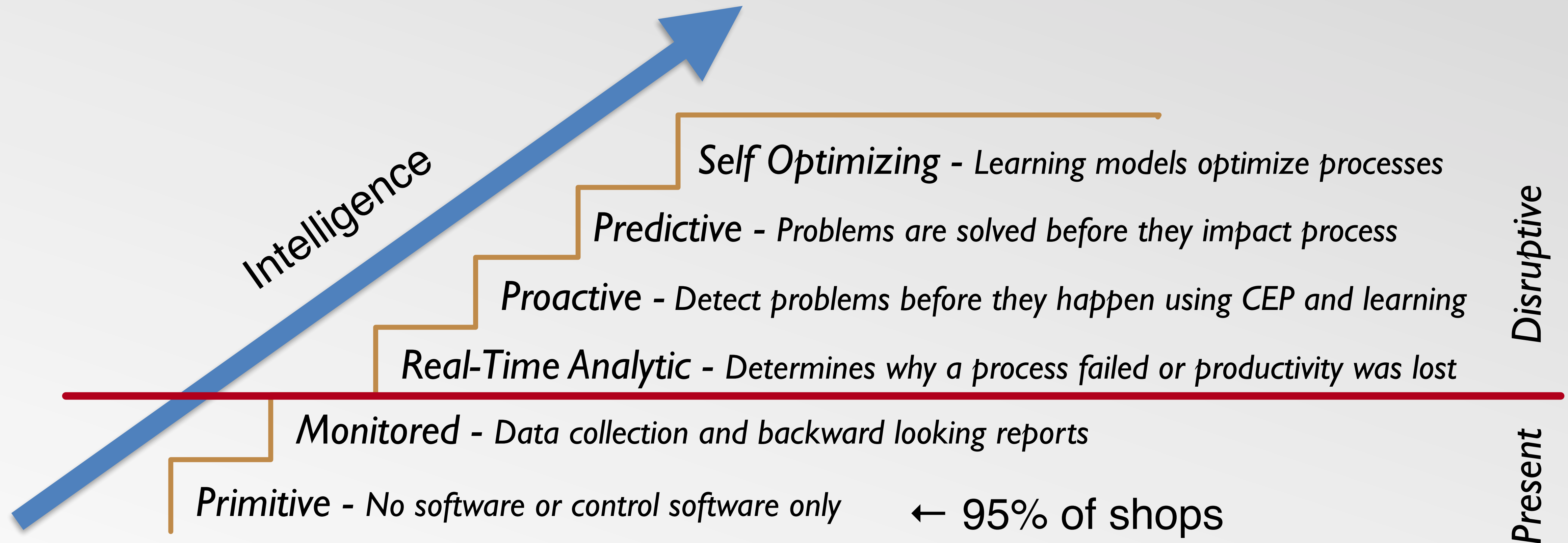


New Economies

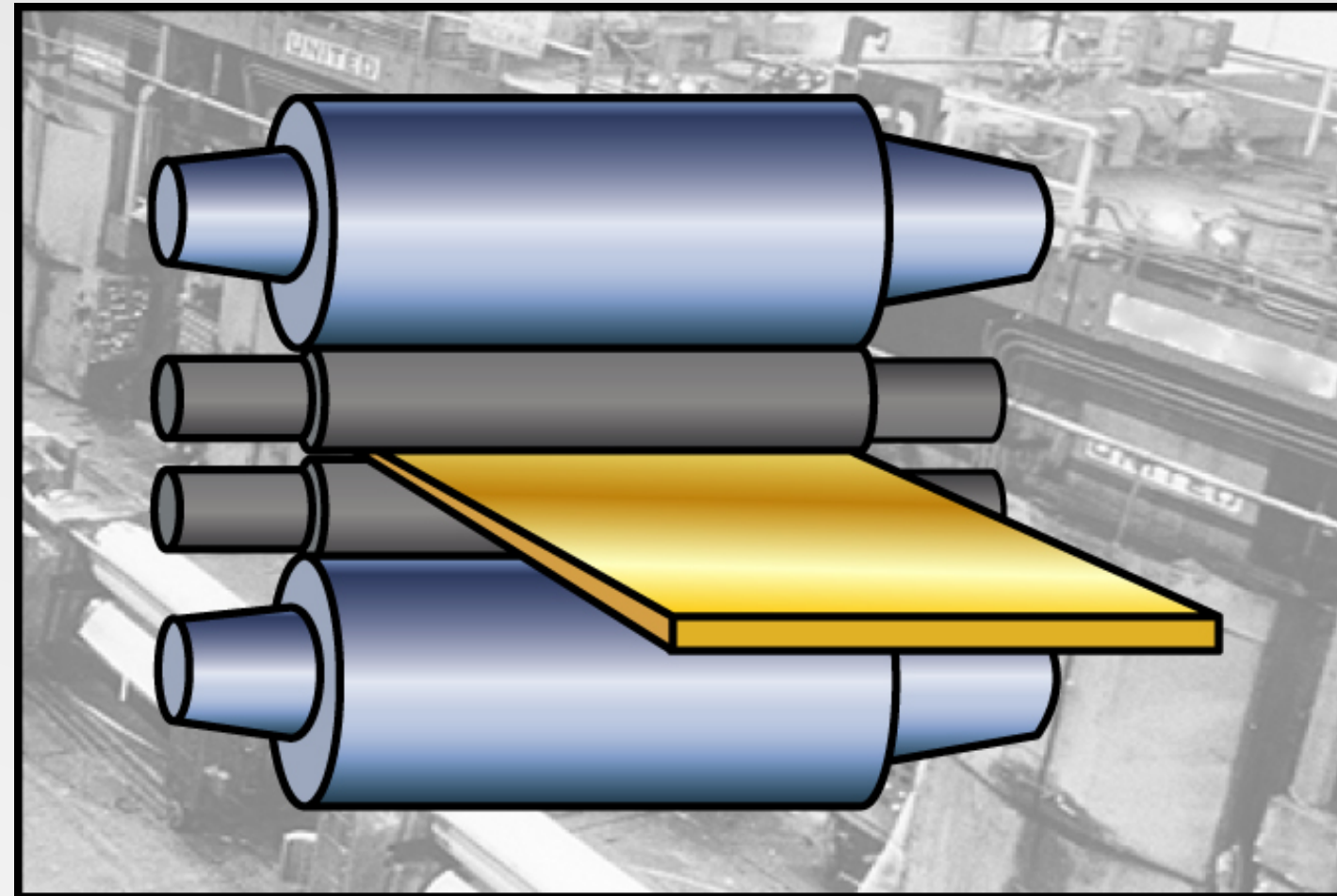


*World Economic Forum: Industrial Internet of Things:
Unleashing the Potential of Connected Products and Services, Jan 2011*

