IIoT Platforms for the Factory Floor

February 14, 2017

Evolution of IoT on the Factory Floor

Controller (respond) → **System** ← **Sensor (sense)**
input → System → output

ERP / EAM
MES / MOM
HMI / SCADA
DCS / PLC

Contextualize
Connect
Capture (sense) | Control (respond)

1868   **1960**   **1995**   **2017**

Control theory is first published…

Computing comes to industrial processes…

Proliferation of the Internet …

Process control of thing/physical asset
(motors, pumps, etc. / sub-seconds)

Supervisory control for coordinating multiple assets
(work center / seconds - minutes)

Orchestration of production resources
(factory / minutes - hours)

Lifecycle management of enterprise assets
(enterprise, supply chain / hours - weeks)

The Manufacturing IT Engine has Stalled

80% OF FACTORIES do not have MES systems

Ref: LNS Consulting

Moving from Monolithic to Modular MES: How IIoT Is Transforming Manufacturing Operations
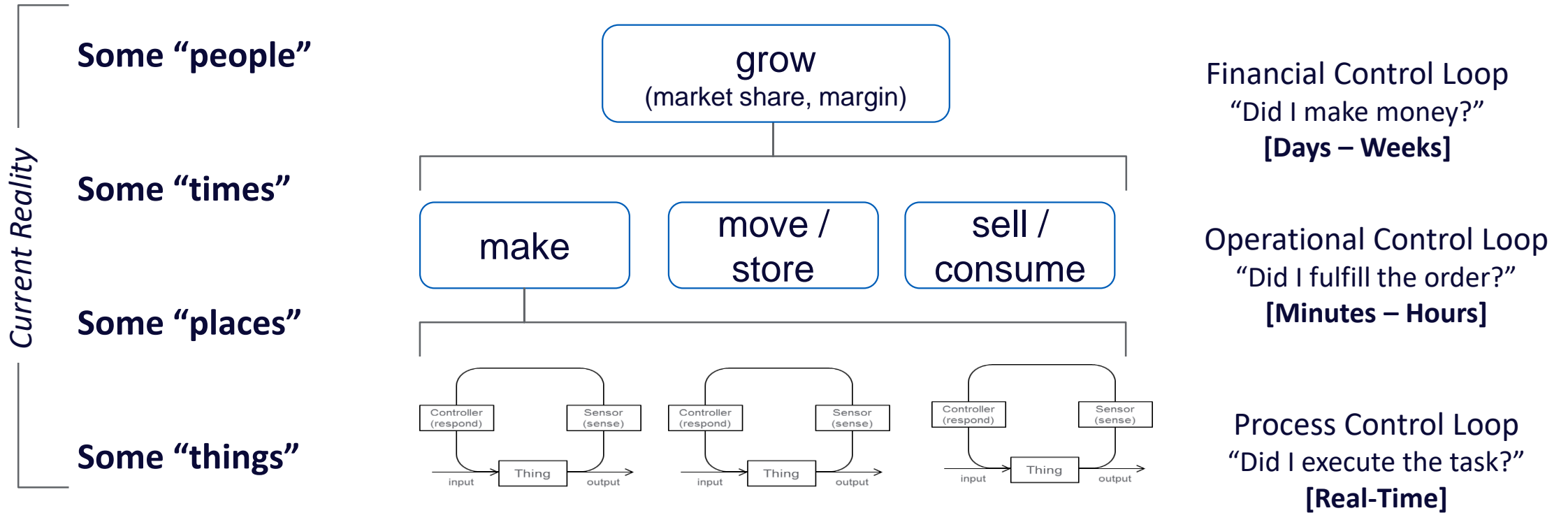
70% Of factory generated data goes unused

Ref: Gartner

Need to converge IT and OT to Increase Velocity

IT today: Managing a world of "**Persons**"

Current Reality

Some "people"

Some "times"

Some "places"

Some "things"

grow
(market share, margin)

make

move /
store

sell /
consume

Controller
(respond)   Sensor
(sense)

input   Thing   output

Controller
(respond)   Sensor
(sense)

input   Thing   output

Controller
(respond)   Sensor
(sense)

input   Thing   output

Financial Control Loop
"Did I make money?"
[Days – Weeks]

Operational Control Loop
"Did I fulfill the order?"
[Minutes – Hours]

Process Control Loop
"Did I execute the task?"
[Real-Time]

OT today: Controlling a world of "**Things**"

