

Industry 4.0 Depends on People

Brad Zorn



Bio & Background – Brad Zorn / Kennametal

- Brad

- Bachelor of Science in Industrial Engineering from Rensselaer Polytechnic Institute
- Began career as a shop floor improvement engineer for STIHL Inc.
- Transitioned into IT, and now works in a Digital Manufacturing Center of Excellence at Kennametal



- Kennametal (KMT)

- Headquartered in Pittsburgh, PA
- Mission Statement: Through the skill and innovation of our people, we deliver industry-leading tools and technologies that solve customer challenges and enable exceptional performance.
- End Markets: Aerospace, Transportation, Energy, Earthworks, General Engineering
- FY2019 Annual Report
 - \$2.375B Sales
 - 1,770 Total Active Patents
 - Approx ~10,000 employees
- Major Modernization – Industry 4.0 – funding over past 3 years



What is Industry 4.0?

- *The Fourth Industrial Revolution or Industry 4.0, is the ongoing transformation of traditional manufacturing and industrial practices combined with the latest smart technology. This primarily focuses on the use of large-scale machine to machine communication (M2M) and Internet of Things (IoT) deployments to provide increased automation, improved communication and self-monitoring, as well as smart machines that can analyze and diagnose issues **without the need for human intervention.***

~Wikipedia, Industry 4.0, sourced 7/2020

- Satya Nadella (MSFT CEO):
 - “We’ve always focused with our tools, the knowledge worker. But the real opportunity for us is to bring knowledge workers and first-line workers together to empower companies and people...”
- ~Keynote, MSFT Inspire 2019

The KMT Modernization Journey - Four Pillars

Operational Excellence

- Modern Manufacturing requires World Class Processes
- Includes Lean, Gemba, 5S

System Integration

- Link demand, supply, capacity, and shop floor signals
- Information to flow freely between people and equipment
- Enable Data Driven Decisions

Equipment/Automation

- Invest in improved equipment
- Invest in Operational Technologies (Controls, IoT)
- Automate where it makes sense

Organizational Development

- Train, Skill, and reshape the workforce for a Digital world
- Print Reading, Mechanical/Electrical controls training, Integration training (eg MTConnect)

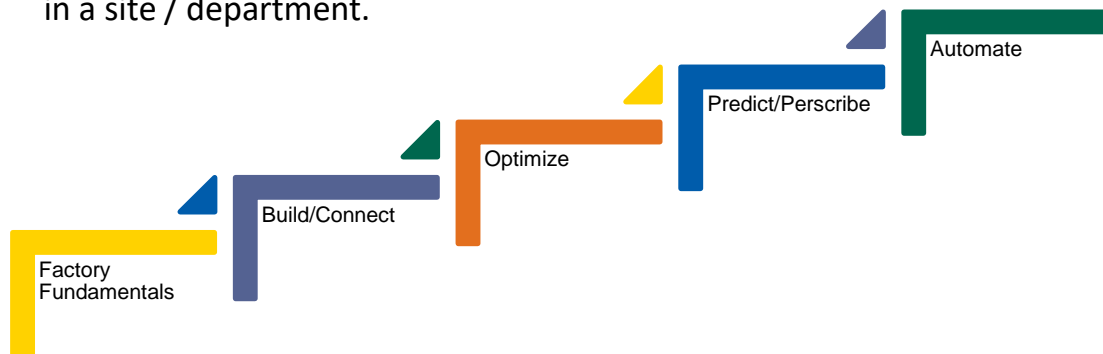
Focus on projects that make our factories smarter

The KMT Modernization Journey – Maturity Mapping

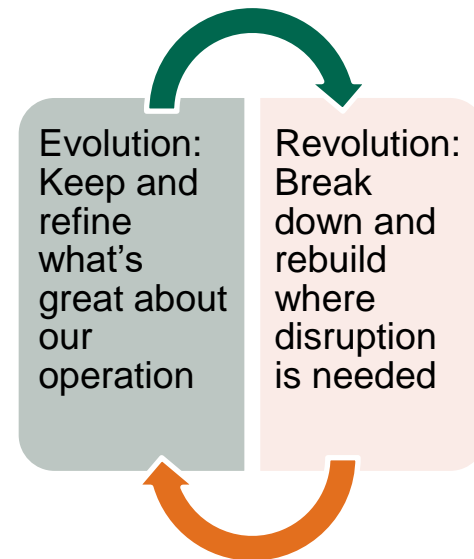
Question: *“But when are we going to be 4.0?”*

Answer: *“It’s a journey, not a destination”*

Use a maturity curve to understand where a particular process is in a site / department.



