Predictive Analytics for Smart Manufacturing

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NIST Research & Standards Focus

- Smart Manufacturing Processes and Systems
- Data Analytics
- Standards
How Can Data Analytics Improve Manufacturing?

From data to insight

DATA ➔ INFORMATION ➔ KNOWLEDGE ➔ INSIGHT

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The goal is how to use the data to make the connections between the different stages of the pipeline and share knowledge across PLM pipeline in a timely manner.
Data Analytics Capabilities

- **Descriptive** (What happened?)
- **Diagnostic** (Why did it happen?)
- **Predictive** (What will happen?)
- **Prescriptive** (How to make it happen?)

Data → Descriptive → Diagnostic → Predictive → Prescriptive → Decision and control
Building & Using Prediction Models

Data collection

Data Pre-processing

Processed data

Prediction Model

Validation data

Prediction model validation

Data Post-processing & Visualization

Deployment (Prediction)

Data Pre-processing

New data

Decision and control
Illustrative Example: Data-driven Energy Consumption Prediction

Machine tool controller data
- Feed rate
- Spindle speed
- Machine position

Data from external devices
- Depth of cut
- Cutting direction
- Cutting strategy
- Power demand
- Temperature, etc.
- ...

Part design
NC code
Target machine
Machined part

Energy Consumption Prediction
Building the Prediction Model

- Data filtering
- Input parameters selection
- Data transformation

\[ \begin{array}{cccc|c}
\text{Input data} & x_1 & x_2 & \ldots & x_n & y \\
\hline
x_1^1 & x_2^1 & \ldots & x_n^1 & y^1 \\
x_1^2 & x_2^2 & \ldots & x_n^2 & y^2 \\
\vdots & \vdots & \ddots & \vdots & \vdots \\
x_1^m & x_2^m & \ldots & x_n^m & y^m \\
\end{array} \]

Energy Consumption Prediction Model
Using the Prediction Model

New data

Energy Consumption Prediction Model
PMML is a Language to Represent Prediction Models