New Expectations in Manufacturing Operations Management

Processes
↑ Quality
↑ Throughput
↓ Waste / Rework
↓ Lead Time

Assets
↑ Reliability
↑ Availability
↓ Operational Cost
↓ Operational Risk

People
↑ Decisions
↑ Engagement
↓ Cycle Time
↓ Turnover
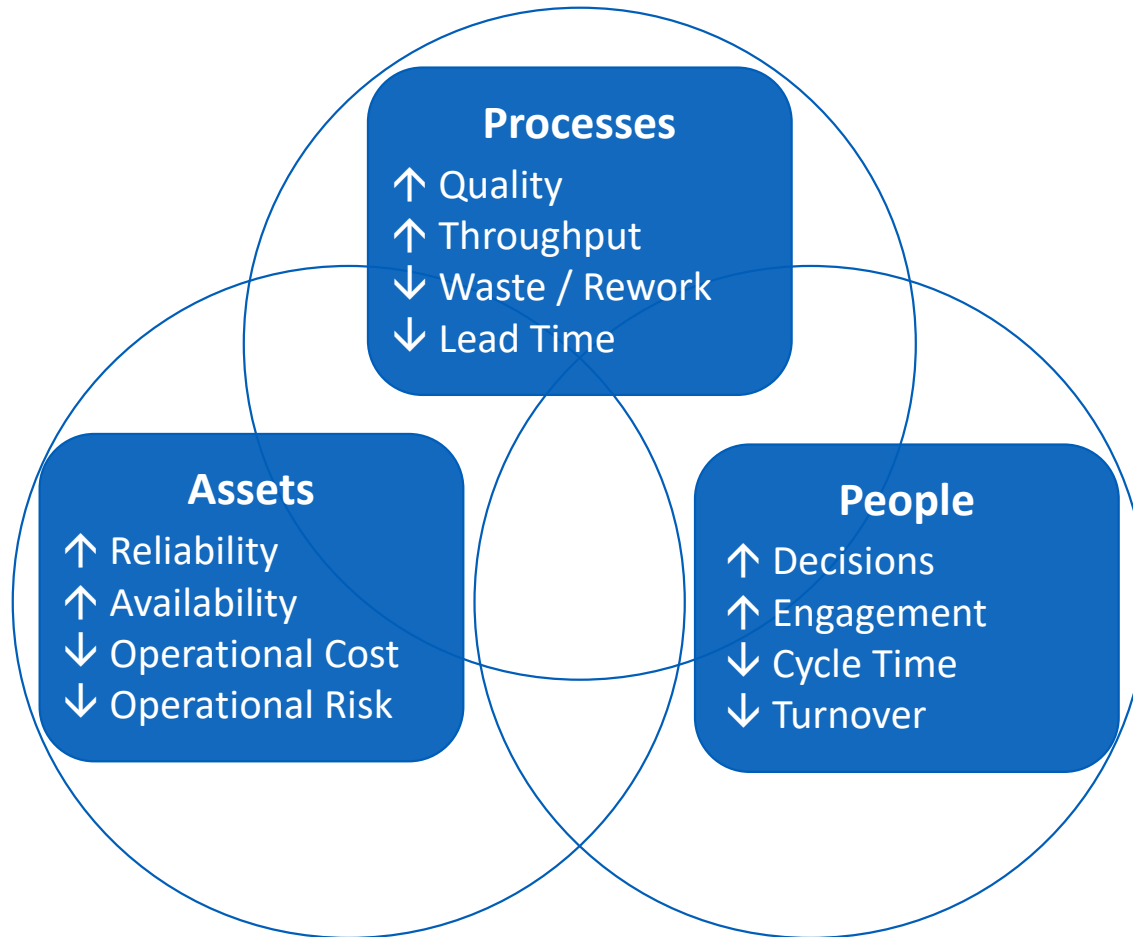
It is not enough to manage operations in silos anymore