Strike a Balance



The KMT Modernization Journey – Systems Examples

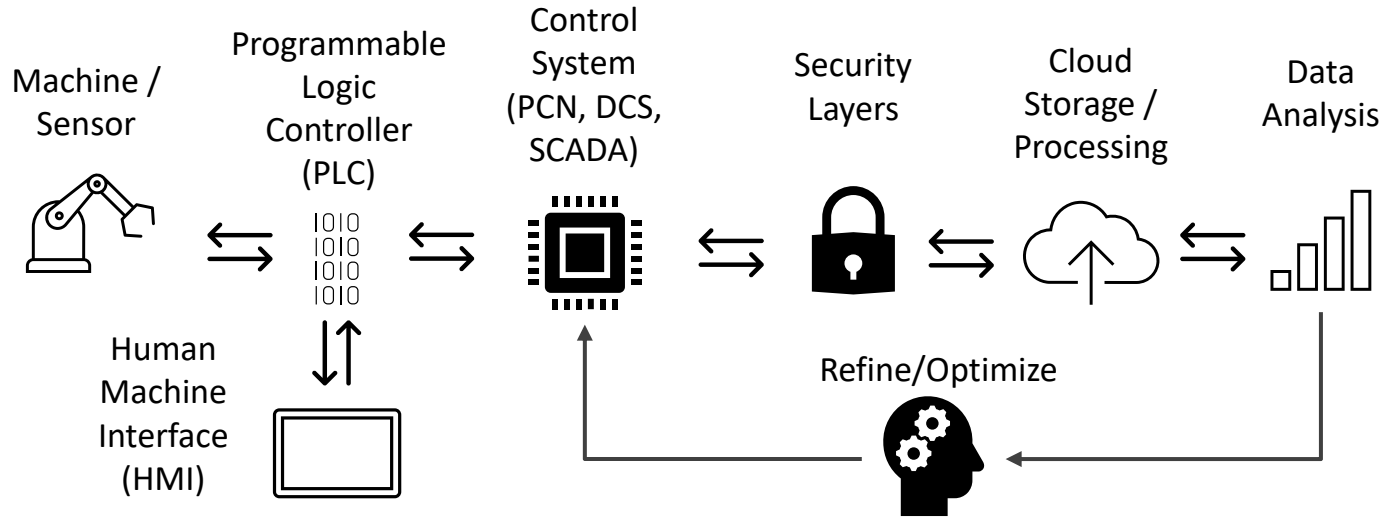
- Automate master data generation
 - Opportunity: Technicians and engineers spend **nonvalue-added** time reading prints to find data points
 - Solution: Leverage CAD integration to automatically classify materials
 - Opportunity: Manufacturing resources spend **nonvalue-added** time identifying the manufacturing steps required for a material and keeping that up to date
 - Solution: Capture additional data and manufacturing rules and automatically generate manufacturing steps
- Shop floor scheduling
 - Opportunity: Planners and operators spend **nonvalue-added** time sequencing orders to minimize downtime
 - Solution: Finite Scheduling system with Optimization and Planning Boards
 - Opportunity: Maintenance teams spend **nonvalue-added** time communicating planned preventative maintenance checks to planning resources
 - Solution: Integrate PM schedules into the production plan schedules
- Tool / Resource Management
 - Opportunity: Manufacturing resources spend **nonvalue-added** time tracking tools and communicating tool status to planning teams
 - Solution: Tool management platform integrated to Production Planning

Maximize human capital and leverage human intelligence by taking away nonvalue-added tasks

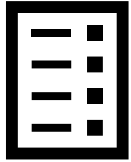
The Industrial Internet of Things (IIoT)

- The Industrial Internet of Things (IIoT) refers to interconnected sensors, instruments, and other devices networked together with computers' industrial applications, including manufacturing and energy management. This connectivity allows for data collection, exchange, and analysis, potentially facilitating improvements in productivity and efficiency as well as other economic benefits. The IIoT is an evolution of a distributed control system (DCS) that allows for a higher degree of automation by using cloud computing to refine and optimize the process controls.