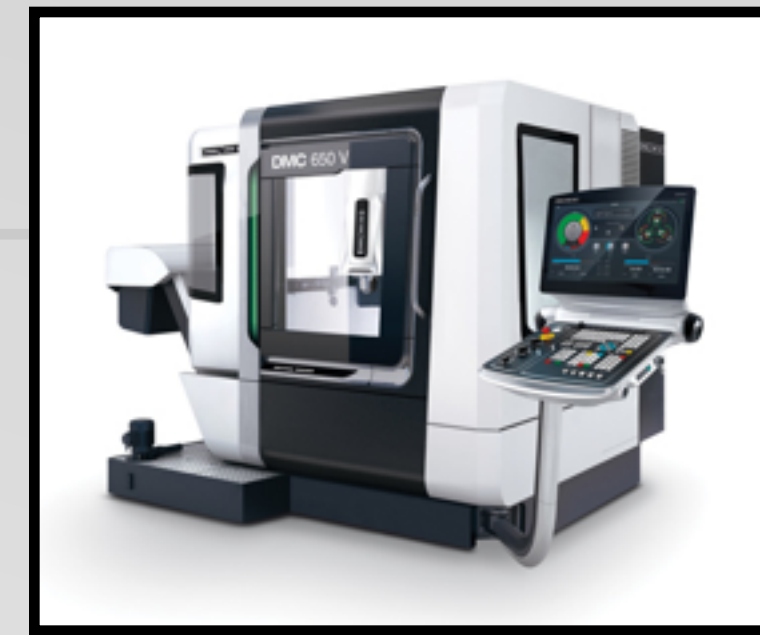
Intelligence Hierarchy



Steel Production



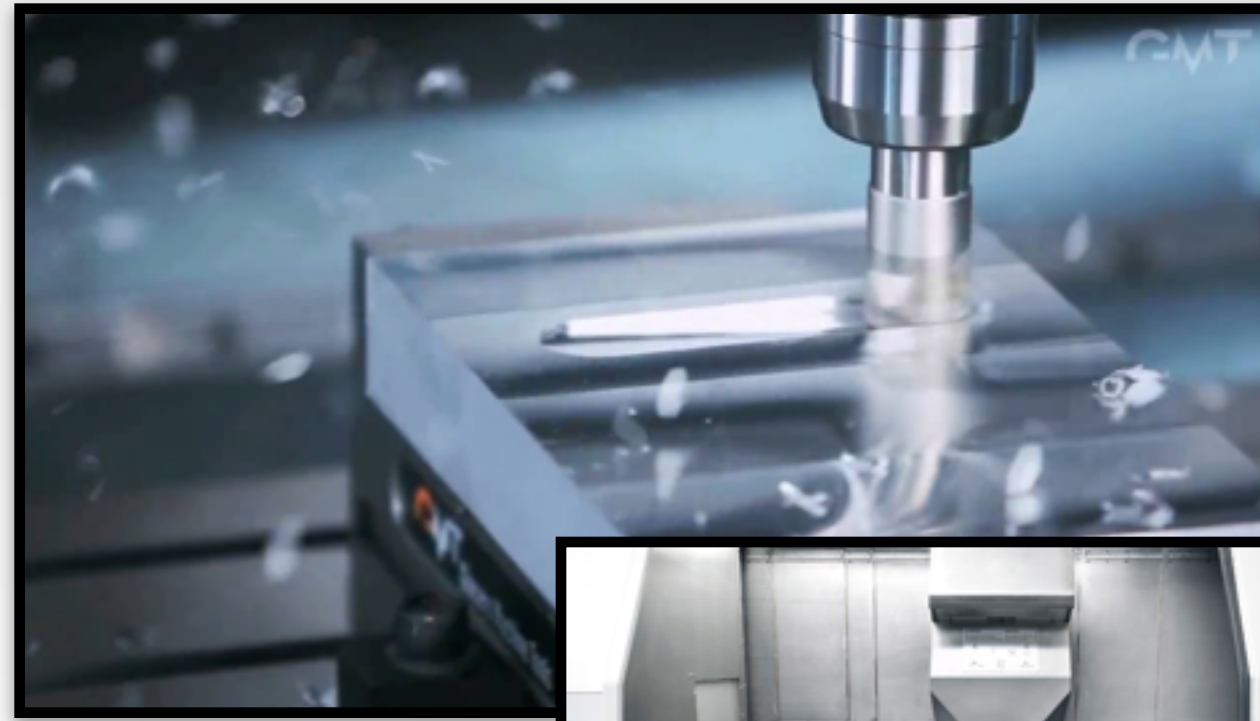
Metal Cutting



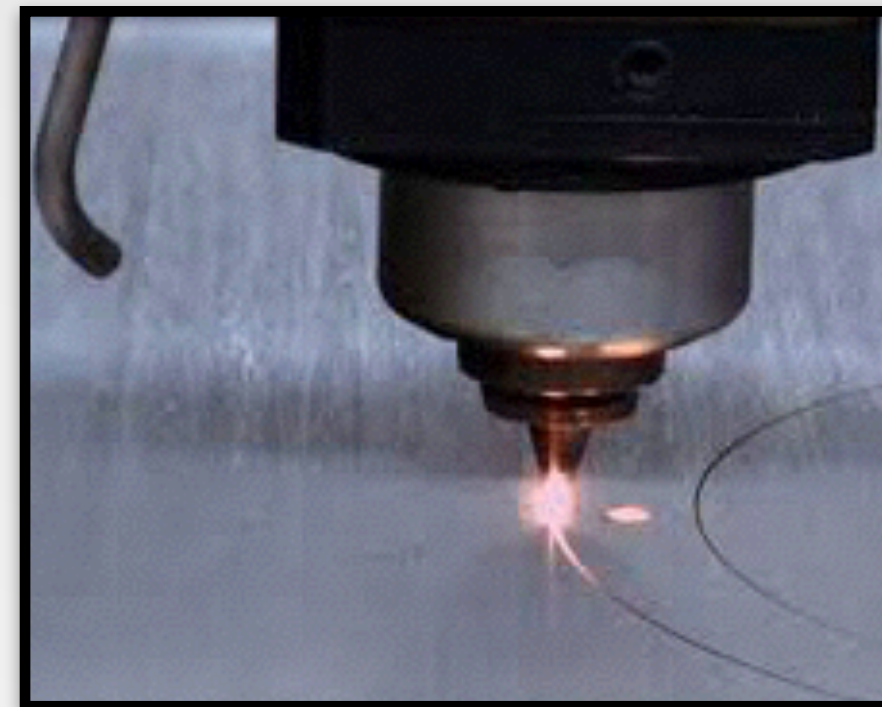
Traditional

Non Traditional

Milling



Laser

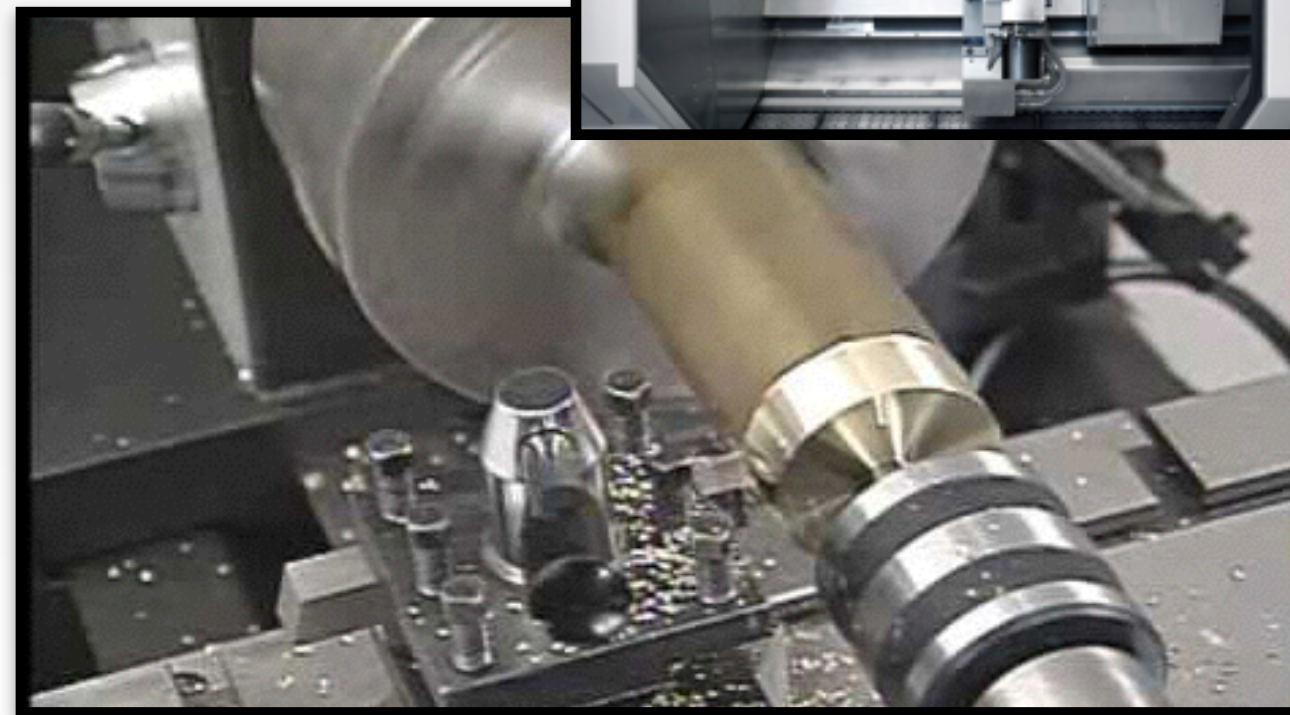


Wire EDM



Hybrid Additive

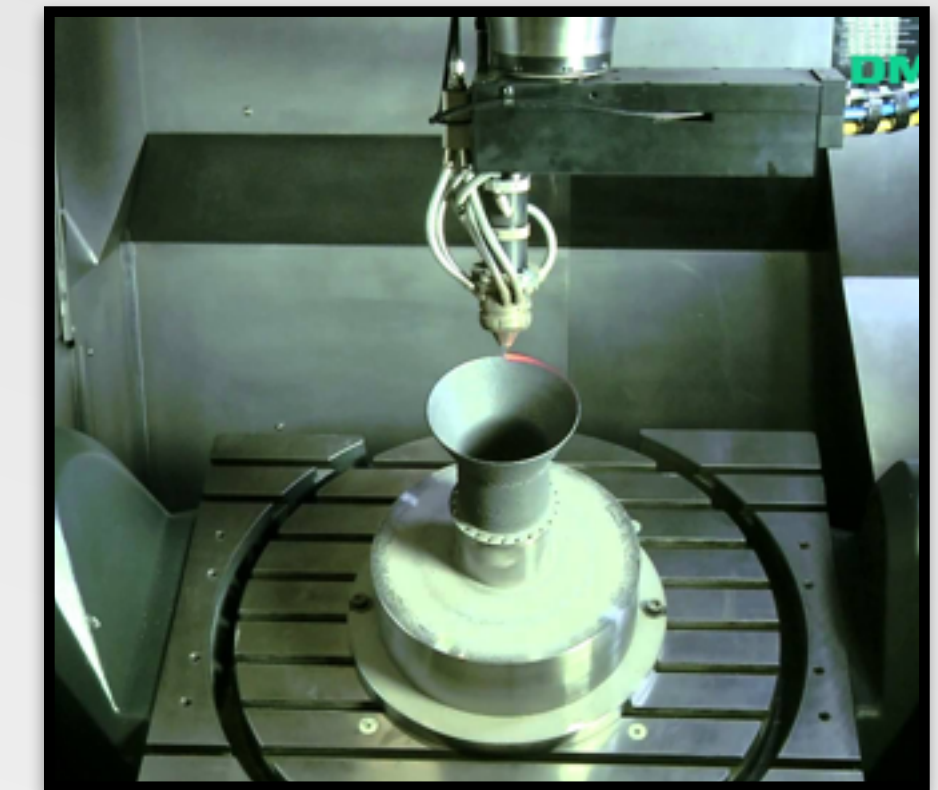
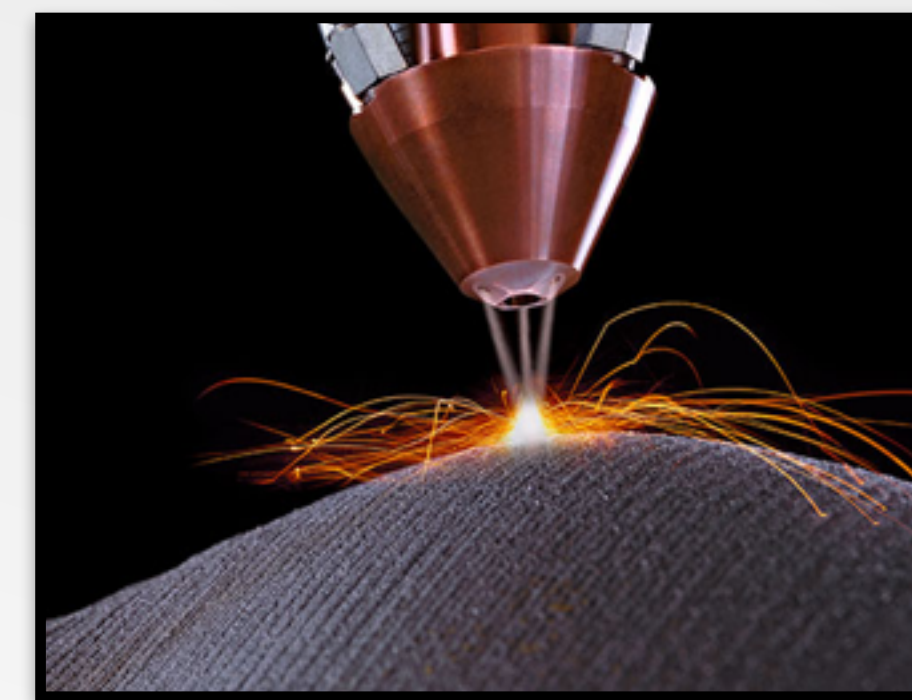
Turning



