Digital Transformation in the Industrial World

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## Waves of Digital Transformation

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<th>1800s - Paper</th>
<th>1960s - IT</th>
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<td><strong>Value Chain Dispersion and Integration</strong></td>
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- **Products are mechanical/electrical** and information processing is performed **manually**
- **IT automates processes and information collection** of activities in the value chain
- **The internet enables coordination and integration** across the value chain, across geography, and with customers and business partners
- **IT is embedded in products themselves**, expanding the way products create value and shifting the nature of competition
- **Digital information** is delivered and captured in **3D and in context**, changing how humans interact with products and environments
FORCES THAT GET WORK DONE IN THE ENTERPRISE

Machine Advantages:
• Physical Power
• Consistency
• Resistance to harsh environments

Digital Advantages:
• Calculating Power
• Data Processing
• Artificial Intelligence

Human Advantages:
• Ideation/Creativity/Innovation
• Broad sensory pattern recognition
• Complex communication
• Sophisticated sensorimotor skills
IoT advances the capability of machines

Smart, Connected Products

Digital Twin

Analytics

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IOT IS TRANSFORMING EVERYTHING

Product → Smart Product → Smart, Connected Product → Product System → System Of Systems

- Tractors
- Tillers
- Planters
- Irrigation System
- Farm Equipment System
- Farm Management System Platform
- Weather Data System
- Seed Optimization System

SMART PRODUCTS

SMART OPERATIONS/ FACTORIES

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NEW CAPABILITIES ENABLED BY THE IOT

1. Monitoring
2. Control
3. Optimization
4. Autonomy
FOR MISSION-CRITICAL POWER DELIVERY, ASSET MONITORING IS KEY

Caterpillar’s remote asset monitoring system helps ensure a continuous supply of power in mission-critical settings, even in remote regions and harsh climates.
If we had not solved that (cavitation) problem for our customer in 30 minutes, the downtime would have cost them more than $1.6 million. If we had not solved it in an hour, the impact could have been $16 million or more.
Deployed real-time visibility into critical manufacturing equipment within six weeks. Efficiencies resulted in a reduction of planned capital expenditures.
Implemented a cloud-based real-time performance tracking system to accelerate OEE improvements, increase packaging line performance, and gain real-time visibility into factories.

- Deploying enterprise-wide – 1 factory/month since 2018
AR devices convert "bits and bytes" to "sounds and sights" and vice versa.
AR ADVANCES THE CAPABILITY OF WORKERS

“AR is IOT for People”
Holographic Product Catalog
Manufacturing Work Instructions
Knowledge Transfer - Capture
Just-in-Time Training

Tip: Make sure to hold base of tool as you double tap and tool back button.
Customer Self-Service
NEW CAPABILITIES ENABLED BY CONNECTING PEOPLE

- 1. Monitoring
- 2. Control
- 3. Optimization
OPTIMIZING WORK OF MAN AND MACHINE IN HARMONY

Smart, Connected Products

Smart, Connected Humans

DIGITAL TWIN ANALYTICS

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Optimizing Work of Man and Machine
DIGITAL TRANSFORMATION IN INDUSTRIAL WORLD

**Engineering Excellence**
Breakthrough designs and model-centric workflow that enables data-driven decisions throughout the design and manufacturing process.

**Service Optimization**
Improve customer success, reduce service, and deliver new value via product performance and world-class service.

**Customer Experience**
Develop new products, services, and business models that enable differentiation and new revenue opportunities.

**Manufacturing Efficiency**
Improve operational efficiency, reduce manufacturing costs, accelerate time to market, and ensure quality and compliance.

**Redefined Sales & Marketing**
Virtual product demonstrations, product companions, “voice of the product” feedback, and augmented experiences.
DIGITAL TRANSFORMATION IN INDUSTRIAL WORLD

Customer Service
- Customer success management enabled by IOT
- Predictive service using digital twins and IOT/AI and simulation replaces break-fix
- Remote service & customer self-service via AR & IOT significantly decrease truck rolls
- Technician productivity, safety, and effectiveness increases via IOT & AR
- Optimized spare parts inventory via SLM and IOT
- Spare parts production via additive manufacturing

Engineering
- Breakthrough products via AI-driven generative design
- Dramatic time-to-market acceleration through real-time simulation
- Designs optimized for additive manufacturing by 3D CAD
- Performance feedback from 3D digital twins of fielded products via IOT & PLM
- Digital thread to speed flow-down & maintain x-functional alignment via PLM
- Virtual team collaboration via AR and VR

Customer Operations
- Breakthrough digital product experiences via IOT and AR
- New value-add services enabled by digital twins of customer operations using IOT/AI
- Customer training and self-service via IOT & AR increases uptime

Corporate/CXO
- Product-as-a-service and other new business models enabled via IOT
- Substantial savings by reimagining training through AR/VR
- Workforce modernization via digital culture and branding
- Shareholder value through revenue and margin growth

Manufacturing & Supply Chain
- Increased operational efficiency & asset utilization via IOT/AI
- Optimized production using digital process twins enabled by IOT/AI & AR
- Increased worker productivity, quality, and safety through AR & IOT/AI
- Less unplanned asset downtime via IOT/AI & AR
- Agile production of parts through additive and hybrid manufacturing
- Real-time agile supply chain via IOT/AI

Sales & Marketing
- Configured products demonstrated with 3D holograms via PLM & AR
- Differentiated product/brand experiences via IOT & AR
- Sales leverage of “Voice of the Product” customer awareness and upsell/consumable opportunities through IOT-enabled feedback

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From:

1. 100s of people not always aligned
2. Not optimal priorities
3. Not repeatable

To:

1. 100s of people are aligned
2. Only top customer impact priorities
3. Always repeatable, proven, and scalable

- Improve front-end impact analysis
- Align PTC organization to create solutions and prove impact weekly
INTRODUCING CRAIG MELROSE

Craig Melrose
Executive Vice President
Digital Transformation Solutions

ROLE

• Build transformative solutions that incorporate PTC’s portfolio of products leveraging differentiating technologies and partners.