~ Wikipedia, Industrial Internet of Things, sourced 7/2020



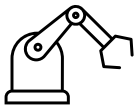
The KMT Modernization Journey - Scenario



- Paper driven production process
- Basic digital order tracking added via kiosks where operators key in when a work order is complete and how much labor and machine time was used
- Limited digital resources to operators on which orders to process in which order

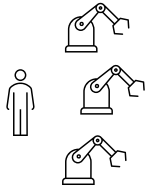


- Manually gathered time study information to understand utilization
- Some equipment offers reporting functionality on HMI's
- WIP tracking accuracy increased (due to kiosks and entry of order completion)



- Individually programmed automation (or manual recipe sharing)
- No connectivity requirements for incoming equipment
- Limited connections from legacy equipment

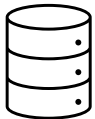
The KMT Modernization Journey - Scenario



- Operators attending to more pieces of equipment (driven by automation and updated equipment) with the following impacts:
 - Maintenance – abnormalities less visible
 - Machine utilization – not always visible that a piece of equipment is idle
 - Labor utilization – changeover overlap becomes more critical and data entry requirements increase



- Limited experience with controls languages (eg Siemens, Allen Bradley, etc) and integration languages (eg MT Connect)
- Limited digital skillset in pockets due to limited interactions with technology
- Increase in equipment complexity requires training / reskilling for plant staff



- No data strategy for streaming high velocity data
- No governance / retention strategy for streamed data
- In need of a scalable Machine Learning platform
- Limited infrastructure (network/servers/security) to move data securely

The KMT Modernization Journey - Ideation & Prioritization

- Facilitate a workshop to analyze the current state and generate improvement ideas
- Leverage Human Intelligence! Key Workshop Participants:
 - Domain Experts (Operators, Supervisors, Engineers, Maintenance)
 - Organizational Experts (Human Resources)
 - Technical Experts (IT, Controls Engineering, etc)
 - Operations Experts (Production Planning, Lean, etc)

Identify Gaps



Our automation is in place, but it isn't always running so we aren't getting the planned ROI



Brainstorm Opportunities



Let's put a monitoring system in place and use that data to ask operators how we can improve



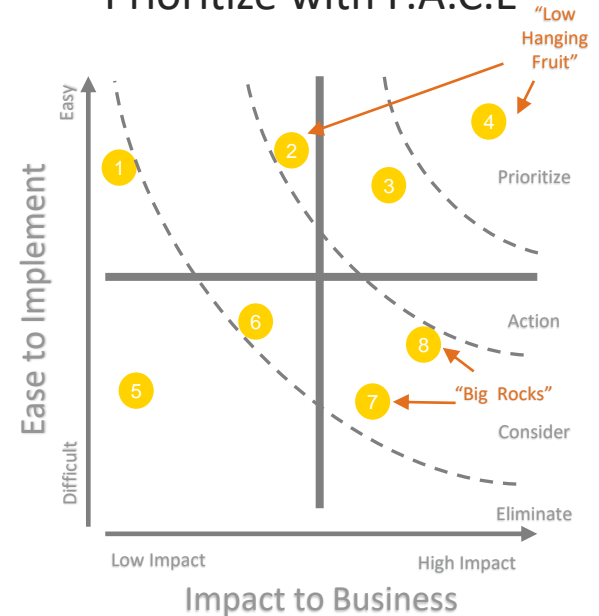
Identify Actions

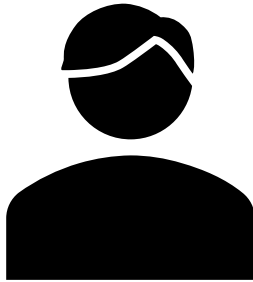
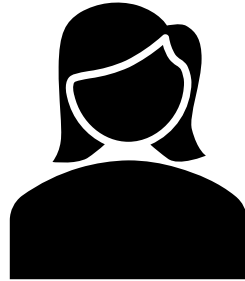
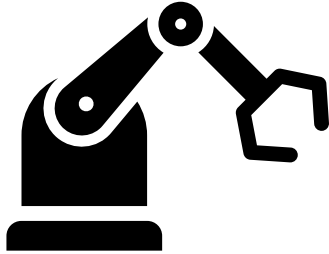


1. Connect Equipment
2. Build Dashboards
3. Create Operator Downtime Tracking App
4. Create Idea Tracking App



Prioritize with P.A.C.E





The KMT IIoT Application Journey

- Scope
- Fundamentals Analysis
- Connect / Build
- Optimize
- And still progressing...