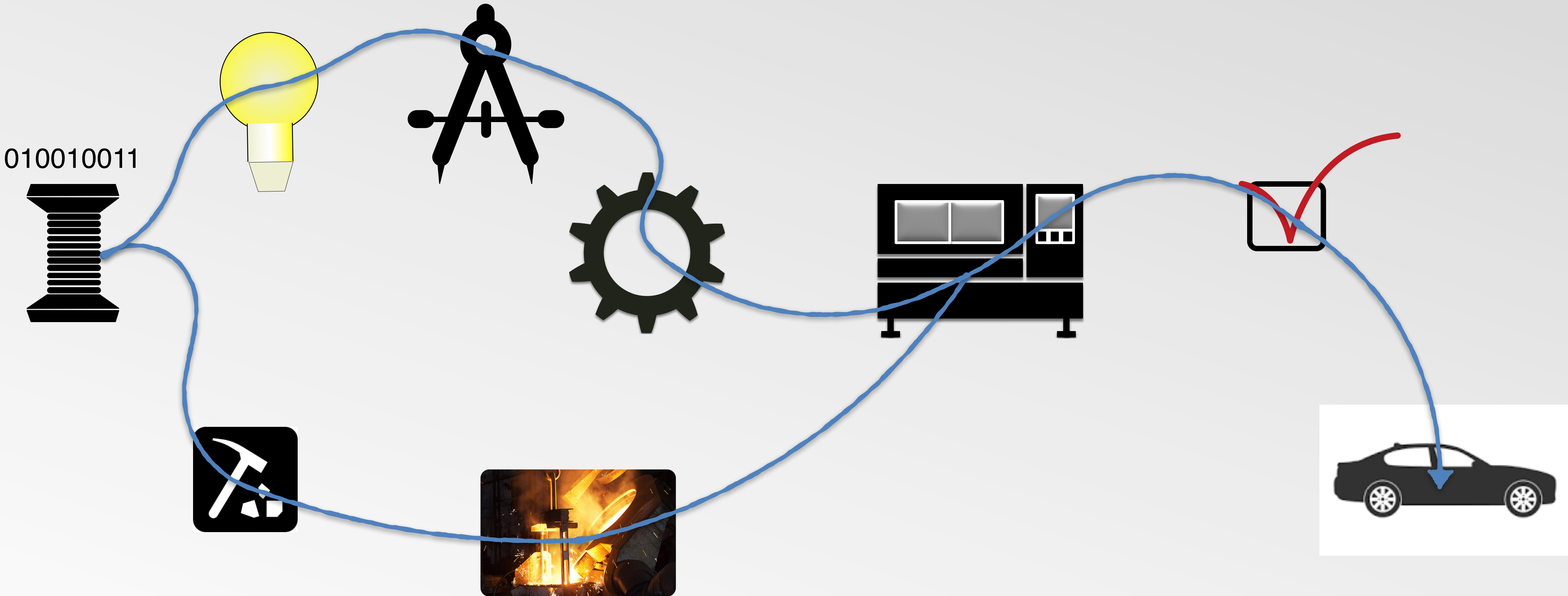
Water Jet



Additive



Digital Thread



Products



Case Study: Predictive Analytics for Process Manufacturing

Karthik Ranganathan

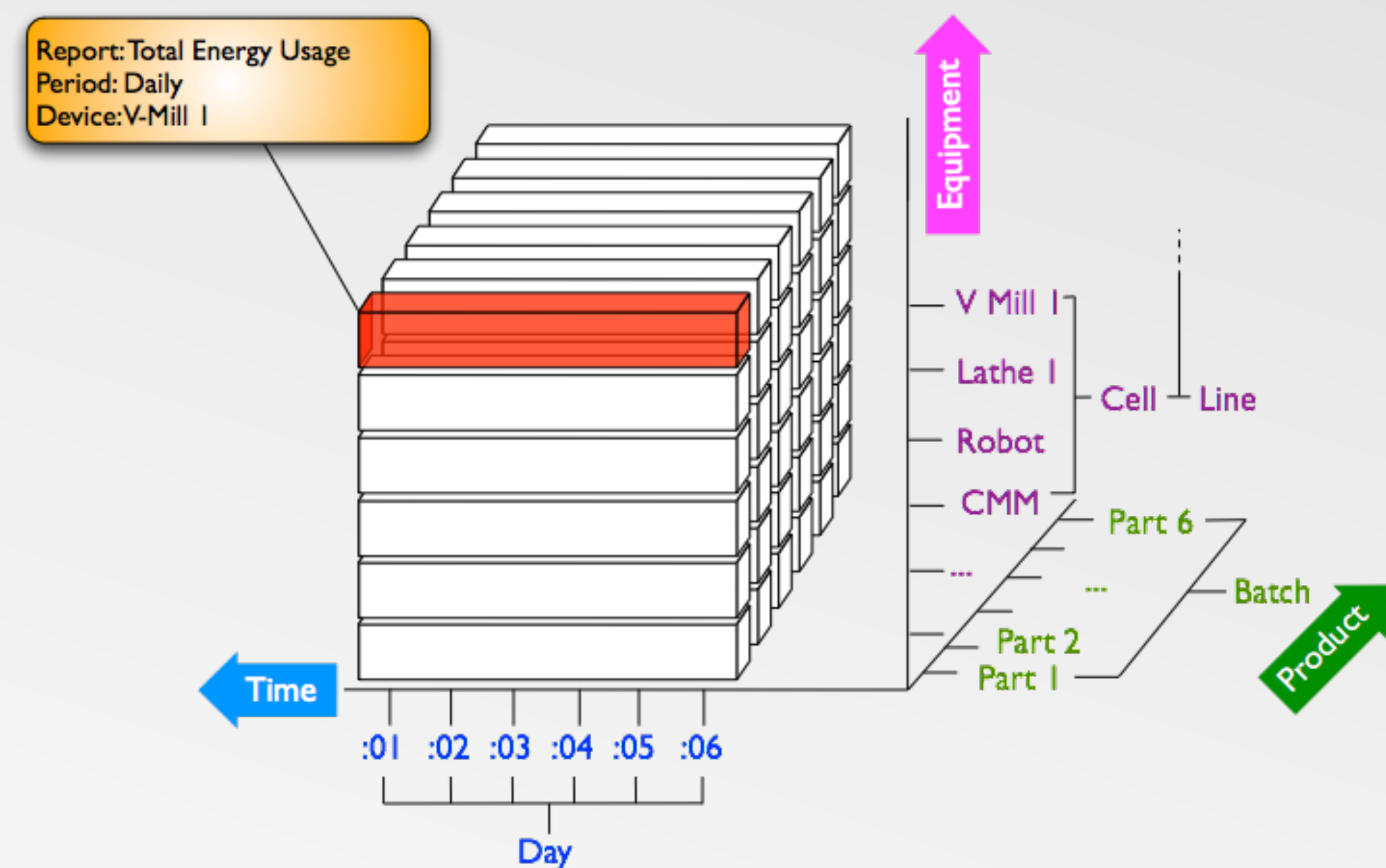
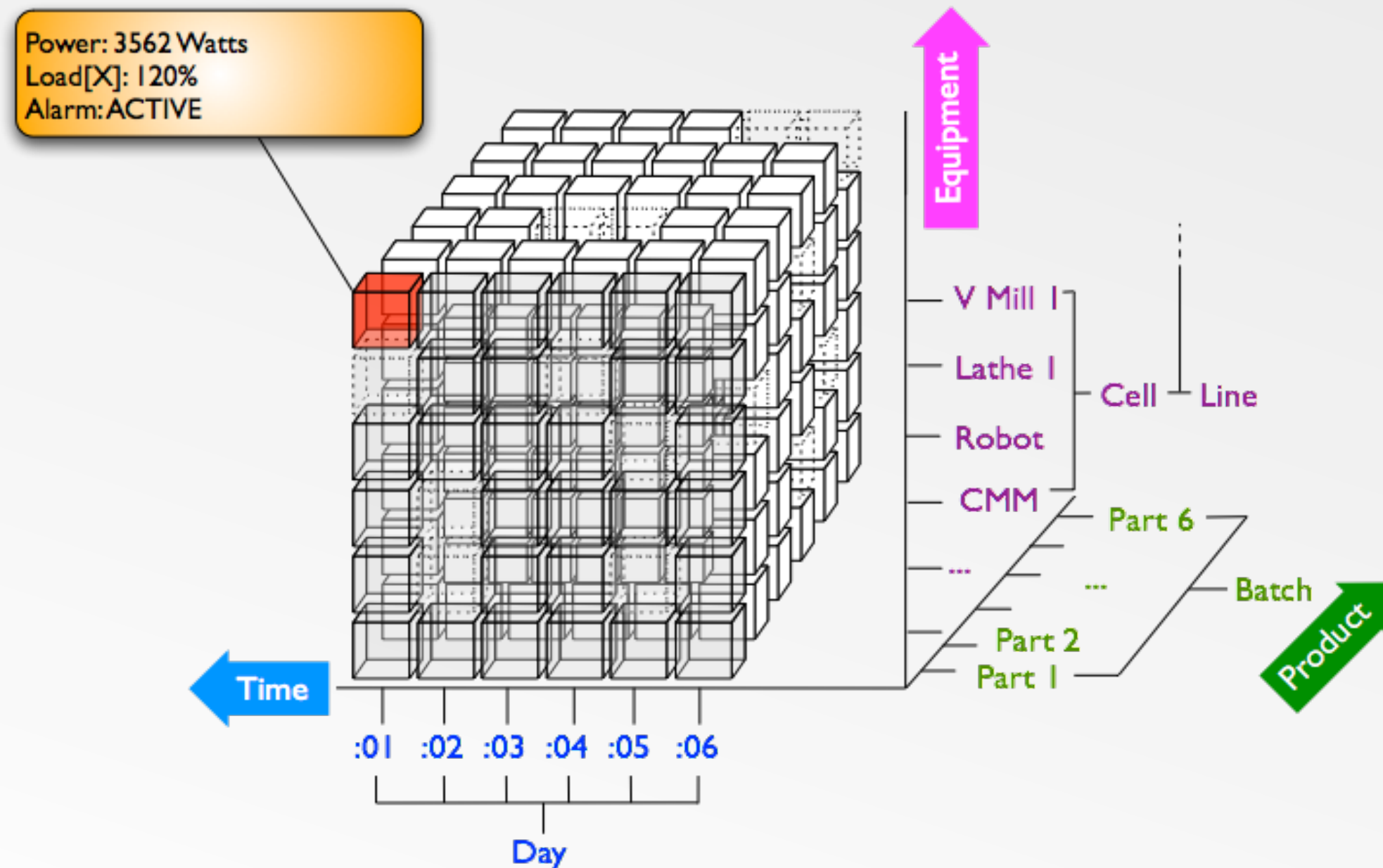
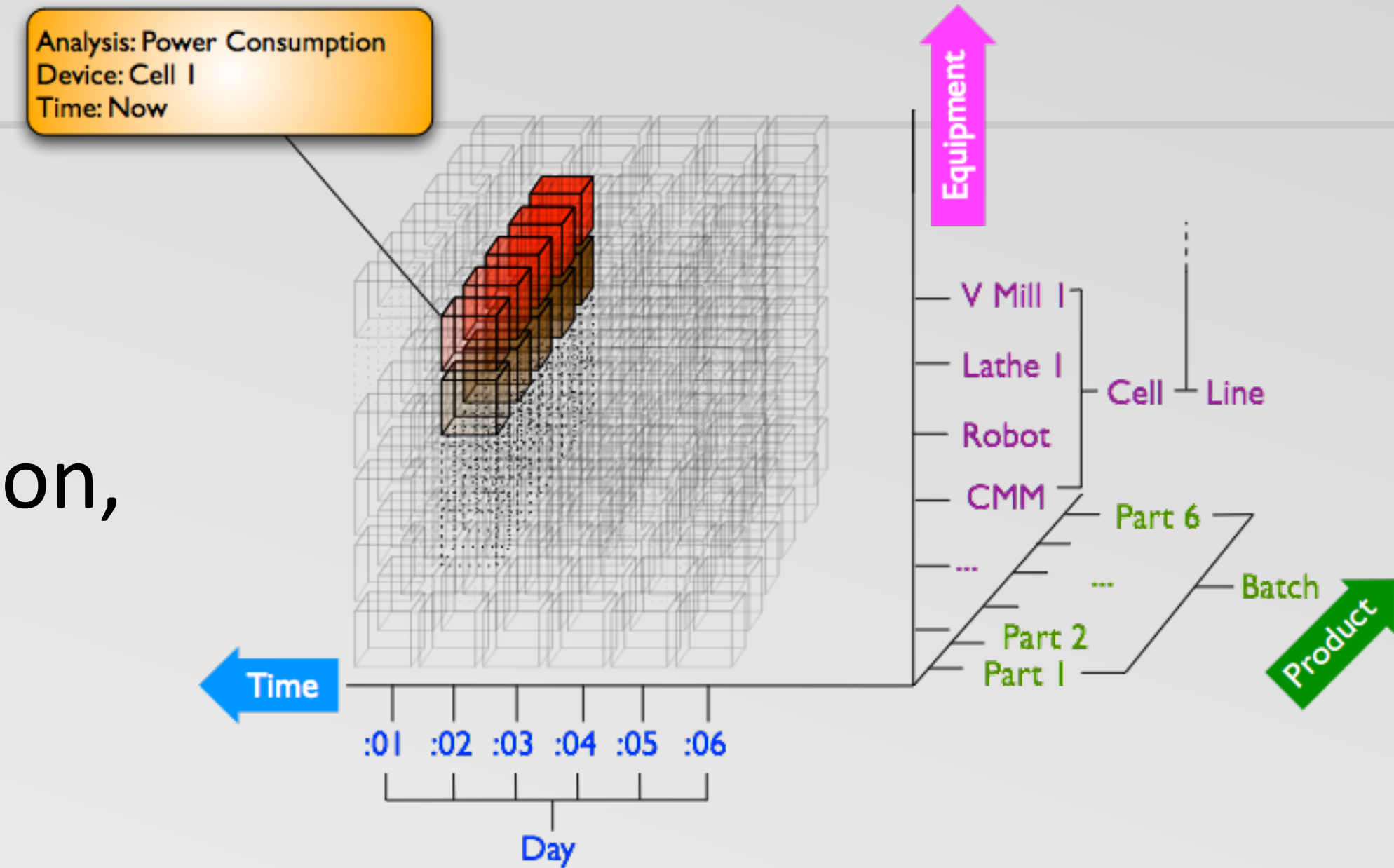
Predictive Quality and Yield



- Complex multi-stage high-speed manufacturing process
- Process is manually configured and adjusted
- Utilize legacy data collection of low-level sensor data
- Data Cleansing and Semantic Transformation
 - Multidimensional Data Modeling
- Contextualize Data with Device, Part and Process

