Smart Manufacturing for SMM
Opportunities and Challenges

Small to Medium Manufacturing (SMM) Needs and Case Studies
- Presentations & Panel Session -

NIST Industry Forum
May 8, 2018
Gaithersburg, USA
1. Smart Manufacturing
2. SmartMfg Survey of SMEs in West Virginia
3. Projects & Case Studies
4. Recommendations
You may have heard of

Smart Manufacturing           Intelligent Manufacturing
Industrial Internet            IMS
Cyper-Physical (Production) Systems Industrie 4.0
Factory of the Future          Industry 4.0
Cloud Manufacturing           Smart Factory
Manufacturing Intelligence     ... and many more!

All these terms describe a similar development!
SMART MANUFACTURING PRINCIPLES

/ CONNECTIVITY
/ VIRTUALIZATION
/ DATA UTILIZATION
Smart Manufacturing Vision

Fully Connected Smart Factory

Alerts monitor: Problem with machine #2. Please check.

Control center: Aggregated data reveal improvement areas.

I'm customer order #312 and want to be red colored.

Packing material is low. Please release order.

I need more materials.

End of line test: Machine #1, Please adjust machine parameters.

Cogwheel will break in five days. I have ordered spare parts and scheduled external service provider.

Source: http://smartamerica.org/teams/smart-manufacturing/

Schmid & Wuest, 2017
SMART MANUFACTURING MARRIES
TECHNOLOGY, DATA AND HUMAN INGENUITY
Smart Manufacturing in Small- and Medium-sized Enterprises (SMEs)
Status of Industry

Source: Jinwoo Park, 2015
Siemens Digital factory

• Siemens’ plant in Amberg, Germany

• *Products communicate* with manufacturing machines

• IT systems control and optimize all processes

• Production quality is at **99.99885 %**
## SMEs vs MNEs – Different requirements

<table>
<thead>
<tr>
<th></th>
<th>Features</th>
<th>SMEs</th>
<th>MNEs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Use of Advance Manufacturing Technologies</td>
<td>Low</td>
<td>Very High</td>
</tr>
<tr>
<td>2</td>
<td>Financial Resources</td>
<td>Limited</td>
<td>Comparatively more</td>
</tr>
<tr>
<td>3</td>
<td>Organization Culture/Leadership</td>
<td>Conservative</td>
<td>Flexible</td>
</tr>
<tr>
<td>4</td>
<td>Company</td>
<td>Dictated by Gut Feeling of the Leader (Owner)</td>
<td>Market Research and Accurate Analyses</td>
</tr>
<tr>
<td>5</td>
<td>Strategy</td>
<td>Restricted to Leader/ Few Knowledge Carriers</td>
<td>Board of Advisory</td>
</tr>
<tr>
<td>6</td>
<td>Decision Making</td>
<td>Engaged in Multiple Domains</td>
<td>Have Own Area of Specialization</td>
</tr>
<tr>
<td>7</td>
<td>Human Resources</td>
<td>Exposure</td>
<td>Training, Mentors, Workshops</td>
</tr>
<tr>
<td>8</td>
<td>Alliances with Universities/Research Institutions</td>
<td>Not so Strong</td>
<td>Strong</td>
</tr>
<tr>
<td>9</td>
<td>Important Activities</td>
<td>Outsourced</td>
<td>Internal to the Organization</td>
</tr>
<tr>
<td>10</td>
<td>Nature of Product</td>
<td>Highly</td>
<td>Little</td>
</tr>
<tr>
<td>11</td>
<td>Collaborative Network</td>
<td>High</td>
<td>Not so much</td>
</tr>
<tr>
<td>12</td>
<td>Collaborative Relations (Partner Dependence)</td>
<td>Very</td>
<td>Strong</td>
</tr>
<tr>
<td>13</td>
<td>Standards</td>
<td>Not so</td>
<td>Strictly</td>
</tr>
<tr>
<td>14</td>
<td>Organizational Structure</td>
<td>Less Complex</td>
<td>Complex</td>
</tr>
<tr>
<td>15</td>
<td>Software</td>
<td>Provides Tailored Solutions to Problems</td>
<td>Standardized Solutions</td>
</tr>
<tr>
<td>16</td>
<td>Use of Resources/Research &amp; Development</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>17</td>
<td>Knowledge and Experience</td>
<td>Focused in a Specific Area</td>
<td>Spread Around Different Areas</td>
</tr>
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</table>
Upgrade existing systems

- Bosch upgraded *Lathe from 1887* to be Smart Manufacturing ready

- **New capabilities:**
  - process monitoring for constant quality assurance
  - another is condition monitoring in order to prevent unplanned downtimes

- Extreme example but *showcases the potential*

Project Scope

Background
- Internet of Things is changing the industrial landscape
- Manufacturing is undergoing a major transition
- Large corporations are dealing with this topic intensively

⇒ But how to apply Smart Manufacturing in small companies?
⇒ How can small manufacturers take advantage of it?

Objectives
- Examine the current state of manufacturing with a survey
- Understand the manufacturing landscape and its specific challenges and concerns by conducting interviews and plant visits
- Support small manufacturers in adopting Smart Manufacturing technologies by setting up a training workshop

Work Packages
1. Online survey
2. Interviews & plant visits
3. Analysis of results & report
4. Training workshop
Survey Report

Available for free

Download here:
https://t.co/8uTam5lQtI

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Survey Method
Who participated in the survey?