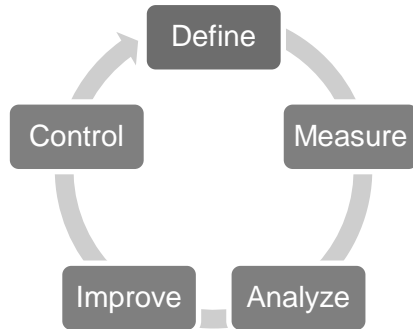
The KMT IIoT App – Refined Scope

Using digital tools, augment operations in one process area to provide actionable and analytical insights to the business process.

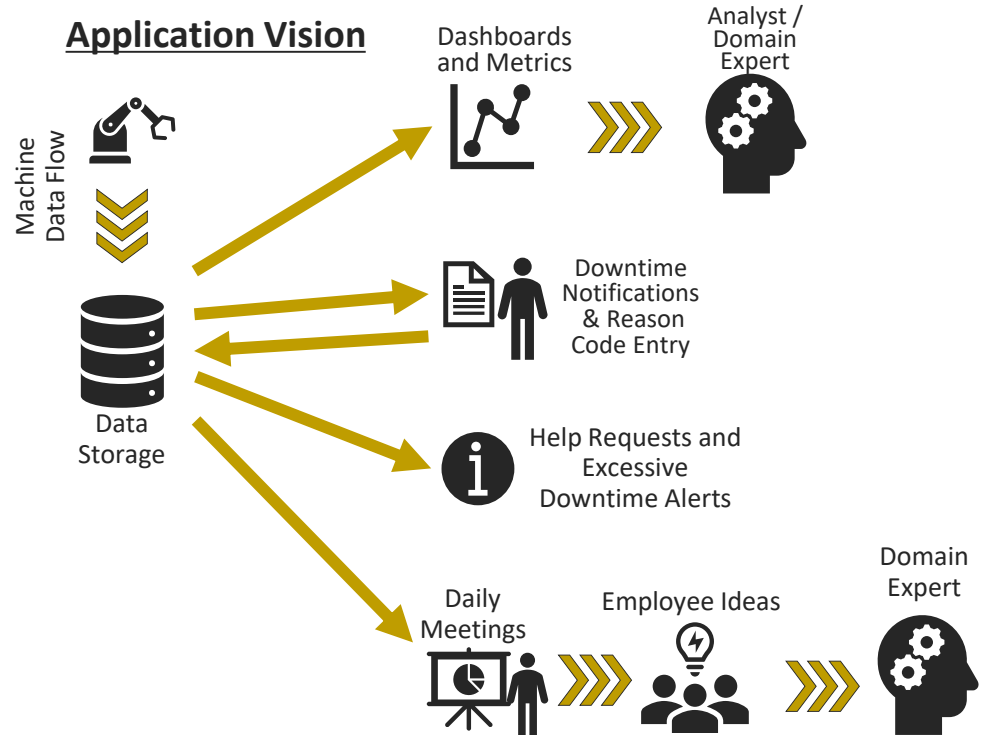
Principle 1



Principle 2



Application Vision



The KMT IIoT App – Fundamentals Analysis

Assessment Areas

KMT Plant Assessment Team

- Plant Assessment Corporate Resources:
 - Advanced Manufacturing Engineering
 - Information Technology
 - Operational Excellence (LEAN)
- Plant Assessment Local Resources:
 - Human Resources
 - Domain Experts
 - Operations Experts
 - Technical Experts

Operational Excellence

- Standard Work for Operations
- Standard Work for Leaders
- Leaderboard Meetings

System Integration

- Connection / Networking
- Firewalls / Security
- Storage Solutions
- Dashboard Solutions

Equipment/Automation

- Controls knowledge
- Available Tags and mappings

Organizational Development

- Problem Solving Fundamentals
- Technology Basics – Interacting with computers

The KMT IIoT App – Connect / Build

Manufacturing Intelligence App

- Real time Overall Equipment Effectiveness (OEE) components:
 - Availability
 - Performance
 - Quality
- Downtime Event Tracker
 - Triggered by extended downtime events per machine monitoring
- Process Data Collection
 - High velocity process data
- Idea Capture & Motion