Multi-dimensional data

1. Store Everything – Can't create data
2. Distributed analysis: Slice data across any plane, including: time, machine organization, parts – Find patterns and correlations
3. Everything must have context

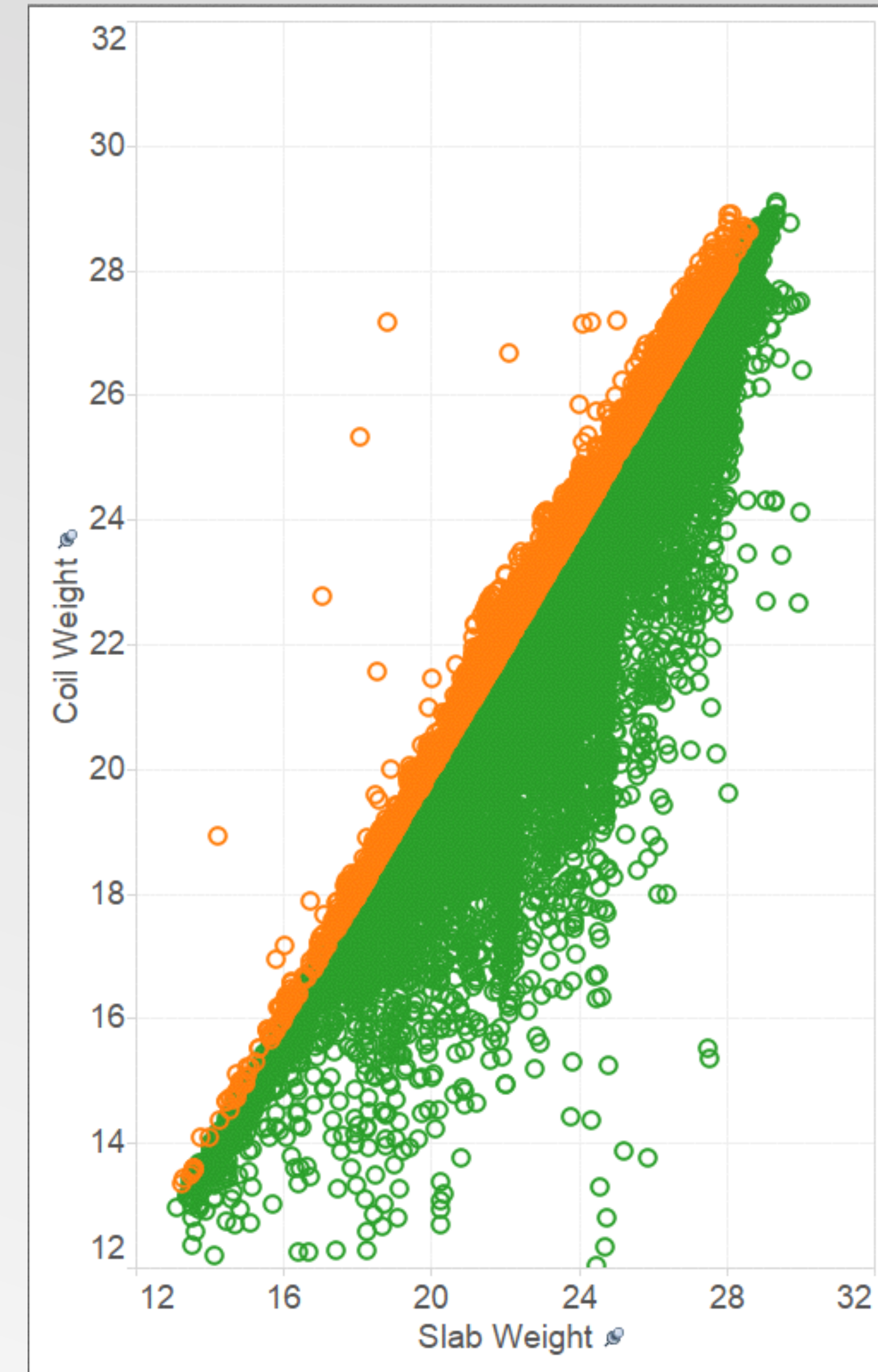


Data Set

- Source
 - 33 Tables and 800+ variables/columns
 - Size: 250+ GB
- Challenges
 - Data was organized per-operation, not across all operations
 - Varied parameters across operations and type of equipment
 - Potential missing data and data entry errors
- The data had to be prepped for analysis, including Cleanup and Contextualization