53 Total # of respondents from manufacturing

Company size by #employees
- less that 20
- 100 - 499
- 20 - 99
- 500 and more

Subsectors in Manufacturing

- Machinery: 12
- Metal Products: 10
- Wood & Furniture Products: 8
- Plastics & Rubber Products: 6
- Food: 4
- Electrical Equipment: 3
- Chemical: 2
- Transportation Equipment: 2
- Nonmetallic Mineral Products: 2
- Textile & Apparel Products: 1
- Miscellaneous: 1

Schmid & Wuest, 2017
Survey Results
How aware are companies of the transition towards Smart Manufacturing?

I have already heard about...

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<th>Smart Manufacturing</th>
<th>Industrial Internet</th>
<th>Internet of Things (IoT)</th>
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<th>Cyber-physical system</th>
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My company is dealing with...

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Survey Results
How prepared are companies for Smart Manufacturing?

**How relevant is Smart Manufacturing for your company?**

- Very relevant: 50%
- Moderately relevant: 40%
- Not relevant at all: 10%

**To what extent is your company and your employees prepared?**

- Very prepared: 10%
- Moderately prepared: 30%
- Slightly prepared: 60%
Survey Results
What are the needs of manufacturers when it comes to Smart Manufacturing?
Interview Method
Who participated in the interview sessions?

Manufacturers
10 Interviewees in manufacturing companies

Manufacturing Experts
8 Experts in academia, associations & state agencies
Smart Manufacturing in SMEs

Lack of opportunity

Resources & cost

Knowledge & awareness

Skilled workforce

Missing ‘success stories’
‘Capability creates Opportunity’

Craig Hartzell, Azimuth Inc., 2017
SMART MANUFACTURING IS NOT ONLY FOR THE BIG GUYS.
Opportunities for entrepreneurs

Brave new world

‘Low’ initial investment

Dedicated ‘Apps’ (Platform solution)

Scalable solutions (interoperable & extensible)

Fast deployment
Boiler Revision Project (1/2)
at Eagle Manufacturing

Concept to revise boiler controls
Plant maintenance can control and monitor the steam boilers from outside of the plant instead of coming to the plant to schedule and check on them physically

Before

Provided by: Eagle Manufacturing, jmcknight@eagle-mfg.com

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Schmid & Wuest, 2017
Boiler Revision Project (2/2)
at Eagle Manufacturing

Solution
- Using newer technology
- **PLCs** with integrated *Ethernet* and SMTP (email) protocol
- along with advanced HMI and **smart hub network** functionality

Benefits
- **Better control** & scheduling of system
- **Real-time alarm** monitoring (through mobile devices)

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Schmid & Wuest, 2017
Compressed Air System Monitoring (1/2)
at Homer Laughlin China Company

Problem
- Compressed Air System was experiencing unacceptable pressure variations during peak demand hours
- Current system inefficient consuming 80% of full load energy while producing 20% capacity

Solution
- Balance system (compressor relocation, piping improvements, and increased storage capacity)
- Change control method to a load – no load system managed by a computer system

System operation
- Compressors are monitored & system is monitored for pressure
- Compressors are started and stopped with systematic method based on demand
- Operating sequence is determined to maintain pressure and equal compressor run-time

Provided by: Homer Laughlin, sadkins@homerlaughlin.net
Compressed Air System Monitoring (2/2)
at Homer Laughlin China Company

System benefits
- Annual energy savings over $100,000
- Real time information allows personnel to quickly identify problems
- Run time of compressors is reduced extending their operating life
- Preventative Maintenance tracking and scheduling
- Consistent system operating pressure

Next steps
- Vibration and air end temperature monitoring to improve predictive maintenance of system
- Investigating use of Bosch CISS (Connected Industrial Sensor Solution multi-sensor device)

Further benefits
- One device type can be used in a variety of applications
- CISS connects existing machines without intervening to the machine control
- Visualize live and historic data
- CISS integrates easily to various platforms

Provided by: Homer Laughlin, sadkins@homerlaughlin.net

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Smart Services Project
at Conair Group (IPEG Inc.)

Problem
• How to provide the best possible service for manufacturing equipment to customers?

Approach
• Collaborate & Innovate

Solution
• I4.0 Platform that provides interface and cloud access to machine data incl. visualization
• Allows monitoring all equipment set points and actuals incl. feedback on performance
• Uptime Guaranteed™ with Smart Services

Source & more information:
https://www.conairgroup.com/product/smart-services/

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Recommendations (1/2) for Smart Manufacturing in SMEs

• Provide **educational resources** on Smart Manufacturing and Industry 4.0 (‘spread the word’ in an accessible way) for industrial partners.

• Jointly develop **curriculum for 1) professionals** to equip them with required knowledge to innovate and operate within a Smart Manufacturing environment, and 2) include Smart Manufacturing in **existing engineering curricula** across institutions (‘high school to masters/Ph.D.’), departments and majors.

• **Communicate successes** broadly and encourage peer-to-peer exchange (across industries) of best practices and lessons learned.
Recommendations (2/2)
for Smart Manufacturing in SMEs

• Build **strong and sustainable partnerships** between companies, academia and industry associations. For example, leverage (local) technology start-ups to team-up with established manufacturers and academia.

• Start with small ‘**lighthouse’ projects** targeting specific pain points to learn and achieve quick wins.

• **Leverage state and federal funding** to complement the limited recourses available to manufacturing SMEs.
SMART MANUFACTURING CANNOT BE BOUGHT. THE SUCCESS HAS TO BE EARNED.
My take on this issue:

- Solutions must be **tailored to SMEs’** (real!) needs & requirements!
- Create **real value** (short AND long term)!
- Fit the strategy / vision!

To do so **SMEs need** to:

- **Assess** their current processes critically
- **Identify** their core competencies
- **Build** on those and
- Develop a roadmap with specific milestones / objectives
- (keep **80/20 rule** in mind!)
Thank You!

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