Activities

Operational Excellence

- Acts as a voice of the shop to the design team
- Provides feedback to build iterations, further guiding design

System Integration

- Build data flows
- Table and storage architecture

Equipment/Automation

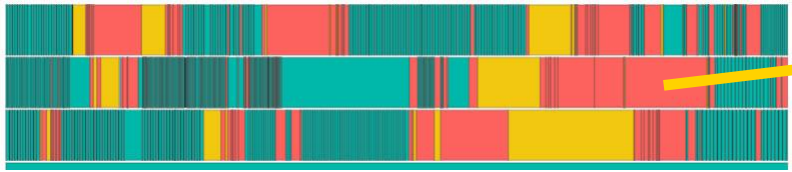
- Create Tag structure
- Develop equipment connection standard

Organizational Development

- Operator & Management Training

The KMT IIoT App – Optimize

Showcase Patterns of Recent Production



Categorize Unclassified Downtime Events

KENNAMETAL Factory Intelligence

Downtime Events

52 Stopped **Assign Reason Code**

Start: 7/14/2020 1:44 PM
End: 7/14/2020 1:44 PM
Duration (min): 26

Edit

Review a set of Standard Data Daily with operation teams on the shop floor

Pressing Lead Board

Headcount Yesterday
Shift: ● First Shift ● Second Shift

Confirm Qty Yesterday
BY LOCAL MACHINE NAME • REFRESHED: JUL 7, 2020, 2:24:49 PM

Downtime Reason Pareto Yesterday
BY SECONDARY REASON CODE • 1

Absolute Availability
REFRESHED: 3 MINUTES AGO

Confirm Qty
Local Machine Name

Hours in Event
Secondary Reason Code

Average: 42%
25% 18% 45% 30% 45%

Confirmed Count Yesterday
REFRESHED: JUL 7, 2020, 2:26:49 ...

Scrap Qty Yesterday
BY REASON DESCRIPTION, LOCAL MACHINE NAME • REFRESHED: JUL 7, 2020, 2:2...

Today: Setup Time vs Plan

Absolute Availability t
REFRESHED: 3 MINUTES AGO

Scrap Count Yesterday
REFRESHED: JUL 7, 2020, 2:26:49 ...

Scrap Qty
Local Machine Name

Average: 73%
85% 89% 66%

Solicit Ideas

KENNAMETAL New Idea Form

Created By: Brad Zorn
Topic / Idea Name:
Category:

Assignments:
N. Complete: 0

Submit

Manage Ideas

KENNAMETAL Assign Dates Stage

Submitted Ideas → Assign Owner → **Assign Dates** → In Queue → In Motion → Completed

pressing 1

Idea Creator: Factory: Department: Category: Potential Impact:

Description: pressing 1
On date & time 07/14/2020 11:43:27, wrote:

Update Comments: On date & time 07/14/2020 14:55:13, Brad Zorn wrote:

Creation Date: 7/14/2020 Start Date: 12/31/2001 Due Date: 12/31/2001

% Complete: 0

Idea Stage: Assign Dates

Move the Needle

Questions (Tee Up)

- Please go ahead and start typing questions in as we begin to conclude...



Conclusion

1. Manufacturing 4.0, Smart Factory, Industry 4.0.... Can be many things, but human intelligence is the backbone
2. In many industries, Digital Transformation implies operation augmentation *with an operator*, not complete automation
 - Digital tools should be targeted to provide information / functionality to help operators be more productive
3. Striving for Smart Factories is a journey, not a destination.
4. Don't copy / paste this model, but have some agreed upon approach
 - Come up with your companies representation for People/Processes/Technology
 - Devise your own maturity curves
 - Find pragmatic ways of analyzing current state, performing gap analysis, and prioritizing action
5. Choose technologies that meet your set of requirements (and those will be different by customer)
 - Mobile, Collaborative, Touch-Screen, etc...
6. Don't use these tools for big-brother monitoring; instead they need to be effective for the shop floor
7. Remember that people are the heart of our manufacturing operations. Value their knowledge, skills, and experience by providing them digital tools to make them even more productive than they already are!

Questions



