Dr. Ulrich Rossederer, Siemens PLM Software

Manufacturing Simulation – An Important Element for Improving the Energy Efficiency of Your Factory
Challenges for the industry are growing worldwide

Siemens has the right answers to the challenges of our customers in the manufacturing industry.

- Shorter innovation cycles
- More complex products
- Larger data volumes
- Individualized mass production
- Volatile markets
- High productivity
- Energy and resource efficiency as key competitive factors
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Strengthening our customers’ competitiveness

Reducing the time to market

Enhancing flexibility

Increasing efficiency
Division Profile

The Division Digital Factory offers a comprehensive, seamlessly integrated portfolio of leading edge PLM Software solutions and automation technologies covering the complete lifecycle from Product Design to Production Execution to Services. This helps manufacturing companies worldwide in enhancing the flexibility and efficiency of their processes and reducing time to market.

Siemens seamlessly integrates development, production and suppliers.
# Organization

## Digital Factory Division

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<th>Control Products</th>
<th>Product Lifecycle Management</th>
<th>Motion Control</th>
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## Customer Services

![Customer Services](image6)

**Integrated product portfolio paves the way for the Digital Enterprise.**
Production Simulation & Energy Efficiency
Energy Efficiency and Production Simulation

Not only the CO2 emission during use of a product is relevant but also the CO2 emission spent during manufacturing.

Therefore, manufacturing companies are giving more and more attention to energy efficiency of their factories.

Besides using more smart and more energy efficient equipment, the manufacturing processes themselves can be optimized for energy efficiency as well.

Digital Models should help analyzing various energy saving scenarios without disrupting running production.
Robotic Energy Simulation
Motivation

• Huge amount of robots in car production, saving energy per robot scale-up over the full line
• Motions of robots being programmed considering collision and cycle time only
• No consideration of the “ergonomics” of a robot
• Dynamics of motion and position of robot has significant influence on energy consumption
• By measuring and displaying energy consumption, programs can be optimized both for time and energy
Robot Energy Saving Scenarios
Influence off Path Smoothness

Edgy 100%
Rounded 83%
Smooth 65%

35% saving
Robot Energy Saving Scenarios
Influence of Motion Height

High Arc  Low Arc

61% saving
Robot Energy Saving Scenarios
Influence of Motion Speed

Speed Max

Speed 75% of Max

14% saving
Robotic Energy Simulation
Enable Energy Measurement in Robot Simulation

- Display energy consumption in robot simulation systems
- Consider energy values during robot offline programming
- Consortium of users, robot vendors and simulation vendors
- Agreed on a set of extensions to existing standard (RRS-1)
- RRS consortium meeting will be held to extend the audience and get global feedback on the proposal
- Proposed extension is already being implemented by some of the consortium members
RRS is a well established standard protocol (since 1994) enabling realistic simulation of robot motions using the robot vendor specific algorithms encapsulated as black-box.

“The projects of Realistic Robot Simulation (RRS) aim at achieving high accuracy when simulating the controllers of manufacturing systems.”
- Fraunhofer IPK, Project Coordinator

Membership includes a variety of manufacturers and simulation suppliers in support of all robotic and automation applications.
RRS Extension – Key Capabilities

New function calls for:
- Definition for robot energy state and transition
- Set robot energy state for controller
- Set energy saving level for robot controller (as available)
- Calculate total energy consumption for a given time interval
- Optional: provide energy consumption break-down by system element

The accuracy of energy values is responsibility of robot vendors

Siemens PLM is targeting to provide virtual measurement capabilities in a first stage. Future development include more assistance and optimization for energy optimized motion generation
Energy Simulation in Tecnomatix Process Simulate
Robotic Energy Simulation
Beneficial Scenarios

Switch and compare robot types

Analyze new robot types

* Assuming RRS extension implemented by robot vendors
Robotic Energy Simulation
Beneficial Scenarios

Optimal Placement considering reachability and energy consumption

Balance process sequence, speed and energy consumption in multi-robot setups
Production Simulation & Energy Efficiency

INDUSTRY
ROBOTS

LOGISTICS
MATERIAL FLOW
Tecnomatix Plant Simulation

- Digital model of real or planned production facilities
- Realistic behavior based on Random Number and Stochastic
- Using product and layout data for visualization (CAD)
- Connected to real input data from ERP systems and planning departments
- Virtual commissioning for PLC and MES controls
- Creates proven manufacturing KPI’s from simulation experiments
- Energy settings and evaluations for developing green factories
- Provides Value Stream Simulation for lean manufacturing aspects
Tecnomatix Plant Simulation: Energy related Machine Settings

Scope:

• Introduction of energy consumption levels for working, operational, stand-by,…
• Tracking of overall energy consumption profiles

Benefit:

• Possibility to evaluate and optimize the production process according to energy related issues

Plant Simulation introduces energy related parameter for machine and transportation objects according to the new PROFIenergy standard.
PROFlenergy: Smart Energy Management over PROFINET

Tecnomatix Plant Simulation supports testing of PROFlenergy control strategies for manufacturing equipment
Tecnomatix Plant Simulation: Energy Settings and Power Management

- Energy consumption of machines and conveyors
- Switching times for powering on/off
- Energy related statistics
- Automatic state change according to shift calendar
Analysis of Energy Consumption

- Graphical high-lighting of stations with high energy consumption
- Chart for energy consumption per object
- Plot of overall energy consumption in a complete manufacturing line or factory
- Detailed statistics tables
Simulation Model of a LCD-TV Production Line
Case Study

Saving 1.66 Mio kWh per year through “start-stop” control strategy for machines
Measurement did match simulation prediction
Additional 1.4 Mio kWh saving through turning of high-pressure pumps for cooling lubricants in case of idling machines
Positive side-effect: noise reduction
Plant Simulation Energy Simulation Summary

Energy consumption will be a major differentiator for competitive bidding and a key criteria for manufacturing production and facility related decisions.

Tecnomatix Plant Simulation offers an Off-The-Shelf toolset for manufacturing production:

• Modeling
• Simulation and Analysis
• Experimentation and Optimization

Energy Simulation allows you to easily analyze and manage energy consumption in complex, dynamic production environments.
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