Why INDUSTRY 4.0?
Connecting Inputs to Assessments to KPIs to Business Value

Todd Hutcheson, University of Northern Iowa
introduction.

• Executive-in-Residence at UNI’s Center for Business Growth & Innovation
• Business Strategy & Policy Instructor for UNI’s Wilson College of Business
• Industry 4.0 Professional Certificate from MIT
• 32 years of leadership in the aerospace and defense industry’s business/corporate environment
• 13 years of academic leadership and instruction at an undergraduate and graduate level
• Areas of experience include Industry 4.0, Continuous Improvement, Strategic Management, Project Management and Manufacturing/Supply Chain Operations
Thought-starter questions ...

? What does “Industry 4.0”, or “Foundry 4.0” mean to you?

? Do you find assessments to be worthwhile?

? Why or why not?

? What constitutes “value” to your business?

? What constitutes “value” to your customers?
METALCASTING INDUSTRY Statistics

- **US economic benefit** from metalcasting in 2020\(^{(1)}\)
  - **Economic Impact** = $110.5B (Direct = $44.3B)
  - **Jobs** = 492.6K (Direct = 162.8K)
  - **Wages** = $32.2B (Direct = $11.6B)
  - **Tax revenue** = $10.6B

- **US Government** equipment, product and service supply chains rely **HEAVILY** on the foundry & casting industry

- From 2014 and 2023-est \(^{(2)}\)
  - 162 (9%) of **existing US foundry facilities closed**
  - **Per facility revenue increased** by $6.5M (30%)

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Metalcasting Industry Vital to the U.S. Economy

A highly modern industry with ancient roots and today’s cutting-edge technology, metalcasting is the backbone of the manufacturing economy. It is an industry with a total economic output of $110.52 billion that provides almost 500,000 U.S. jobs, directly and indirectly. The industry is central to a growing economy, modern infrastructure, and national defense. Moreover, metalcasting provides excellent careers for those with the right skills.

Metalcasting Matters

U.S.-made metal castings are critical to:
- Aircraft
- Appliances
- Automobiles
- Motorcycles and Tractors
- Cookware
- Consumer Technology
- Farm Equipment Needed to Feed the World
- Golf Clubs
- Medical Devices
- Mining and Construction Equipment
- Pipes that Deliver Clean Water
- Power Plants that Supply Electricity
- Pulp and Paper
- Railroads and Mass Transit

This 2020 economic research was conducted by John Dunham & Associates.
MANUFACTURING’S PERFECT STORM

Attraction
Retention

Employee Concerns
Supply Chain

Reliability
Cost

Labor

Cost
Expertise

Our CURRENT SITUATION requires a TOTALLY DIFFERENT APPROACH…

This research is sponsored by the DLA-Troop Support, Philadelphia, PA and the Defense Logistics Agency Information Operations, J68, Research & Development, Ft. Belvoir, VA.

Create resiliency in the FOUNDRY & CASTING INDUSTRY through the implementation of Industry 4.0 technology.
Projects in 30 states

Foundry 4.0 Partnership Facts...

Outreach Facts
- Hosted 2 Steps-to-Success Workshop Events to 81 individuals in the USA Representing 25 businesses and employee groups, as well as 15 business support organizations.
- Have presented at 3 regional and 3 national industry events.

Assessments Facts
- I4.0 Assessments completed with 10 companies
- Actively conducting assessment engagements with 5 additional companies
- Building a significant industry response database with 60+ responses from 15 companies to date

Future Plans
- **MORE!** Additional workshops and regional/national presentations planned
- 7 businesses have been in contact regarding the potential of starting an assessment
- A goal of 50+ assessments reaching 300+ individuals for response
About the UNI Center for Business Growth & Innovation:

About the UNI Foundry 4.0 & Metal Casting Centers:
https://advanceiowa.com/sites/default/files/uni_foundry_4.0_metal_casting_centers.pdf
What is **INDUSTRY 4.0**? & HOW DID WE GET HERE?

**INDUSTRY 4.0**

*applied to an industry or function can become “Foundry 4.0”, “Manufacturing 4.0”, “Logistics 4.0”… all apply similar principles*

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**NOTE:**

INDUSTRY 4.0 applied to an industry or function can become “Foundry 4.0”, “Manufacturing 4.0”, “Logistics 4.0”… all apply similar principles.