Digital Twin of the Manufacturing Enterprise -

Each twin behaves differently in a group vs running by itself
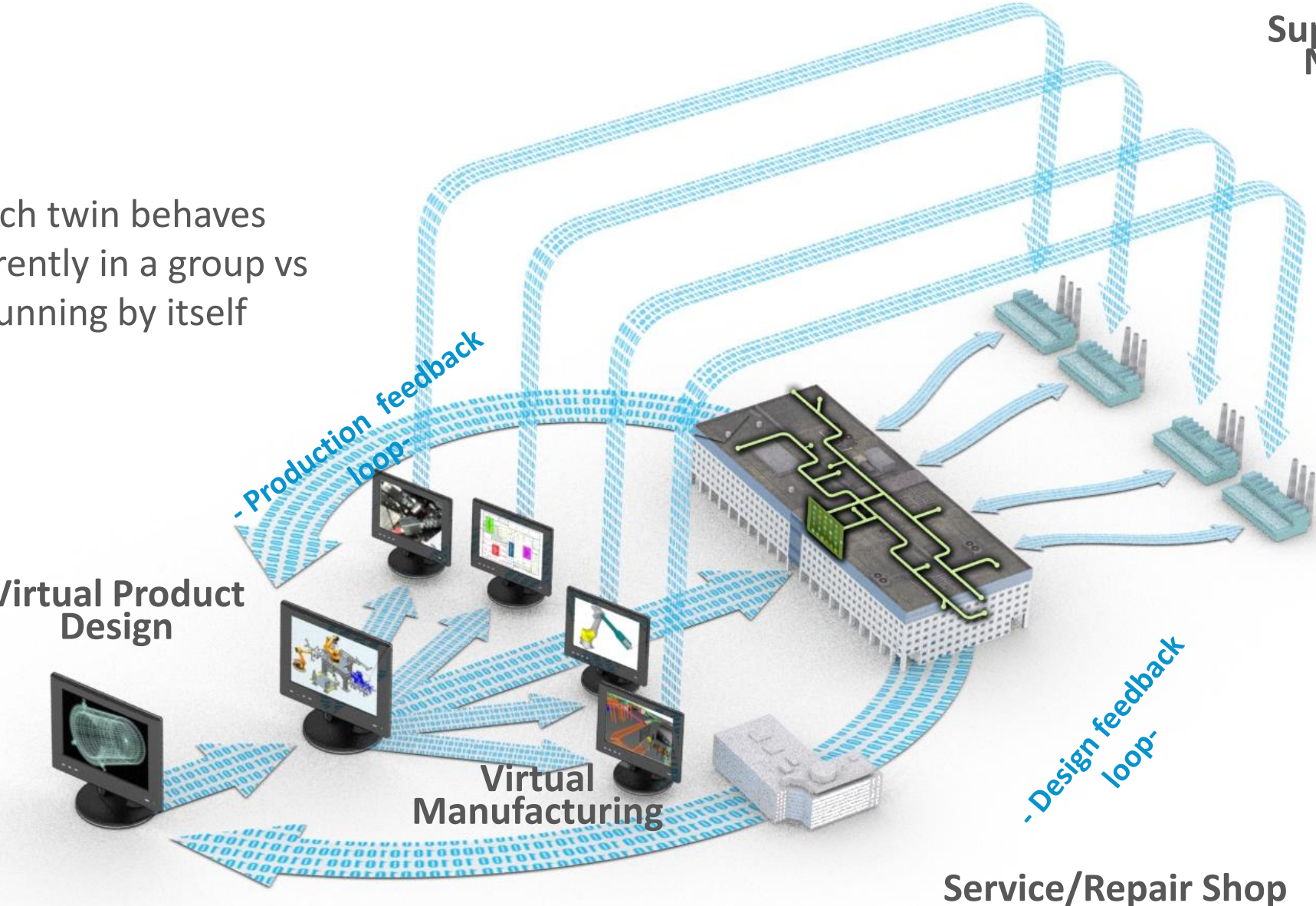
Supply Chain Network

- Production feedback loop-

Virtual Product Design

Virtual Manufacturing

- Design feedback loop-

Service/Repair Shop

$1 + 2 + 3 \neq 6$

Drive Insights

Make decisions for People, Processes and Assets

Correlate and Create Data Dependencies

Growth

Understand Data

Realize Outcomes

Repeat at scale

Industrial Internet platform requirements

Mobile

Cloud

Security

Edge

User Experience

Predictive insights

Asset Management

The Expansion of Cloud Architecture in Manufacturing

Operator | Supervisor | Plant Manager | Administrator | Engineer | Data Scientist

Customer Systems **And** Manufacturing Operations **And** Big Data Metrics & Analytics

Cloud

Intelligence and Analytics- Efficiency, KPI, WIP, Routing, Quality, Genealogy Functions)

Real-Time

"Big Data" Warehouse

Field Agent

Business Systems
ERP, PLM, LIMS, EAM, HRM,…

Exchange

Control Systems
PLC, DCS, SCADA, Scanners, Printers

Field Agent

Incremental Batch Ingest

APIs & Data Feeds

Edge Processing

Customer Data Center/Cloud and Other Apps

Exchange

Existing Manufacturing Execution Systems

Historian

Mfg SQL Database

On Premise

Move from Cognitive Analytics to Predictive Analytics

Level of Manual Cognition (y-axis)

Degree of Intelligence (x-axis)

What's The Best That Can Happen?

