TACTON DAYS

SMART, CONNECTED PRODUCTS AND OPERATIONS – THE BENEFITS AND HOW TO MAKE IT HAPPEN

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Senior Advisor, PTC

2018-10-24
PTC IS A GLOBAL SOFTWARE TECHNOLOGY COMPANY

GEOGRAPHIC COVERAGE

- Americas: 42%
- Europe: 37%
- Asia Pacific: 21%

NEW HQ: BOSTON SEAPORT

REVENUE BY VERTICAL

- Industrial Products: 31%
- Electronics & High Tech: 18%
- Automotive: 14%
- Federal, Aerospace & Defense: 16%
- Life Sciences: 5%
- Other: 9%
- Retail & Consumer: 7%

BRANDS

- Americas: 42%
- Europe: 37%
- Asia Pacific: 21%

FAST FACTS

- FY17 total revenue: $1.17B
- FY17 software revenue: $989M
- FY17 recurring software revenue: $856M
- FY17 new software bookings subscription: 68%
- Active customers: 30,000
- Partners: 750
- Employees: 6,000
- Universities: 1,800
AGENDA

A changing world

Key trends and benefits

How you can make it happen
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A changing world

Key trends and benefits

How you can make it happen
Now a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres.

**Klaus Schwab**  
Founder and Executive Chairman, World Economic Forum
THE 4TH INDUSTRIAL REVOLUTION

1.0 Mechanization – Machines

2.0 Electrification – Mass Production

3.0 Computerization – Automation

4.0 Convergence
   Physical, Digital and Human
   Cyber-Physical Systems

Today

~1764

~1850

~1950
PHOENIX CONTACT - IOT AND AUGMENTED REALITY IN SMART OPERATIONS

https://youtu.be/UhW12bILH7U
The changing nature of products is disrupting value chains, forcing companies to rethink and retool nearly everything they do.

Value of an Industrial Innovation Platform

Read full HBR articles at www.ptc.com/go/hbr
ATTAIN THE VALUE STEPWISE

1. Monitor

2. Control

3. Optimize

4. Automate

Read full HBR articles at www.ptc.com/go/hbr
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Key trends and benefits

Close loop lifecycle management
Augmented reality
Innovation platform, digital twin and analytics

How you can make it happen
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How you can make it happen
TRADITIONAL PRODUCT LIFE CYCLE MANAGEMENT - PLM

Industry 3.0

Waterfall Quality Gates

- Requirements Management
- System Architecture
- Validation
- Verification
- Software
- Electrical
- Mechanical
- Manufacturing
- Service

Source: e.GO Mobile AG
TRUE PLM - CLOSED LOOP LIFECYCLE

Agile, Scrum, Evergreen, ...

Requirements Management
System Architecture
Software
Electrical
Mechanical
Manufacturing
Service
Validation
Verification
CLOSED LOOP LIFECYCLE OF SYSTEMS OF SYSTEMS

Industry 4.0
THE PHYSICAL AND DIGITAL CONVERGENCE IS OUR LOGO

Physical

Digital
A changing world

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Close loop lifecycle management

**Augmented reality**

Innovation platform, digital twin and analytics

How you can make it happen
DATA CAN CREATE A COGNITIVE OVERLOAD

DATA GROWTH* (ZETTABYTES)

<table>
<thead>
<tr>
<th>Year</th>
<th>Zettabytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>4.4</td>
</tr>
<tr>
<td>2015</td>
<td>8.5</td>
</tr>
<tr>
<td>2017</td>
<td>16.4</td>
</tr>
<tr>
<td>2020</td>
<td>44.0</td>
</tr>
</tbody>
</table>

* IDC’s Digital Universe study, 2014
How long has Electronic Augmented Display hardware been around?
AUGMENTED REALITY YESTERDAY AND IN A NEAR FUTURE

Yesterday (1968)

The Sword of Damocles’ Ivan Sutherland while he was attempting to invent "the ultimate display".

In a near future

Today, UI design is often limited by technology.

Separated Physical & Digital Worlds

Mentally understanding GPS images and then transposing them onto the road ahead is demanding and prone to errors.
AR ALLOWS BEST POSSIBLE HUMAN PERCEPTION

Converged Worlds

AR speeds humans ability to absorb and act on digital information by putting it in context of the physical world.
AUGMENTED REALITY – INDUSTRIAL APPLICATIONS

- **Product Development**
  - Collaborative Design Review
  - Digital Design Review

- **Manufacturing Operations**
  - Maintenance Work Instructions
  - Operator & Assembly Work Instructions

- **Logistics**
  - Augmented Operator Manual
  - Head-up Display
  - Augmented Interface

- **Marketing & Sales**
  - Virtual Product Companions
  - Augmented Brand Experience
  - Retail Space Optimization

- **Service**
  - Service Manual Instructions
  - Service Inspection & Verification
  - Remote Expertise

- **Human Resources**
  - Job Specific Training
  - Safety & Security Training
  - Expert Coaching

PTC AR survey
IMPROVES PRODUCTIVITY

**BOEING & IOWA STATE**
- **30%** Faster simulated wing assembly
  
  *Source: AREA*

**SRI**
- **47%** Faster comprehending training instructions
  
  *Source: SRI*

**GE ENERGY**
- **34%** Faster wiring a turbine control box
  
  *Source: HBR*

**BOEING**
- **25%** Faster installing wiring harnesses
  
  *Source: AREA*

**GE HEALTHCARE**
- **46%** Faster completing a warehouse picklist
  
  *Source: HBR*
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How you can make it happen
INNOVATION PLATFORM
DIGITAL TWIN

