Arconic Smart Manufacturing

FOCAPO/CPC

January 9, 2017
Arconic: Transforming the way we fly, drive, build and power

2015 Revenue: $12.5B | Locations: 156 locations around the globe | Employees: 42,250

EPS
Arconic Engineered Products and Solutions
- Arconic Power and Propulsion
- Arconic Fastening Systems and Rings
- Arconic Forgings and Extrusions
- Arconic Titanium and Engineered Products

GRP
Arconic Global Rolled Products
- Aerospace and Automotive Products
- Micromill Products and Services
- Brazing, Commercial Transportation and Industrial Solutions

TCS
Arconic Transportation and Construction Solutions
- Arconic Wheel and Transportation Products
- Building and Construction Systems
- Latin American Extrusions

Source: Arconic
Arconic’s vision for Automation & Smart Manufacturing

Arconic’s vision for Automation & Smart Manufacturing

- Analytics
- Modeling
- Simulation
- Optimization
- Predictive
- Real-time
- Flexibility
- Access
- Visualization
- Integration
- Sensing
- Data Driven
- Decisions
- Right data
- Right time
- Right form
- Right people

Phase 1: Information
- Access
- Visualization
- Integration
- Sensing
- Data Driven
- Decisions
- Right data
- Right time
- Right form
- Right people

Phase 2: Intelligence
- Analytics
- Modeling
- Simulation
- Optimization
- Predictive
- Real-time
- Flexibility

Recovery
- Quality
- Productivity

Source: Arconic Automation & Smart Manufacturing Team
Competencies critical for developing Smart Manufacturing solutions

- In-situ Sensing & NDE
- Visualization
- Process Modeling & Simulation
- Smart Infrastructure
- Physical Automation & Robotics
- Advanced Control & Automation Systems
- Advanced Analytics & Optimization

Source: Manufacturing Intelligence & Automation Technologies ATC
Using Advanced Analytics for Energy Forecasting

Predicting peaks helps optimize energy usage.
Leveraging internal and external research

Advanced Analytics Methods

Physics Based Modeling

Simulation Tools

Advanced Optimization Techniques

Advanced Process Control

Advanced Sensing/NDE

Advanced Visualization Methods

Source: Arconic Automation & Smart Manufacturing Team
FOCAPO-CPC
Smart Manufacturing in Energy Intensive Industries
January 2017
Praxair at Glance

- A Fortune 300 company with sales of $10.8 billion in 2015
- One of the largest industrial gases companies
- Operations in more than 30 countries
- 26,000 employees
- One million customers worldwide

Presence

Service

Industries

- Energy 13%
- Healthcare 8%
- Manufacturing 24%
- PMT 17%
- Electronics 8%
- Other 9%
- Food / Beverages 8%
Praxair Business

- 200+ air separation plants worldwide
  - A large air separation plant can consume 60+ MW of power/hr
- 40+ hydrogen plants
- Hundreds of smaller plants
- Large distribution business
  - 500+ trailers in USA alone
- Large packaged gas business
  - 10MM+ cylinders in USA alone
- $1B+ expend in electricity & NG/year
Praxair Strategy on Smart Manufacturing

KPI's to real time decision making

Information
- Sensors and wireless
- Mobile data collection

Insight
- Automated monitoring
- Intelligent platforms

Impact
- Advanced control
- Business & value chain tools

Reactive to proactive business

Predictive
- Variety Velocity Volume
- "Big Data"
- Sensors and wireless
- Automated monitoring
- Mobile data collection
- Intelligent platforms
- Advanced control
- Business & value chain tools

Descriptive
- Reactive to proactive business
- Information
- Insight
- Impact

Diagnostic
- Variety Velocity Volume
- "Big Data"
- Sensors and wireless
- Automated monitoring
- Mobile data collection
- Intelligent platforms
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- Business & value chain tools

Prescriptive
- Variety Velocity Volume
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Faster replication

Variety
- Variety Velocity Volume
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Velocity
- Variety Velocity Volume
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Volume
- Variety Velocity Volume
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Implications
- Variety Velocity Volume
- "Big Data"
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Insight
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Intelligent platforms
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Advanced control
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Business & value chain tools
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Making our planet more productive
IloT and Big Data

1 Billion+ measurements per year for a single compressor

- Vibration
- Pressure/volume
- Rod runout
- RPM

500K+ measurements per second

Data logger

Server per plant & lack of analytics!

Advanced Analytics & visualization

1 Billion+ measurements per year for a single compressor
Steam Methane Reformer

Before balancing

- Each camera collects millions Ts/min
- Model based algorithms to recommend burner fuel valve positions to balance the reformer
- Embedded algorithms into a user-friendly, web-based interface

Good Partnership with UT & SMLC!
Next Generation Product Allocation System

Next Gen PAMS Objective: Minimize total merchant liquid network costs by better coordinating sourcing, production, and distribution decisions

Network of plants, customers, and 3rd party sources

Enable integrated production and distribution planning
Next Gen PAMS Key Challenges

Key Modeling Features
- Production: energy contracts and production modes/slates
- Distribution: driver contracts and vehicle capacities
- Market: electricity and demand forecasts
- Horizon: One week to one month at various granularity

Key Decisions
- Electricity demand & liquid production at plants
- Liquid sourcing & transfers to existing / new customers
- Liquid inventory targets at plants and liquid depots
- Response to outages & spot sales
- Resource plan (# trailers & #drivers)
- Strategic analysis (e.g. competitor swap, fleet sizing)

Technical Challenges
- Computational time bounded by 15 min
- Decisions that impact groups with conflicting metrics
  - Plant vs Cluster Unit production cost
  - Production vs Distribution
- Gaps in production and routing scheduling

Holistic approach to merchant liquid sales and operations
Providing manufacturing context to the research community

Industry
- Awareness
- Collaboration
- Environment
- Manufacturing Challenges & Opportunities
- Innovative Solutions
- Talent
- Marketplace

Academia
- Exploratory Freedom
- Talent & Tools
- Experimental Facilities

Materials
Process Expertise
Production Facilities

Source: Arconic Technology Center, Praxair
Research Areas of Interest for Arconic & Praxair

- Integrated Computational Materials Engineering (ICME)
- **Multi-physics simulation** for metals solidification, deformation processes
- **Prediction of surface topography** in metals manufacturing operations
- **Multi-variate optimization** for multi-production center flow paths
- Model based process control with **uncertainty quantification**
- **In-situ property & surface sensing** in metals manufacturing operations

Using technology to maintain competitive edge