What Will Happen Next? (Machinery Failure)

What If Trends Continue?

Why Is This Happening?

What Action Is Needed? (Check Soak Time)

What Is The Cause of The Problem? (Temperature)

How Many, How Often, Where? (Top 5 Sites Material Usage)

What Happened? (Daily Material Usage)

- Optimization
- Predictive Modeling
- Forecasting
- Statistical Analysis
- Notification Alerts
- Query Drilldown
- Ad Hoc Reports
- Standard Reports

Remember this?

Now it's this
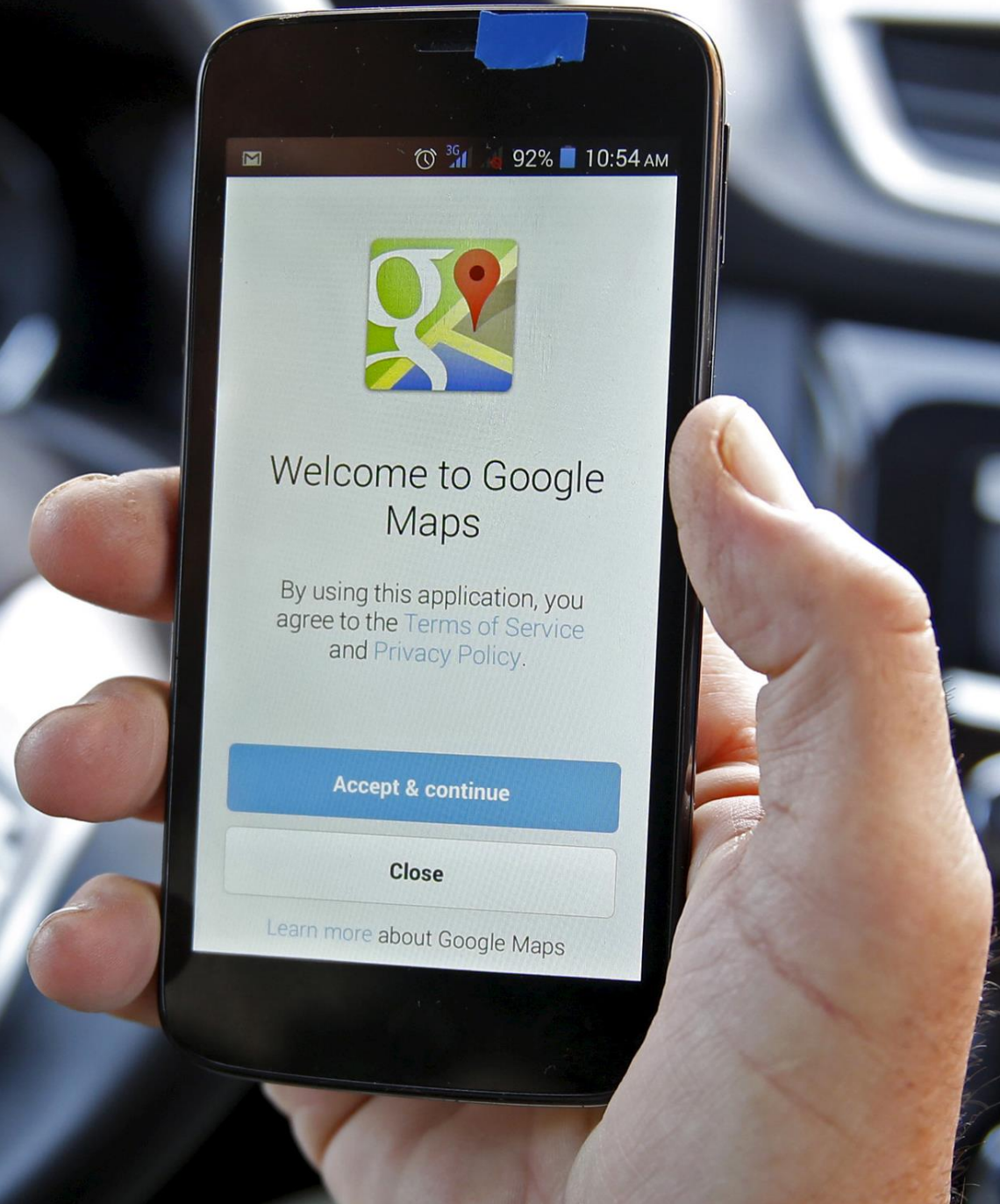
Google maps analogy - gather data

