California Plug Load Research Center
Workshop

Prof. G. P. Li, PI
California Institute for Telecommunications and Information Technology, Irvine Division

Dr. Richard P Donovan, Director of Research Development, Donald Bren School of Information and Computer Sciences and the Henry Samueli School of Engineering

What is Smart Manufacturing?

Smart Manufacturing (SM) is the **business, technology, infrastructure, and workforce** practice of optimizing manufacturing through the use of engineered systems that integrate operational technologies and information technologies (i.e. cyber-physical systems).
Clean Energy Smart Manufacturing Innovation Institute - Vision

**Connected Supply Chain**
- Agile
- Demand Driven
- Raw Material to Finished Product

**Sustainable Production**
- Higher value products
- Data for decision making
- Product Lifecycle Management

**Safe Production**
- Improved safety
- Fewer incidents
- More user friendly

**Energy Efficient**
- Lower emissions
- Less energy used
- Green manufacturing

**Optimization**
- Asset Utility/Zero Downtime
- Quality/Zero Defects
- Reliable results

CESMII Overview

CESMII Vision: Smart Manufacturing is manufacturing in 2030

MISSION
Radically accelerate the development and adoption of advanced sensors, controls, platforms, and models to enable Smart Manufacturing (SM) to become the driving, sustainable engine that delivers real-time business improvements in U.S. manufacturing.

GOALS
15% improvement in energy efficiency in first-of-a-kind demonstrations at manufacturing plants or of major processes within 5 years

50% reduction in cost and time to deploy SM in existing processes within 5 years

Significant industry adoption of SM technology within 5 years

Sustainable portfolio of business, technology, research and development, and workforce development activities that directly replaces initial Federal funding within 6 years

50% improvement in energy productivity within 10 years

OBJECTIVES
To enhance U.S. manufacturing productivity, global competitiveness, and reinvestment by:

- Energy productivity
- Economic performance
- Institute sustainability
- Workforce capacity

California Energy Data Analysis Reflects a Diverse Manufacturing Ecosystem

<table>
<thead>
<tr>
<th>Rank</th>
<th>Energy (All enterprises)</th>
<th>TBTU</th>
<th>Output (All enterprises)</th>
<th>$Million</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Petroleum and Coal Products</td>
<td>100-120</td>
<td>Computer and Electronic Products</td>
<td>57,405</td>
</tr>
<tr>
<td>2</td>
<td>Primary Metals</td>
<td>75-85</td>
<td>Petroleum and Coal Products</td>
<td>33,359</td>
</tr>
<tr>
<td>3</td>
<td>Food &amp; Beverage Processing</td>
<td>40-50</td>
<td>Chemicals</td>
<td>25,500</td>
</tr>
<tr>
<td>4</td>
<td>Chemicals</td>
<td>40-50</td>
<td>Food &amp; Beverage Processing</td>
<td>19,900</td>
</tr>
<tr>
<td>5</td>
<td>Nonmetallic Mineral Products</td>
<td>25-30</td>
<td>Aerospace &amp; Other Transp. Eq.</td>
<td>12,585</td>
</tr>
<tr>
<td>6</td>
<td>Paper Products</td>
<td>25-30</td>
<td>Miscellaneous</td>
<td>12,395</td>
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<tr>
<td>7</td>
<td>Miscellaneous</td>
<td>15-20</td>
<td>Fabricated Metal Products</td>
<td>11,331</td>
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<tr>
<td>8</td>
<td>Fabricated Metal Products</td>
<td>8-15</td>
<td>Machinery</td>
<td>10,058</td>
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<tr>
<td>9</td>
<td>Plastics and Rubber Products</td>
<td>7-12</td>
<td>Motor Vehicles</td>
<td>5,142</td>
</tr>
<tr>
<td>10</td>
<td>Machinery</td>
<td>5-10</td>
<td>Plastics and Rubber Products</td>
<td>4,682</td>
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</table>