Data Cleansing

- Outliers
 - Observations which deviate significantly from the norm, with suspect veracity
 - Can remove to prevent model corruption
- Probable Causes
 - Data Entry Errors
 - Missing Data
 - Differing Units
 - Measurement flaws
- Examples
 - UTS/LYS values > 1000 MPa, < 10 MPa
 - Output slab weight $>$ Input slab weight ($\sim 1.85\%$)



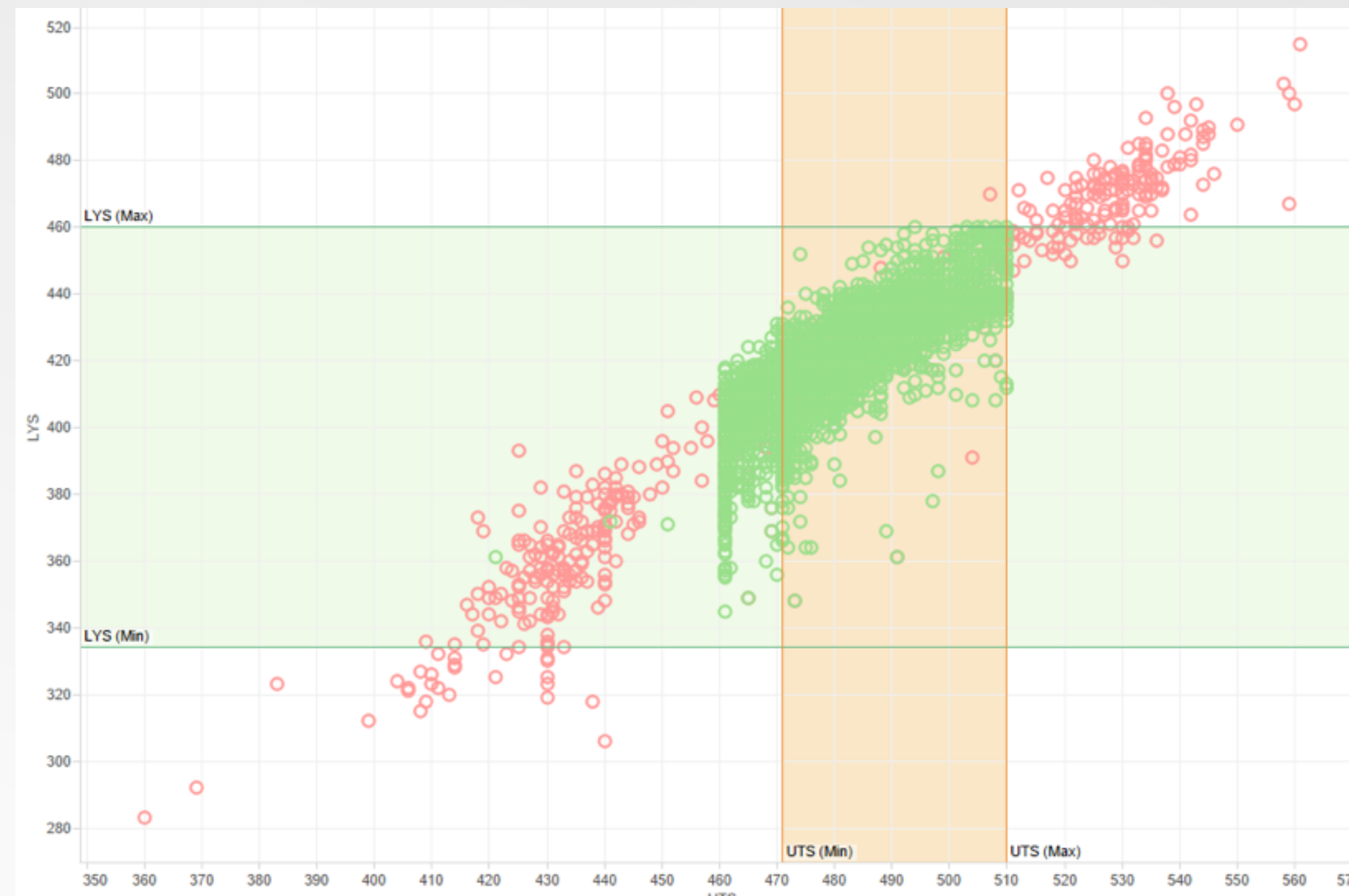
Process-based Quality Prediction

Build process-based model to predict final quality



Quality Prediction

- Expected quality parameters provided by customer
- However, it was seen that these bounds are not strictly followed while attributing grade
- We detected the true quality limits automatically from the data
- Reduction of lower boundary by 10 ~ 20 MPa for both LYS and UTS



Predicting Grade

- Predict grade based on the input parameters
- Analysis:
 - 5 Grades Analyzed
 - Total Observations – 5008
 - Training Data – 80%

**Production of Coils that match
Expected Grade**

92 +/- 1%

Matched Plant Predictions

99 +/- 0.5%

Improvement on Missed Predictions

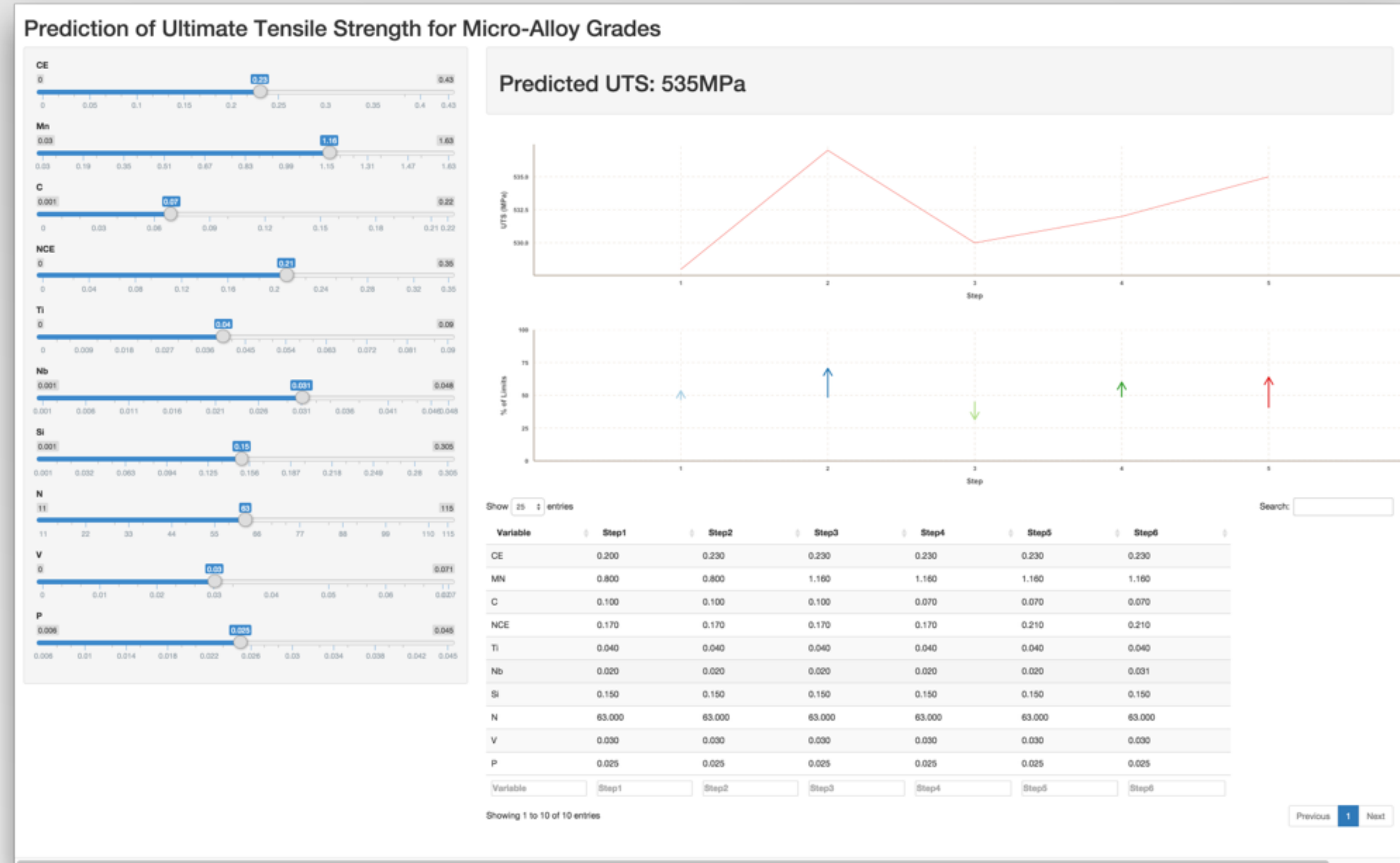
45 +/- 10%

New Prediction Methodology

95 +/- 1%

Predictive Services

- Using the models, we can predict the UTS with to 95% Accuracy based on chemistry
- Derived from empirical analysis of manufacturing process and data analytics