Google Maps

- Collects map data

- Consumes road information, speed limits, user input and other forms of exogenous data, including construction data, school schedules over time

- Creates a rich data set that provides an overall picture of all the roads in the world
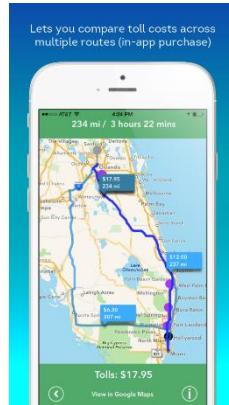
Efficiency Analysis

- Collects manufacturing data

- Consumes machine data, production throughput, waste/quality metrics as well as other data sources, over time

- Aggregates information to calculate OEE KPI's for a line, plant and/or global enterprise

Google maps analogy – help me decide

Google Maps Route Optimization

Enterprise & Plant Optimization

- Uses data to calculate the optimal route and provides an estimated time of arrival

- Provides a recommendation as to when the user should leave to make it on time to their desired location taking into account current traffic

- Uses data calculate the best route and time to start a work order and provides an estimated time of completion

- Provides the context to understand production throughput, inventory, quality issues and accounts for any disruptions and maintenance that could impact the ability to complete the work
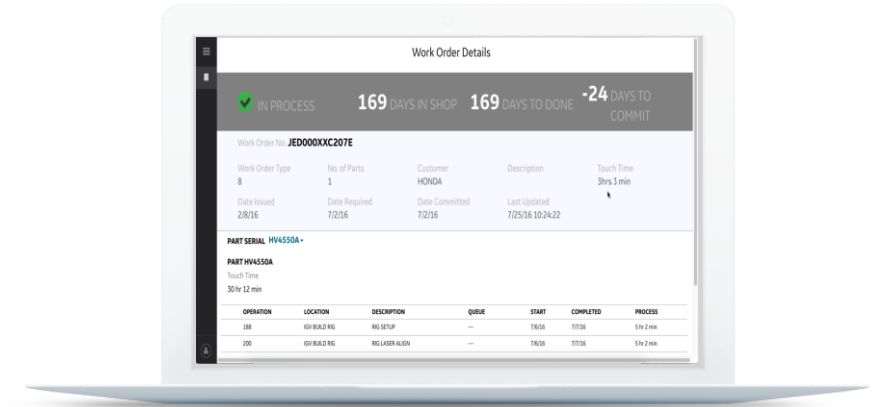
Google maps analogy – route guidance & optimization

Google Maps Route Guidance

Execution Tracking

- Provides route guidance and estimates the completion time based on the existing conditions