SOURCE / CONTEXTUALIZE / SYNTHESIZE / ORCHESTRATE / ENGAGE

Factory/Operations
CAD & PLM
Digital Map
Model

Model

AWS
Azure
GE Predix
SAP

Business/IT Systems

Computer Vision

Desktop/Laptop

Mobile

Digitize via scan, photo, or video

AR/Wearables
VR/Wearables
INNOVATION PLATFORM
ADVANCED ANALYTICS AND SIMULATIONS

SOURCE / CONTEXTUALIZE / SYNTHESIZE / ORCHESTRATE / ENGAGE

AWS
Azure
GE Predix
SAP

Business/IT Systems

Computer Vision

Desktop/Laptop
Mobile

Factory/Operations
CAD & PLM
AEC & BIM
Digital Context

Model

Analyze
Simulate
Digital Map

Digitize via scan, photo, or video
„INTERNET OF PRODUCTION“ THE NEW REFERENCE ARCHITECTURE

SOURCE: HTTPS://E4TC.RWTH-CAMPUS.COM/ANGEBOT/4-0-TRANSFORMATIONSPROGRAMME/
**Dev. Cycle**

Example: Engineering Dashboard

**Requirements**

<table>
<thead>
<tr>
<th>TEXT</th>
<th>PASSED TO ENG</th>
<th>SATISFIED</th>
<th>VALIDATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run weight (without battery) is 450kg</td>
<td>☑️</td>
<td>☑️</td>
<td>☑️</td>
</tr>
<tr>
<td>The vehicle must have a purely electric drive</td>
<td>☑️</td>
<td>☑️</td>
<td>☑️</td>
</tr>
<tr>
<td>The powertrain must run at 48V</td>
<td>☑️</td>
<td>☑️</td>
<td>☑️</td>
</tr>
<tr>
<td>The top speed must be 50 km/h or less</td>
<td>☑️</td>
<td>☑️</td>
<td>☑️</td>
</tr>
<tr>
<td>The range must be more than 350 km</td>
<td>☑️</td>
<td>☑️</td>
<td>☑️</td>
</tr>
<tr>
<td>Additional seats in the back</td>
<td>☑️</td>
<td>☑️</td>
<td>☑️</td>
</tr>
</tbody>
</table>

**Engineering BOM**

- e.GO Life
  - LEG01 Powertrain
  - LEG02 Battery
  - LEG03 Body
  - LEG03 E/E
  - LEG04 Chassis And Safety Systems
  - LEG07 Interior
  - LEG08 Exterior
  - LEG09 Hang-On-Parts

**Visualization**

**Weight**

- LEG01 Powertrain: 11%
- LEG02 Battery: 17%
- LEG03 Body: 13%
- LEG03 E/E: 17%
- LEG04 Chassis And Safety Systems: 13%
- LEG07 Interior: 14%
- LEG08 Exterior: 14%
- LEG09 Hang-On-Parts: 25%

- Bar chart showing actual and target weight.
Example: Full Factory Digital Twin
Example: Digital Twin Co-Simulation
Example:
Sales and Marketing Tools
USER CYCLE: AUGMENTED REALITY CASE STUDY

e.GO different car body options as market input before decision what to physically offer.

Used at a fair with only metal chassis.
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“Vision without execution is just hallucination.”

Henry Ford
MONETIZATION PRINCIPLES

Strategic Differentiation
- Improve Customer Experience
- Differentiate Product and Service Offering
- Enable New Revenue Streams

Operational Effectiveness
- Optimize Operational Performance
- Improve Risk Management
- Reduce Product and Service Costs
LET US VIEW CUSTOMER FULFILLMENT AS A SET OF DAILY OPERATIONS

Ecosystem for one Customer Segment

Customer

Daily Operations

Daily Operations

Daily Operations

Daily Operations

Daily Operations
LET US VIEW CUSTOMER FULFILLMENT AS A SET OF DAILY OPERATIONS

Digital Backbone
Ecosystem Innovation Platform

Digital Frontend
Ecosystem Innovation Platform

Customer

Daily Operations
Daily Operations
Daily Operations
Daily Operations
Daily Operations
LET US FOCUS ON ONE DAILY OPERATIONS

Daily Operations

Customer

Ecosystem for one Customer Segment
THE ABC OF SUCCESSFUL DIGITAL TRANSFORMATION

A Digital Transformation Office
- Vision
- Ecosystem
- Prioritization
- Governance
- Adaptation

B Innovation Factory
- Art of the Possible / Ideation
- Assess
- Discover
- Accelerate
- Use Cases / Roadmaps

C Digital Transformation Enablement
- “Lean Startup” Evaluations
- Business Support
- Innovation Platform
- Rapid Outcomes
- Market Trends

Daily Operations
- Business Results
- Proof of value
- Digital Lean
- Agile
- Business Infrastructure
THE ABC OF SUCCESSFUL DIGITAL TRANSFORMATION

A
Aspirational sponsorship and goal definition

B
Business driven use-case delivery

C
Continuously improve digital@scale for a sustainable pace
THANK YOU FOR YOUR TIME!

ANALYST RECOGNITION OF PLATFORM LEADERSHIP

CLEAR MARKET LEADER
IIoT PLATFORM MARKET

CLEAR MARKET LEADER
IoT PLATFORM MARKET

CLEAR MARKET LEADER
IoT PLATFORM MARKET

CLEAR MARKET LEADER
IoT PLATFORM MARKET

CLEAR MARKET LEADER
IoT TECHNOLOGY PLATFORMS

CLEAR MARKET LEADER
INDUSTRIE 4.0 IoT VENDOR BENCHMARK

Source: Gartner

Source: IDC

Source: Forrester Research

Source: Lux Research, Inc.

Source: BCC Research

Source: Experton Market Insight

PTC

PTC

PTC

PTC

Source: IDC

Source: BCC Research