Value

- Reduce cost of quality
 - Control quality with critical parameters
 - Understand process parameters to control to have biggest impact on part quality
 - Set parameter limits – higher granularity and control over process
- Capture Tribal Knowledge
 - Capture and quantify know-how of the “humans in the loop”
 - Improve knowledge transfer and management oversight
- Target areas for process improvement
 - Significant process variation – identify areas where it has significant impact on quality



Market

- Global Steel Industry
 - Production (2015) – 1690 million tonnes
 - Market – \$1.3 Trillion
- One Company in Study
 - Market: \$3 billion
 - Operational profit: \$700 million
- Estimated Savings:
 - Based on a 3-5% reduction in operational costs
 - \$150 million in potential profit
 - \$250 billion in potential profit for entire market

Big Data Services

Present: Feed - Forward Processes



Programmer

- Part
- Machine
- Tool
- Processes

- Was the part produced to plan?
 - Faster or slower?
 - Why?

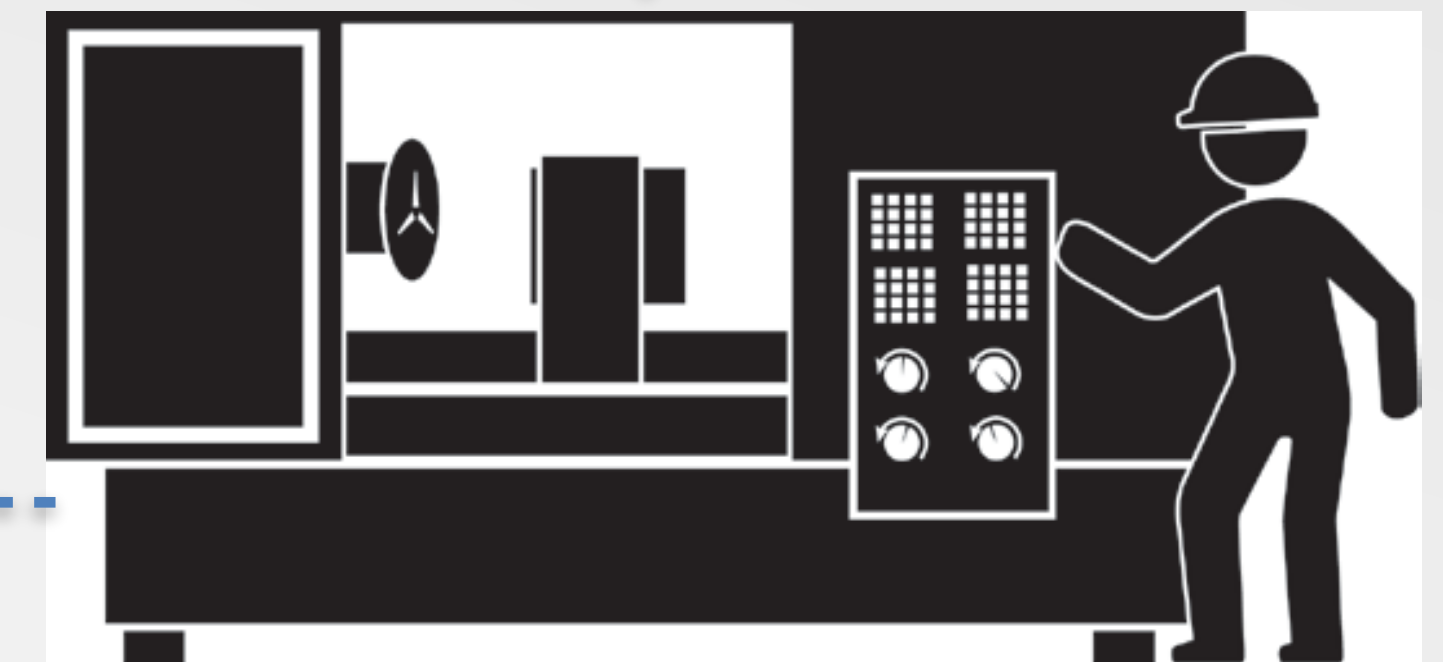


- Part Program
- Setup Sheet
- Work Instructions

- Best Practices
- Improvement Opportunities
- Deviations from Plan

No Robust Feedback mechanism to planning functions.

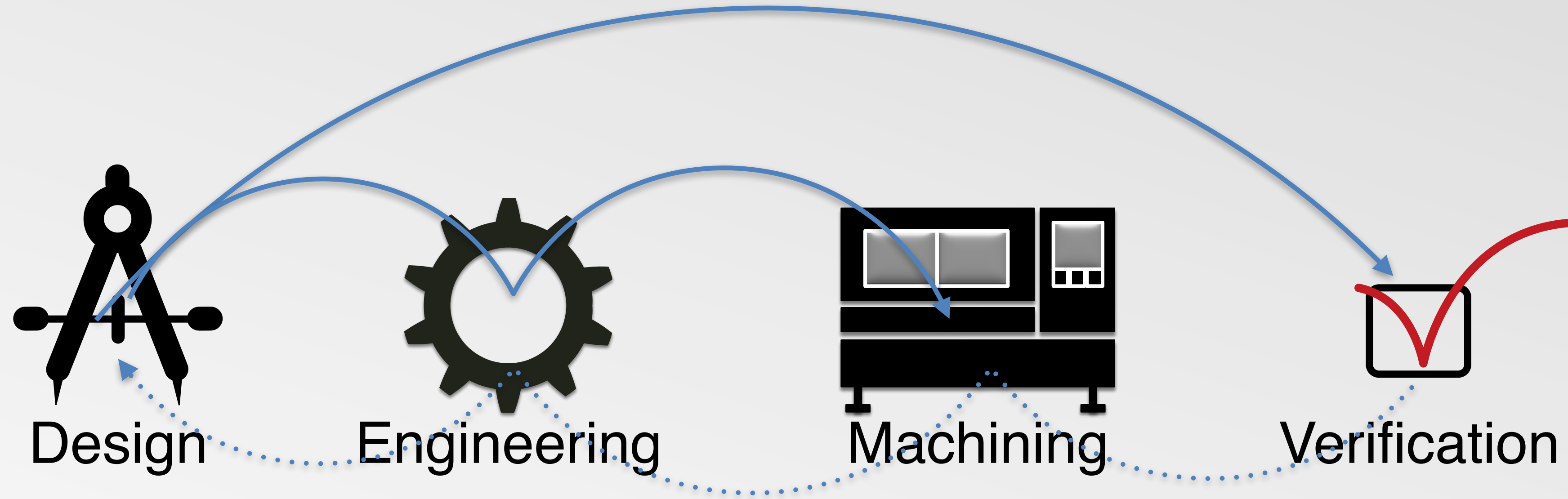
- Process Actuals
 - Feed/Speed
 - Cycle Time
 - Operator Feedback