- Tracks live traffic and updates route guidance. May alert the user that an alternate route is available
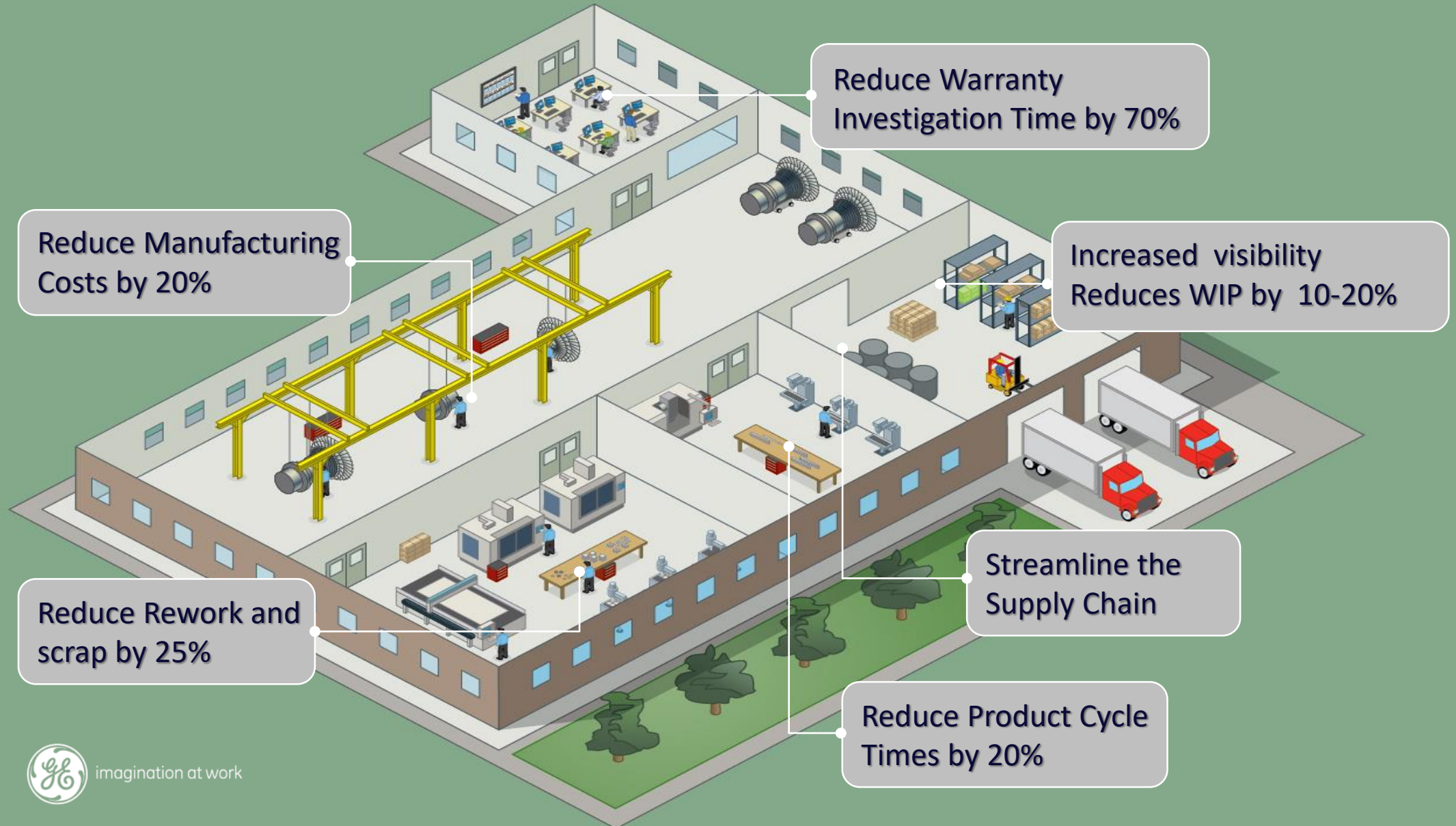
- Provides visibility into orders being produced and manages material movement

- Tracks live order completion, WIP, Takt Time and provides a dashboard to monitor and estimate order completion
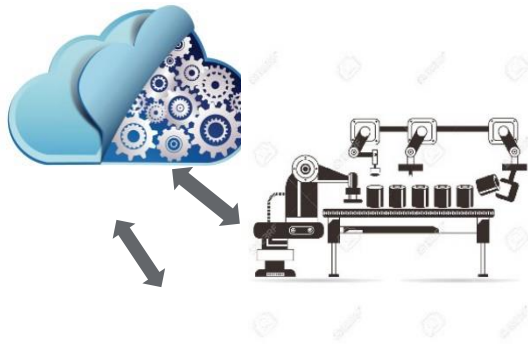
- Calculate best route along with Asset Optimization

Benefits seen from Customers using Analytics

Reduce Warranty Investigation Time by 70%

Reduce Manufacturing Costs by 20%

Increased visibility Reduces WIP by 10-20%

Reduce Rework and scrap by 25%

Streamline the Supply Chain

Reduce Product Cycle Times by 20%

imagination at work

GE Brilliant Manufacturing Strategy

PREDIX

Edge-to-Cloud architecture

Applications discover platform capabilities

Application mashup framework

Shop floor connectivity with core tools

APM for machine impact on production

Digital Model

Digital model of manufacturing capabilities

Collection of Digital Twins

Connect systems and services

Increase manufacturing productivity

Simulate/ Execute

"what if" analysis

Automate the Result