**INDUSTRY 5.0**

*Concept was presented by Japan at the CeBIT 2017 trade fair in Hannover (Society 5.0)*

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**INDUSTRY 1.0**

- Around 1760
- Mechanization
- Mechanization, Steam Power, Weaving Loom

**INDUSTRY 2.0**

- ~1860s onwards
- Automation
- Mass Production, Assembly line, electric energy

**INDUSTRY 3.0**

- ~1970s
- Digital
- Automation, Computers and Electronics

**INDUSTRY 4.0**

- ~2000 - Today
- AI & ML, cyber physical systems
- Cyber Physical Systems, Internet of Things, Networks

**INDUSTRY 5.0**

*Is future of work, referring to people utilizing robots and intelligent machines to drive productivity and economic growth*

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Industry 4.0

- Automation
- Connection
- Cloud computing
- IoT
- Big data
- System integration

BOOSTING PRODUCTION
INCREASING PROFIT MARGINS
TOTAL BUSINESS AUTOMATION
QUICK ADAPTATION TO CUSTOMER NEEDS
REDUCING HUMAN LABOR

UNDERSTANDING **INDUSTRY 4.0** Technologies

**Managing Information**
- Horizontal & Vertical System Integration
- Big Data & Analytics
- Internet of Things (IoT)
- Cloud Computing
- Cyber Security

**Producing & Performing**
- Autonomous Robots
- Additive Manufacturing (3D Printing)
- Designing & Testing
  - Augmented Reality
  - Simulation & Digital Twin

**Business Success Elements**
- Business “Wild Cards”
- Organizational Culture
- Industry 5.0
“Knowledge is only potential power. It becomes true power only when, and if, it is organized into **definite plans of action**, and directed to **a definite end**.”

- Napoleon Hill, *Think and Grow Rich*
DATA & INDUSTRY 4.0
CONVERTING DATA INTO USEFUL INTELLIGENCE

01 Raw DATA

02 Sorted DATA

03 Arranged & Usable INTELLIGENCE
DATA & INDUSTRY 4.0
CONVERTING DATA INTO USEFUL INTELLIGENCE

DATA

EXPLAINED WITH A STORY

SORTED

PRESENTED VISUALLY

ARRANGED
WHY IMPLEMENT INDUSTRY 4.0?

• Real-time Data & Analytics
  • Cost Reduction
    ○ Increased Efficiency & Productivity
    ○ Supply Chain Optimization
    ○ Improved Product Quality
      ■ Reduced Scrap Rates
      ■ Enhanced Quality Control
      ■ Predictive Maintenance
  • Customization & Flexibility
    ○ Faster Time to Market
    ○ Enables Iterative Innovation
    ○ Competitive Advantage
  • Enhanced Safety
  • Workforce Alternatives
  • Global Connectivity
  • Real-time Data & Analytics
  • Customization & Flexibility
    ○ Faster Time to Market
    ○ Enables Iterative Innovation
    ○ Competitive Advantage
  • Enhanced Safety
  • Workforce Alternatives
  • Global Connectivity
**GOAL:**
Optimize Business Value

"If you don't know where you're going, any road will take you there."
- Lewis Carroll in Alice in Wonderland
I4.0 IMPROVEMENT METHODOLOGY

BEGIN HERE

GOAL: Optimize Business Value

Current State

Ideal State

Future State

Action Plan

“Even if you do know where you’re going, if you don’t know where you’re starting, you can’t find the path!
- Todd at Metalcasting Congress 2024
**I4.0 IMPROVEMENT METHODOLOGY**

**BEGIN HERE**

1. **Assessments**
   - **GOAL:** Provide Applied, True Business Value

2. **Key Business Performance Indicators**

3. **Implementation, Integration**

4. **Technology Research & Development**

**BEGIN HERE**
What Are Assessments?

What an assessment **DOES** …
- Provides a set of data points identifying potential opportunities
- Points towards a set of activities that can provide bottom line value
- Allows a company to evaluate and compare the relative value of these activities
- Sets up an opening for discussion from multiple functional areas that can enable connection and collaboration

What an assessment does **NOT** do …
- Identify THE solution of HIGHEST value across ALL companies and situations
- Automatically connect businesses with technology providers and integrators to install solutions
- Give prescriptive direction

The VALUE in Assessment results from the Reflection & Discussion
Current assessments can fall short in:

1. Ease of engagement/use
2. Collaborative involvement of multiple functions and their subject matter expertise/perspectives
3. Connection of assessment results to business value and feasibility
ELEMENTS OF INDUSTRY 4.0

Improvement Implementation

1. DATA COLLECTION
2. ASSESSMENT
3. KEY PERFORMANCE INDICATORS
4. ACTION PLAN & IMPLEMENTATION
5. I4.0 Improvement Summary Report
   • Company Profile
   • Key Opportunities
   • High Value Improvement Actions
   • High Impact KPIs
   • Questions
   • Summary
   • Data
INDUSTRY 4.0 ASSESSMENT

I4.0 Assessments are relatively common, but many suffer from a general lack of ease of use administering the assessment, from gathering inputs from either too few or incorrect participants, to an inability to provide segmented summary data from different groups within the business, to a disconnect of results to actual business value. Correcting these issues is paramount in achieving meaningful results from an assessment.

Input: Data Collection
The assessment engagement begins with a signed NDA and names, positions and email addresses for individuals desired to be assessment participants by a company.

Broad cross-section of survey data collected by I4.0 pillar, by pillar aspect, from subject matter expert at all levels and from all functions identified by the business being assessed.

Survey data is consolidated by company-defined groupings, made available real-time for analysis and discussion.
Automated Assessment

Once the correct level of assessment data has been collected from the most knowledgeable sources within a business, assessment scoring and the consolidation of scores can be processed real-time. Automated report sets can keep up with inputs provided, and the analyzed data can be split into meaningful groups for further discussion. Automating the assessment frees up time for these individuals to discuss implementation value.
## AVERAGE SCORE BY PILLAR

<table>
<thead>
<tr>
<th>Pillar</th>
<th>Average Score</th>
<th>Min Score</th>
<th>Max Score</th>
<th>Average Weight</th>
<th>Adjusted Weight</th>
<th>Min Weight</th>
<th>Max Weight</th>
<th>Gap</th>
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<tbody>
<tr>
<td>1  Autonomous Robots</td>
<td>2.40</td>
<td>2.40</td>
<td>2.40</td>
<td>1.00</td>
<td>0.63</td>
<td>1.00</td>
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<tr>
<td>2  Additive Manufacturing</td>
<td>4.60</td>
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<td>4.60</td>
<td>2.00</td>
<td>1.26</td>
<td>2.00</td>
<td>2.00</td>
<td>-0.76</td>
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<tr>
<td>3  Augmented Reality</td>
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<td>0.63</td>
<td>1.00</td>
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<td>1.92</td>
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<td>4  Simulation &amp; Digital Twin</td>
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<td>0.63</td>
<td>1.00</td>
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<tr>
<td>6  Big Data and Analytics</td>
<td>3.63</td>
<td>3.63</td>
<td>3.63</td>
<td>2.00</td>
<td>1.26</td>
<td>2.00</td>
<td>2.00</td>
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<td>7  The Internet of Things</td>
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<td>1.26</td>
<td>2.00</td>
<td>2.00</td>
<td>0.50</td>
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<tr>
<td>8  Cloud Computing</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>1.00</td>
<td>0.63</td>
<td>1.00</td>
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<tr>
<td>9  Cyber Security</td>
<td>5.00</td>
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<td>5.00</td>
<td>2.00</td>
<td>1.26</td>
<td>2.00</td>
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<td>-1.16</td>
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<tr>
<td>10 Wild Cards within a Business</td>
<td>2.20</td>
<td>2.20</td>
<td>2.20</td>
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<td>0.63</td>
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<td>11 Organizational Culture</td>
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<td>1.26</td>
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<td><strong>Total Average:</strong></td>
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<td><strong>3.04</strong></td>
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<td><strong>1.58</strong></td>
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Different technologies impact different areas in a business environment. Alignment matters. The connections between I4.0 technologies and the key performance indicators they impact has been proven. Although “your results may vary”, by making good assumptions about the potential improvements possible through technology implementation, a predictive model can be created to focus implementation in the highest value areas.
"If a plane is off from its intended flight path by just one degree, after 60 miles it would will be a full mile off course. On a cross country flight, this seemingly small misalignment can place a traveler literally 50 miles or more away from the intended destination. Alignment matters."