• Partner with customers to adopt and roll out tailored industry 4.0 solutions based on their unique business needs with digitally enabled operational improvements.

ABOUT

• McKinsey partner and change agent
  - 20 years
  - Digital operations transformation expertise
  - Product Development, Manufacturing, and Supply Chain broad experiences

• Toyota
  - 5 years
  - Production systems design/operating performance improvement expert
SPORTING CLAYS
WHY SOLUTIONS

**Challenges**

- Under pressure to commit
- Difficult to define ROI
- Confused
- Unable to absorb
- Looking to scale
- Looking to move quickly

**Implications**

- Vested partner
- Knowledgeable and invested partner
- Partner who can orchestrate a full solution
- Partner to build and transfer skills
- Partner who can demonstrate and scale proven cases
- Partner who can execute in months not years

**Financial**

**People**

**Operational**
WHY: “BUSINESS IMPACT FIRST” EXPERIENCE

**Financial Element**

- **Revenue**
  - Increase Revenue
  - Increase volume
  - Increase price
  - Reduce R&D Cost
  - Reduce R&D Cost
  - Reduce COGS
  - Reduce labor cost
  - Reduce material cost
  - Reduce overhead cost
  - Decrease SG&A
  - Reduce sales & marketing costs
  - Reduce service labor cost
  - Reduce supply chain cost
- **Operating Margin**
  - Reduce R&D Cost
  - Reduce R&D Cost
- **CAPEX**
  - Increase OEE and OPE
  - Increase Asset Efficiency
  - Improve Equipment/Asset Efficiency
  - Increase inventory Efficiency

**Value drivers**

- Schedule loss
- Unplanned downtime
- Change over
- Speed
- Operator talking, on computer
- Poor operator techniques
- Quality loss
- Operator or setup error

**Digital Levers**

- Line balancing analysis
- Identify potential issues before they occur
- Benchmark asset perf. & root cause analysis
- Single operator screen with access to all data
- Increase skills w/visual knowledge transfer
- Real-time quality corrective action
- Reduce human errors in process/calibration

**Business Impacts**

- Reduction in unplanned downtime
- Reduction in cycle time
- Increase yield

**Business Outcome**

- Effective Hrs./Wk.
- + 5-8 hours
- +4 - 6 hours
- +2 - 3 hours

**PTC Solutions & Products**

- Enterprise Operational Intelligence
- Digital Workforce Productivity
- Intelligent Asset Optimization
- Scalable Production Management
WHY: BENEFITS OF “BUSINESS IMPACT FIRST”

“Left to Right” - Top Priorities

- Business impact first
- Speed at scale
- Embedded system
- Prescriptive approach

“Right to Left” - Whac-A-Mole

- Unable to define ROI
- Difficult to scale
- Unable to absorb
- Confused with complexities
WHAT: BUSINESS IMPACT OPERATIONAL WITH PEOPLE

Cycle time analysis reveals bottlenecks

Areas To Investigate Further

- Manual
- Automatic
- B Bottleneck

Prepare
Identify
Prioritize
Analyze
Plan
Implement
WHAT: BUSINESS IMPACT OPERATIONAL WITH PEOPLE

- Implement
- Measure
- Reinforce
- Prioritize
- Analyze
- Plan

OEE used to analyze opportunities

Hours per week

- Total time
- Unscheduled Weekend Prod.
- Unscheduled 3rd Shift Prod.
- Available time
- Planned downtime
- Unplanned downtime
- Change overs
- Operating Time
- Minor Stops
- Reduced Speed
- Net Operating Time
- Rework
- Effective Time

- ~55% OEE

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Planned downtime
Minor Stops
Effective Time

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Net Operating Time
Reduced Speed
Operating Time
Change overs
Unplanned downtime
Available time
Total time
Unscheduled 3rd Shift Prod.
Unscheduled Weekend Prod.
WHAT: BUSINESS IMPACT OPERATIONAL WITH PEOPLE

Identify and prioritize improvement initiatives

Focus on top few actions for each key bottleneck

Plan

Implement

Measure

Reinforce
HOW: BUSINESS IMPACT WITH SCALING AND SPEED

- **Deployment #1**: Enterprise, ~$300+M, ~24 months, ~2X
- **Deployment #2**: Enterprise, ~$150M, ~18 months, ~3X
- **Deployment #3-N**: Enterprise, ~$50M, ~12 months, ~10X
- **Proof of Value**: Region, ~$5M, ~3 months

Value vs. Time

- Enterprise
- Business Unit
- Region
- Proof of Value
• Get broad, cross-functional, senior leadership team involvement from the start with focus on financial-impact-first approach

• Focus on agile approach reinforced with periodic, systematic review with broad, senior leadership team to ensure both enterprise impact and speed to scale to enterprise

• Build team and capabilities to iterate quickly, achieve high impact value at scale for full enterprise within ~24-36 months