<table>
<thead>
<tr>
<th>Rank</th>
<th>Small Enterprises (&lt;100 employees)</th>
<th>TBTU</th>
<th>Medium Enterprises (100-499 employees)</th>
<th>TBTU</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Primary Metals</td>
<td>13-19</td>
<td>Petroleum and Coal Products</td>
<td>90-95</td>
</tr>
<tr>
<td>2</td>
<td>Food &amp; Beverage Processing</td>
<td>5-10</td>
<td>Primary Metals</td>
<td>45-50</td>
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<tr>
<td>3</td>
<td>Chemicals</td>
<td>5-10</td>
<td>Food &amp; Beverage Processing</td>
<td>22-28</td>
</tr>
<tr>
<td>4</td>
<td>Nonmetallic Mineral Products</td>
<td>2-6</td>
<td>Chemicals</td>
<td>21-27</td>
</tr>
<tr>
<td>5</td>
<td>Miscellaneous</td>
<td>2-6</td>
<td>Paper Products</td>
<td>15-20</td>
</tr>
<tr>
<td>6</td>
<td>Petroleum and Coal Products</td>
<td>2-6</td>
<td>Nonmetallic Mineral Products</td>
<td>13-19</td>
</tr>
<tr>
<td>7</td>
<td>Paper Products</td>
<td>2-4</td>
<td>Miscellaneous</td>
<td>7-11</td>
</tr>
<tr>
<td>8</td>
<td>Fabricated Metal Products</td>
<td>2-4</td>
<td>Fabricated Metal Products</td>
<td>3-7</td>
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<tr>
<td>9</td>
<td>Plastics and Rubber Products</td>
<td>2-4</td>
<td>Plastics and Rubber Products</td>
<td>2-6</td>
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<tr>
<td>10</td>
<td>Machinery</td>
<td>1-3</td>
<td>Machinery</td>
<td>2-6</td>
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</table>

The map illustrates the energy consumption and GDP distribution in California, highlighting the state's diverse manufacturing ecosystem. The table provides data on the energy consumption and output of different manufacturing sectors, showing the significant contributions of various industries to the state's economy. The data is further categorized by enterprise size, with small, medium, and large enterprises contributing to the overall energy consumption and output. This analysis underscores California's role as a hub for diverse manufacturing activities, with each sector playing a critical role in the state's energy dynamics and economic growth.
California RMC Capabilities Summary

Sensors, Controls & Algorithms, Platforms, HPC

UCLA
UCIrvine
Berkeley
Calit2
USC University of Southern California
Missouri S&T
Jet Propulsion Laboratory
Lawrence Livermore National Laboratory

Energy Sustainability, Economic Development, Workforce Development, etc.

USC Price
CSUN
LAN Sync
City of Los Angeles
CSU5
California Community Colleges
El Camino College
California Governor’s Office of Business and Economic Development
Michigan Tech

From the Internet of Things to the Internet of Smart Workers

Industry IoT (IIOT) brings high value solutions
Optimized production, improved efficiency, preventive maintenance
The manufacturing worker
Losing in the battle against the machine
The manufacturing worker’s asset: Hands

Primary function of industrial workforce has been manual labor
Automotive manufacturing circa 1950
Automotive manufacturing today
The Smart Worker’s asset: Brains
People-The ultimate manufacturing asset

- Sophisticated on-board sensors
- Ability to learn, think, and adapt
- Powerful pattern recognition
- Highly mobile and autonomous
- Ability to troubleshoot

- Contextual awareness
- Ability to use wisdom and judgment
- Ability to draw conclusions
- Ability to make decisions
Smart Connected Workers Infrastructure for Enabling Advanced Manufacturing

Affordable Cloud Services

Google Cloud Platform
Real-time Workflow Assessment

Workflow Energy Signature
- Station 1
- Station 2
- Station 3

% vs. hrs
- Occupant 1
- Occupant 2

Accessible Data Analytics

Scalable Data Acquisition
(via Autology and SCE)

Portable Decision Making


California Plug Load Research Center
Cloud Infrastructure via Pacific Research Platform

Science DMZ for advanced data intensive simulations

Rook/Ceph - Block/Object/FS Swift API compatible with SDSC, AWS and Rackspace

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System Attributes (Includes performance metrics)

- 320 GPUs in 32 FIONAs connected by the PRP into a Condor-managed cloud
  - FIONAs—Custom Platforms built for Fast Data Transfer and GP
- NvN components that are coprocessors drawn from a variety of architecture types, available to users provided over high-speed networks
  - Field Programmable Gate Array (FPGA) Component, KnuEdge Hermosa Processor (sparse ML), IBM’s TrueNorth (neuromorphic), Qualcomm Inc. Snapdragons (mobile)
- Software that includes a wide range of open ML algorithms
  - ML Algorithms deployed on NNvN Processors: Deep Neural Network (DNN) and Recurrent Neural Network (RNN); Reinforcement Learning (RL) algorithms; Variational Autoencoder (VAE) and Markov Chain Monte Carlo (MCMC), Support Vector Machine (SVM)
Acknowledgements

- California Manufacturing Technology Consulting (CMTC)- Greg Profozich, Director of Advanced Manufacturing Technologies

- California Regional Manufacturing Center- Dale Turner, Regional Director

- DOE Clean Energy Smart Manufacturing Innovation Institute- Jim Wetzel CEO

- National Science Foundation (CHASE CI, PRP)
We welcome opportunities for collaboration.

Thank you!