- Sean Rosensteel, The School of Intentional Living
INDUSTRY 4.0

Key Performance Indicators (KPIs)

- Operating Efficiency
- Overall Equipment Effectiveness
- Product and Process Yield (Scrap or Rework $$s$$)
- Capacity and Capacity Utilization
- Inventory Levels ($$s$$, turns)
- Data Security
- Improved Customization
- Throughput Reduction
- Prototype Turnaround Time
- Improved Safety (reduced workers comp, etc.)
- And more…
## Key Performance Indicators (KPIs)

<table>
<thead>
<tr>
<th>Key Performance Indicator Impacted by Implementation</th>
<th>Industry 4.0 Pillar</th>
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<tbody>
<tr>
<td></td>
<td>Autonomous Robots</td>
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<tr>
<td>Operating Efficiency</td>
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<td>Prototype Turnaround Time</td>
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</table>
Key Performance Indicators (KPIs)

• Identified Gap: Augmented Reality
• Potential KPI Impacts:
  ○ Product & Process Yield
  ○ Improved Customization
  ○ Prototype Turnaround Time
• Basic Technology Feasibility (Payback)
  ○ $150K implementation, rolled product yield improvement of 1% in a $30M annual COGs foundry
  ○ Payback = .5 years
• Additional benefit from other KPI improvements reduces payback time
# Key Performance Indicators (KPIs)

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Key Performance Indicators (KPIs)

Improvement Example:

Perspective: KPI Opportunity Identification

• Identified Opportunity: Inventory Level Improvement

• Potential I4.0 technology application:
  ○ Autonomous Robots
  ○ Simulation & Digital Twin
  ○ Big Data & Analytics/IoT

• Basic Technology Feasibility (ROI)
  ○ Data analytics IDs environmental factor changes to improve process yields, resulting in a WIP reduction of $500K
  ○ Sensors, PLCs and data analysis software cost = $100K
  ○ Carrying costs on $500K = 25% or $125K annually
  ○ ROI = $125K/$100K = 125%

• Additional benefit from other KPI improved by data analytic capability implementation improves ROI
Connecting technology gaps to impacted key performance indicators, and creating a prioritized implementation feasibility study that predicts where business value can be seen, allows a business to create an action plan that is sequenced in value priority order. This plan will have predictable contents based on the technologies selected.
Business Value Action Plan

I4.0 Improvement Summary Report

- Company Profile
- Key Opportunities
- High Value Improvement Actions
- High Impact KPIs
- Questions
- Summary
- Data
The FOUNDRY 4.0 Partnership works to provide American-based foundries with the competitive edge in technology that optimizes productivity, output, and product quality. These technological innovations create opportunities that help build a dynamic digital ecosystem. Several notable advantages are cost reduction, shortened deadlines, and excellence in quality and customer satisfaction.
Industry 5.0 (I5.0) focuses on the collaboration between humans and machines, emphasizing human touch, craftsmanship and creative.

I5.0 is aimed at supporting, not superseding, humans.

Builds upon I4.0, which primarily focused on digitization, automation, the Internet of Things (IoT), and advanced analytics.

I5.0 is about finding the optimal balance of efficiency and productivity.

I5.0 provides business value in the areas of:
- Customization & Flexibility
- Environmental Sustainability
- Enhanced Worker Satisfaction
- Economic Growth
- Resilience
What does **INDUSTRY 5.0 OFFER?**

- **Human-Machine Collaboration**
- **Personalization & Customization**
- **Sustainability**
- **Decentralization**
- **Advanced Technologies**
- **Value Creation**
- **Emotional Intelligence & Empathy**
- **Ethical Considerations & Trust**
- **Resilience & Flexibility**
- **Skill Development & Lifelong Learning**

SUMMARY: ELEMENTS OF INDUSTRY 4.0 IMPROVEMENT IMPLEMENTATION

1. INPUT: DATA COLLECTION
2. AUTOMATED ASSESSMENT
3. KEY PERFORMANCE INDICATORS (KPIs)
4. BUSINESS VALUE ACTION PLAN
5. INDUSTRY 4.0 IMPLEMENTATION

JOIN the Conversation!
Please take a moment to scan the QR code or click on the provided link to access our registration form. Once you’ve submitted it, we will quickly get in touch to kickstart the assessment process for both you and your team. This will empower you to harness Industry 4.0 technologies, positioning your business with cutting-edge advancements and driving improvement as well.