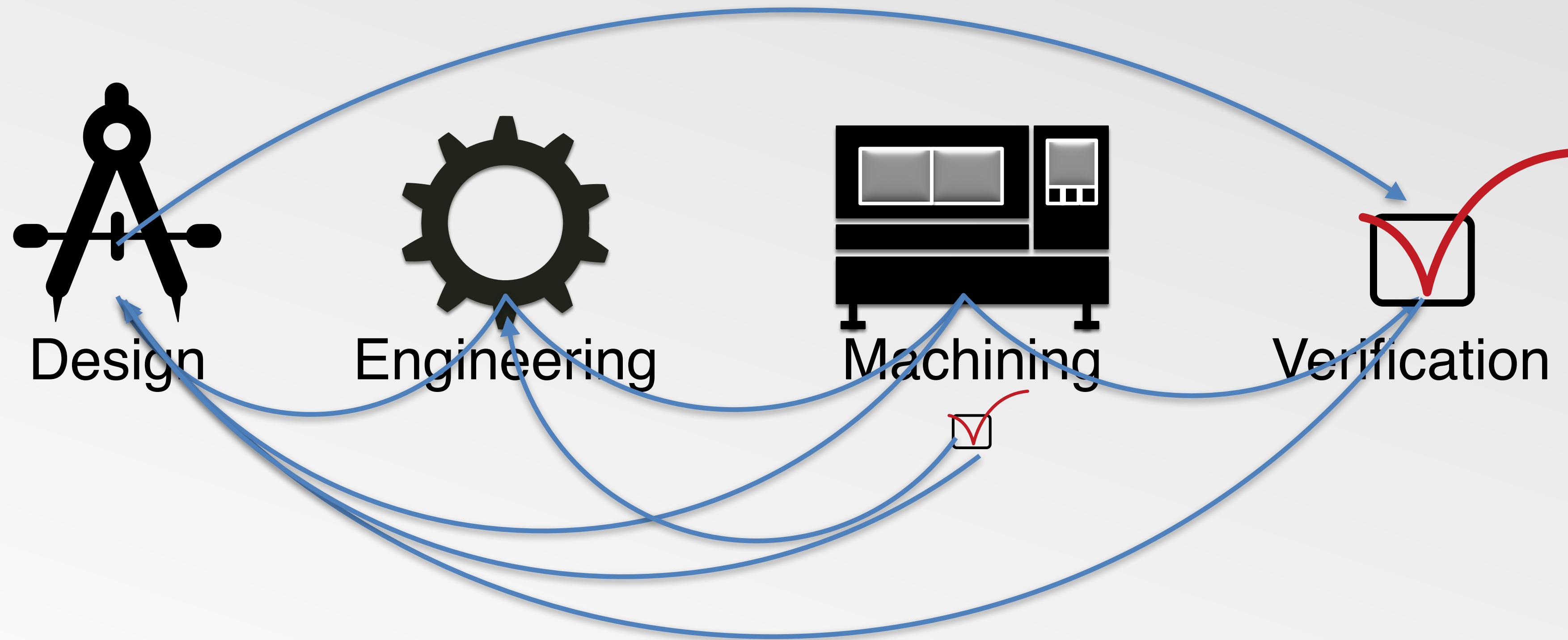
Operator

- Tool Breakage
- Poor Surface Finish
- Productivity Gains

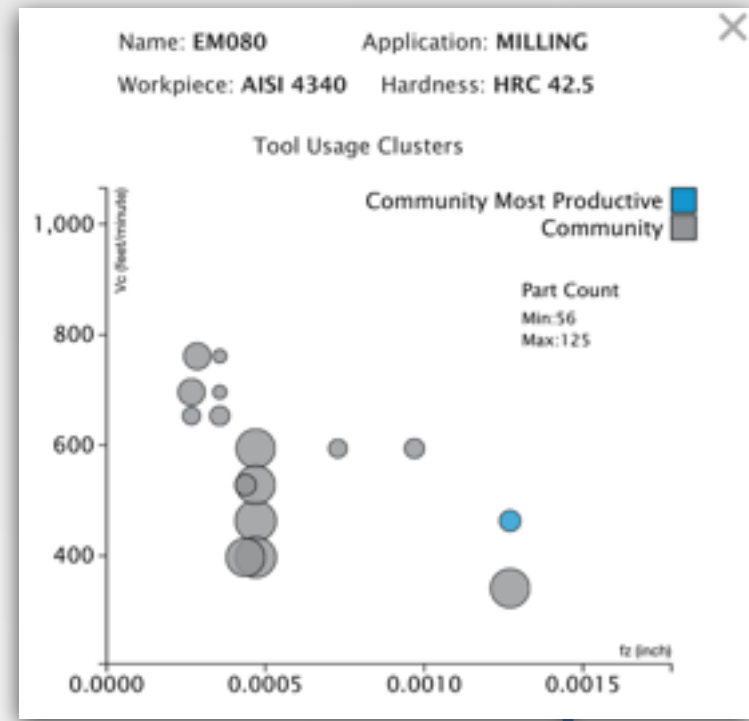
Current Feedback



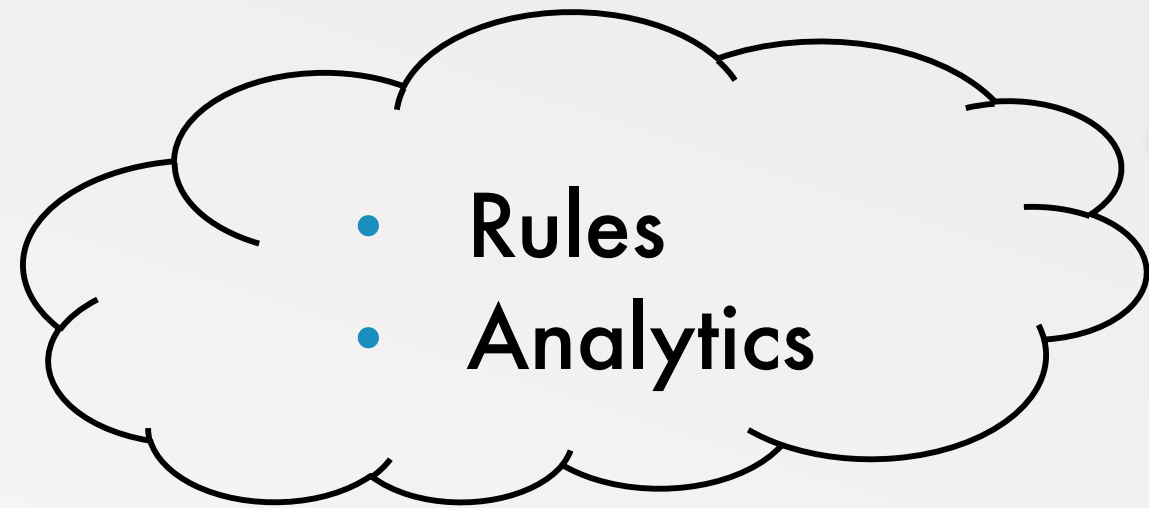
Digital Manufacturing Feedback



Crowd Sourcing for Manufacturing



- Knowledge-Based Recommendations
 - Optimized Conditions
 - Optimized Asset Selection
 - Optimized Throughput



Community Instructions, Plans
& Process Data



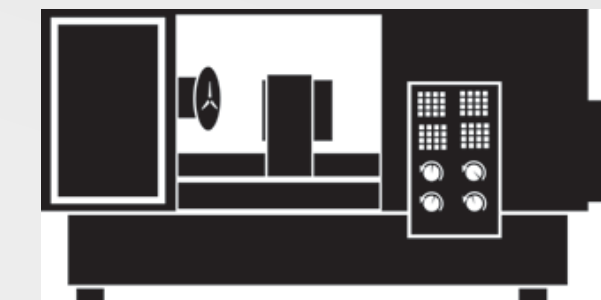
Facility

Programs
Instructions,
& Plans

Analytics = Data → Knowledge



Process Data



Tool and Process Analytics

Analyze process parameters and tooling usage to reduce tool costs and improve tool life

Detailed understanding of cycle time and process parameters

Program	Process	Device	Version	Count	Cycle Time Actual (s)	Cycle Time Planned (s)	
240207D7	845_067_187OPE	High Speed 5-Axis Mill 02	0	145	1349	1350	
614910D5	447_669_180027	High Speed 5-Axis Mill 02	0	137	1886	1768	
210920D7	56R_78J_178027	High Speed 5-Axis Mill 02	0	125	1121	1350	
230111D4	40R_62J_180005	High Speed 5-Axis Mill 02	0	120	756.4	1350	
210902D7	40R_62J_188030	High Speed 5-Axis Mill 02	0	122	1582	1768	
614910D7	40R_62J_180004	High Speed 5-Axis Mill 01	0	147	1159	1101	
614921D5	447_669_1880PE	High Speed 5-Axis Mill 01	0	254	1388	1101	
240203D7	56R_78J_178030	High Speed 5-Axis Mill 02	0	75	1091	1768	
210903D4	28G_40Y_164OPE	High Speed 5-Axis Mill 01	0	160	784.9	1101	

	Path Feedrate	Spindle Speed	Metric
NH-D2	0		56.54
NH-D1	0		23.17
NH-EA	0		176.1
NH-D1	0		91.55
NH-D0	0		148
NH-E2	0		24.85
NH-E2	0		116.4
60-E2	0		172.9
60-E2	0		160.7
NH-E2	0		61.74
NH-D1	0		40.13

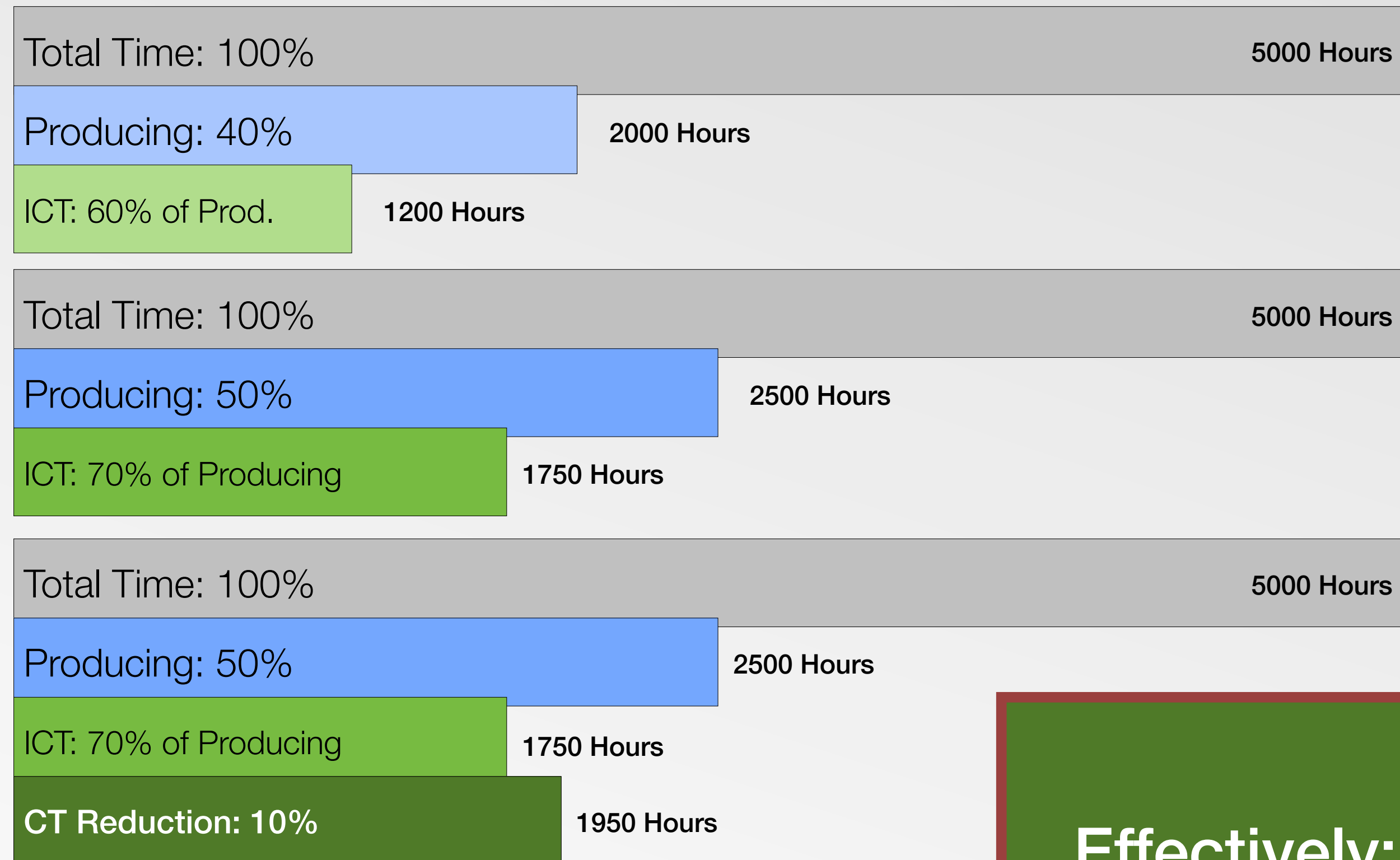
Automatically identify best practices for process planning

