Winning the Fire Drill: How Not To Lose the IIoT Game

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About Dr. John Carrier

- Dr. Carrier works with senior and front-line managers to improve manufacturing and business processes and serves as an on-site hands-on coach in support of projects.
- His research focuses on the competitive advantage of synchronization of operations within supply chains.
- He teaches a popular Executive Education course on Industry 4.0 and IIoT (https://tinyurl.com/yafmbdqe).
- He has more than 20 years of experience in a variety of corporate, entrepreneurial, and consulting environments.
- Dr. Carrier holds a BS in Chemical Engineering from the University of Michigan, a PhD in Chemical Engineering from MIT, and an MBA from Harvard Business School.

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Big Data in Boston

- Home of
  - MIT Sloan Sports Analytics Conference

- Greatest Hitter of All Time (Ted Williams)
  - Batting analysis from 1970
  - #4 in Career Walks
What’s the problem?

- The IIoT world, customers demand make-to-order variety at make-to-stock price and wait times

- As a company, you still need to meet today’s production and make today’s profits

- How do you sequence in new technology into your “human system” without going bankrupt?
The Journey We Are Trying to Avoid …

Source: https://john.do/emotional-journey-creating/
The last wave of technological change ... "No longer must valuable engineering personnel ... now in critical shortage ... spent priceless creative time at routine figuring."
Case Study: Tech Adoption

Location: Germany, 1973

The problem:
• You want to sell calculators
• Engineers aren’t buying

The Innovation: Make it easier for the “customer” to make the transition
In one word …

Fingerspitzengefühl

Where can a manager buy …

• Situational Awareness

• Synchronization
Amazing technologies that may experience slow adoption

Remember these?

Will this fare any better?
People don't want to buy a quarter-inch drill, they want a quarter-inch hole. - Marketing Myopia (1974)
What are we trying to buy with IIoT?

<table>
<thead>
<tr>
<th>Element</th>
<th>Human Body</th>
<th>Industrial Internet of Things</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensors</td>
<td>Sensory Neurons</td>
<td>Temperature, pressure, concentration, light/camera, sound</td>
</tr>
<tr>
<td>Communication</td>
<td>Interneurons</td>
<td>Network</td>
</tr>
<tr>
<td>Command</td>
<td>Motor Neurons</td>
<td>Network</td>
</tr>
<tr>
<td>Actuators</td>
<td>Muscles</td>
<td>Robots, Pumps, Turbines, Furnaces</td>
</tr>
<tr>
<td>Quick Response Loop (feedback)</td>
<td>Ganglia</td>
<td>Fog Computing</td>
</tr>
<tr>
<td>Analysis</td>
<td>Brain</td>
<td>Digital Twin, Analytical and Statistical Apps</td>
</tr>
<tr>
<td>Synthesis and Learning</td>
<td>Brain</td>
<td>Artificial Intelligence and Machine Learning</td>
</tr>
<tr>
<td>Connectivity</td>
<td>Brain has over 100 trillion synapses</td>
<td>31 billion connected devices by 2020</td>
</tr>
<tr>
<td>Development Period</td>
<td>Several hundred million years</td>
<td>approximately 150 years</td>
</tr>
</tbody>
</table>

... what happens when you lose a sensor?
Adoption of IIoT will be very different than in the past ... 

Risk management is key to IIoT adoption

- Traditional Investment ("buy")
  - Large capital investment
  - Long dormant period
  - "flip the switch" moment
  - Disappointment, loss, and turnaround

- New Investment ("pay to use")
  - Use in increments
  - Implement, correct, and make profit
  - Expand and scale to match cash flow
SaaS has fundamentally changed the financial model

- All elements of the stack are available on a subscription basis and fully scalable
- Simple robots can now be rented at a competitive rate to local labor
- Companies are looking to validate a real use case before committing to greater investment
- Unlike past ERP purchases, implementation of IIoT will be based on agile
Example: From Legacy to IIoT in One Day

Cell Prototyping

- Mid-sized US manufacturing company designs work cell for low volume, high industrial vibrators

- Investment based on reaching 90% of full production in six weeks

- Need simple way to collect, analyze, and report cycle time data in real time

- Team tests a simple IIoT device measuring current draw
Example: From Legacy to IIoT in One Day

Cell Operation

IIoT Device

Power Supply

Real Time Display (via Cloud)

The Raw Signal
Example of a “Smart” City Use Case

Creativity abounds, but standards are needed
An early example of System Improvement

- A famous engineer and an ‘unsolvable’ problem
A few timeless lessons …

• A new business model of being paid by the result and not time on the assignment

• Even in the age of “a dollar a sensor”, you still need to know where to put it

• The original digital twin – the model of the system in Steinmetz’s brain.
The DATA IS NOT THE SYSTEM

The Model: how we think the system works (expected)

The System: how it does work (actual)

The Data: the difference between expected and actual (also known as ‘negative feedback’)
STOP AND THINK: APPLY TO YOUR SYSTEM
Culture and Mental Models?