READY TO BEGIN YOUR JOURNEY?
QR Code & LINK TO OUR Google Form
1. Initial contact made (email, phone, weblink, QR)  5 min
2. Discussion of engagement steps and objectives  15-30 min
3. Submission of NDA (2 page … protects client)  15 min
4. Provide email address list of business participants  15 min
5. Link transmitted, survey completed  15 /person
6. Draft summary report created, sent, reviewed  60 mins
7. Final review with draft review comments completed  60 mins

Discussion regarding follow-on project selection and feasibility analysis assistance at the discretion of the assessment partner

https://docs.google.com/forms/d/1J3ts3rpz5DPmPNBXLVH5r13_pl87wMCZMdjWpZlWwo/edit
UNI’s ASSESSMENT REPORTING TOOL provides facilitated, efficient & insightful I4.0 assessments

Complimentary, confidential access...

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Questions? Email us: cbgi@uni.edu or foundry4.0@ncdmm.org

Scan the QR Code....
But

... there’s MORE!
We are building collective **Metal Casting** industry averages …

To date … we’ve received:
• 67 inputs from
• 11 companies
Lowest scoring questions …

- Mobile repair instructions using augmented reality
- Artificial Intelligence driven continuous learning & improvement systems
- Virtual plant-operator training
- Autonomously guided workpieces
- Smart logistics
- Smart maintenance
- Collaborative robotics
- Integrated marketing channels
- Supply chain visibility
- Use of sustainable energy consumption & support technologies
Lowest scoring questions in the most “active” pillars …

Autonomous Robots
- Inventory Control Using Real-Time Data Management
- Material Handling

Additive Manufacturing
- Additive Manufacturing Post-Processing and Finishing
- Additive Manufacturing Materials Expertise

The Internet of Things
- Supply Chain Visibility
- Real-Time Tracking

Simulation & Digital Twin
- Production and Product Simulation
- Digital Modeling

Big Data and Analytics
- Data Driven Customer Service
- Data Driven Procurement
We can also begin to provide Company comparisons to Industry Averages …

Percentile Rankings

Autonomous Robots

Industry 5.0

Additive Manufacturing

Augmented Reality

Organizational Culture

Simulation & Digital Twin

Wild Cards within a Business

Horizontal and Vertical System Integration

Cyber Security

Cloud Computing

Big Data and Analytics

The Internet of Things

Your Percentile

Industry Average (50th Percentile)

Stay Tuned!
EXECUTIVE SUMMARY

• Nearly all business sectors are experiencing a unique set of difficult business headwinds … and they will not go away in the foreseeable future

• Industry 4.0 technology implementation can provide a large boost in combating these headwinds

• Industry 4.0 technology assessments will provide connection to business value to prioritize investments

• Industry 5.0 balances and leverages the interaction between humans and technology

• Add to Metal Casting industry knowledge! We would be excited to begin an Industry 4.0 technology assessment with your company TODAY!

OUR GOAL: Enable Application of Foundry 4.0 Concepts to Continue to Improve the Resiliency of the Foundry & Casting Industry
Next Steps

Call to Action

- Review conference materials for potential additional conversations
- Utilize contacts made to continue collaborative networking discussions
- Contact UNI CBGI to more fully explore topics of interest
- Contact UNI CBGI to begin a F4.0 Assessment Partnership

Our Goal: Enable Application of Foundry 4.0 Concepts to Continue to Improve the Resiliency of the Foundry & Casting Industry
UNI’s ASSESSMENT REPORTING TOOL provides facilitated, efficient & insightful I4.0 assessments

Complimentary, confidential access...

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Questions? Email us: cbgi@uni.edu or foundry4.0@ncdmm.org

Scan the QR Code....
Q&A
Thank YOU

CONTACT US!
cbgj@uni.edu
foundry4.0@ncdmm.org

NOTES:
1. This research is sponsored by the DLA-Troop Support, Philadelphia, PA and the Defense Logistics Agency Information Operations, J68, Research & Development, Ft. Belvoir, VA.

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319-273-4692
info@advanceiowa.com
https://advanceiowa.com/foundry-40-0

NOTES:

1. This research is sponsored by the DLA-Troop Support, Philadelphia, PA and the Defense Logistics Agency Information Operations, J68, Research & Development, Ft. Belvoir, VA.

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