Program	Tool Sequence	Version	Path Feedrate (mm/min)		Spindle Speed (rpm)	
			Actual		Actual	
230111D4	16	0	342.9		4814	
210920D7	18	0	266.7		3742	
210902D7	8	0	213.4		3208	
240203D7	8	0	711.2		3742	
230111D4	19	0	304.8		4278	
614910D5	8	0	266.7		5273	
240207D7	1	0	228.6		5614	
614910D5	9	0	711.2		4814	
210902D7	5	0	533.4		2751	
210920D7	1	0	228.6		3208	
240207D7	2	0	266.7		6149	
240203D7	13	0	266.7		4278	

Increases in Efficiency

Conservative Estimates:
10% Increase in Production Efficiency + 10% Reduction of Cycle Time

Baseline



These improvements are what was referenced in the report – remember?

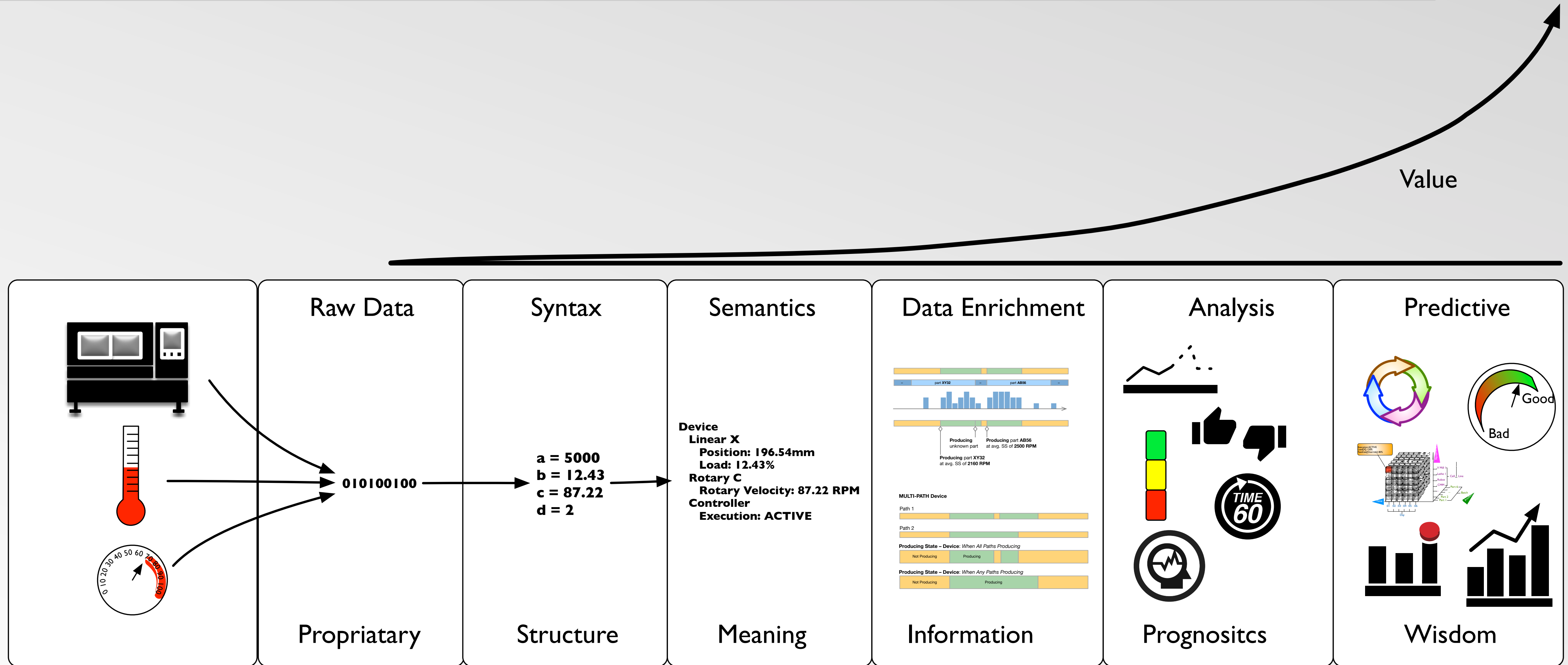
1.2 - 3.7 Trillion

Effectively: 62%
higher production

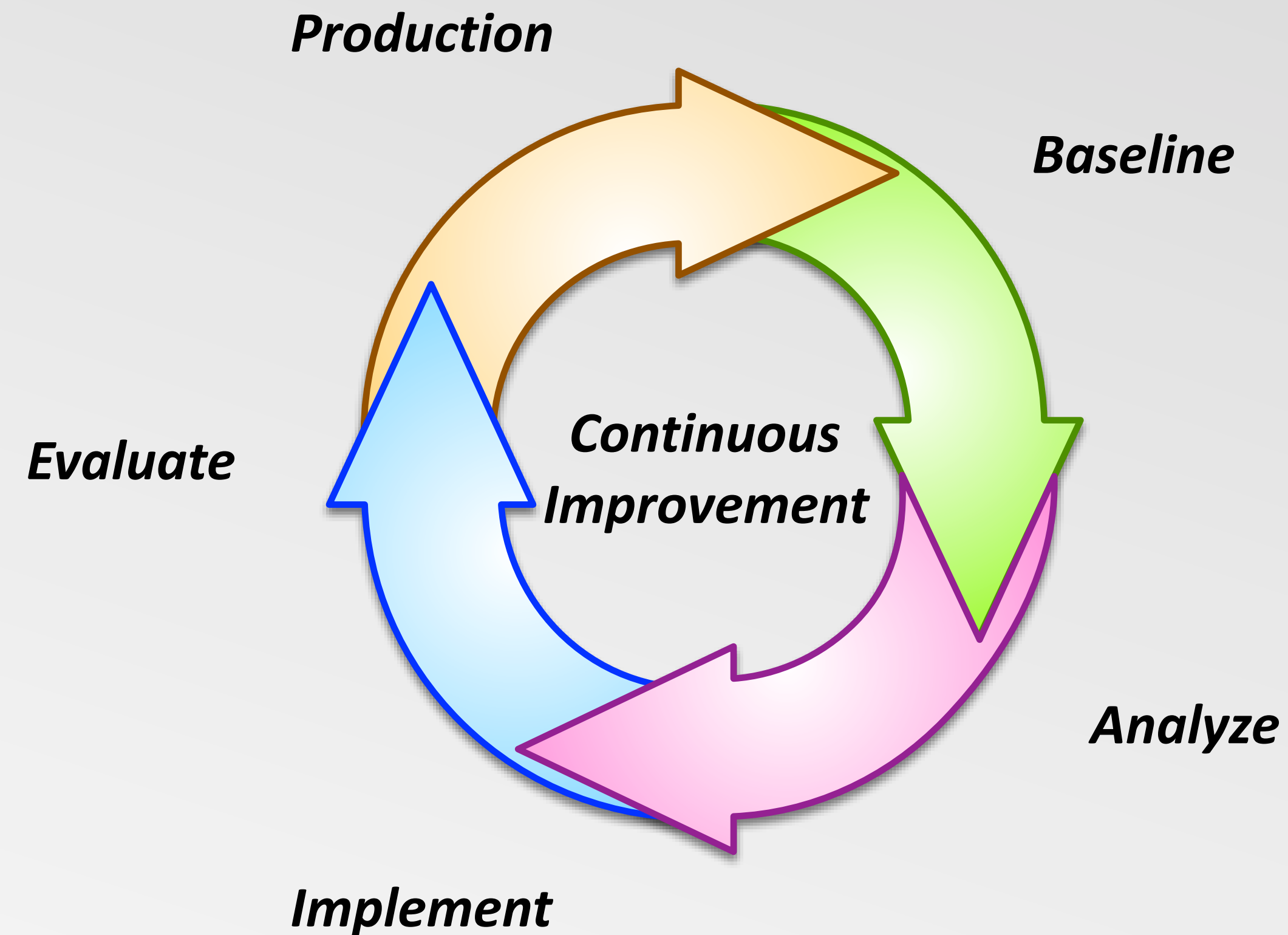
Predictive Analytics

Why would we do anything else?

Semantic Transformation



Continuous Improvement



Execution optimization
Process Improvement
Workforce Training

Tooling Optimization
Predictive Quality
Manufacturing Strategy
Design for Manufacturing

Questions?