Three Levels of Culture (Schein)

- **Artifacts**: Visual organizational structures and processes (hard to decipher).
- **Espoused Values**: Strategies, goals, philosophies (espoused justifications).
- **Basic Underlying Assumptions**: Unconscious, taken for granted beliefs, perceptions, thoughts and feelings (ultimate source of values and action).

Ed Schein
Emeritus Professor
Sloan School of Mgmt

The Spreadsheet is NOT the System
Let’s look at your system …

What happens when we try to introduce new technology (like IIoT) into this system?
Schrodinger’s Valve: Is it open or closed?
Using LL to detect hidden factories.

**Time in System ("W")**

- Step 1
- Step 2
- Step 3
- Step 4

**Defect created**

**Frequency**

**Hidden Factory**
A closer look …

Does this look familiar?

What’s the value of shrinking the hidden factory tail by half?

The CEO asked for it

Visited Hidden Factory

Good process (SYSTEM 1)

Special Cause Failure

Time in System (“W”)
The Value Stream – how we value TIME

### THE 3 TYPES OF VALUE STREAM ACTIVITIES

<table>
<thead>
<tr>
<th>Term</th>
<th>Who pays for it</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value add</td>
<td>Customer</td>
<td>1. Customer will pay for it</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Form, fit, or function of product changed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. It was done right the first time</td>
</tr>
<tr>
<td>Non-Value Add – or– Business Value Add</td>
<td>Business</td>
<td>Sustains the business</td>
</tr>
<tr>
<td>WASTE</td>
<td>Nobody</td>
<td>No one will pay for it (or we ALL pay for it)</td>
</tr>
</tbody>
</table>

What is a minute worth in your system?
How does this provide a business model for IIoT?

- Identify systems with valuable total assets

- Find the “clock” in the system and measure its utilization time – does it “de-synchronize”?

- Look for root causes and ways better information and preparation could improve
This is how the business case is made ...

Look for customers with expensive wait times
## Continuous Improvement vs. AI

<table>
<thead>
<tr>
<th>Action</th>
<th>5S</th>
<th>AI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Find what is needed</td>
<td>Sort</td>
<td>Search</td>
</tr>
<tr>
<td>Identify optimal sequence</td>
<td>Set in Order</td>
<td>Optimization</td>
</tr>
<tr>
<td>Reduce external noise</td>
<td>Shine</td>
<td>&quot;Noise&quot;</td>
</tr>
<tr>
<td>Standardize</td>
<td>Standardize</td>
<td>[ASSUMED]</td>
</tr>
<tr>
<td>Continuously Improve and Adapt</td>
<td>Sustain</td>
<td>Adaptive Learning</td>
</tr>
</tbody>
</table>
Avoid data theft and downtime by extending the security perimeter outside the data-center and protect from increasing frequency, scale and sophistication of web attacks.

An adaptive system for implementing sustainable change (POCA loop)

1. Prepare the system (5S)
2. Let the system run (Execute)
3. Observe defects during execution (5S, Value Stream)
4. Remove and correct (Six Sigma)
5. Create countermeasures to correct defects
6. Re-set system to eliminate defects
## How the IIoT Can Fit In …

Better information, analyzed and shared in real time amplifies the tools

### POCA Formulation for an Adaptive Operating System

<table>
<thead>
<tr>
<th>Phase</th>
<th>Definition</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepare</td>
<td>Organize the Workspace to Execute According to Plan</td>
<td>5S</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SMED (Changeover Reduction)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poke-Yoke (error-proofing)</td>
</tr>
<tr>
<td>Observe</td>
<td>Watch how the work actually flows vs. plan</td>
<td>Value Stream Map (Lean)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control Chart (Six Sigma)</td>
</tr>
<tr>
<td>Correct</td>
<td>Pull defects out of the flow of work</td>
<td>Little's Law, Hidden Factories</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yellow Lines (quality checks)</td>
</tr>
<tr>
<td>Adapt</td>
<td>Re-organize workspace to reduced need corrective actions</td>
<td>Pareto Chart</td>
</tr>
</tbody>
</table>
Example: Plant 247 G

Gates said he also cleans the dinner dishes every night, because he likes the way he does it.

- D (dish)
- O (operating)
- S (system)
The key message

• The IIoT is a low-priced commodity

• There are virtually no barriers to obtaining the technology

• The winners will be determined not by who has the most technology, but by who knows how to best adopt it into their current system

KNOW THY SYSTEM