

# Power Consumption Management in the Digital Factory

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**Abstract** Digital Factory as part of the PLM (Product Lifecycle Management) philosophy consists of different sub-areas of production. Each production process in the engineering company is formed by factors such as planning, design, simulation, tooling, machinery and equipment, installation and robotics, manufacturing cells, quality, production, suppliers, technical support. Every product manufactured goes through those phases of closed cycle and using PLM tools to manage and optimize all processes. Digital Factory effort is to analyze, mapping and digitized this platform to produce a realistic picture of the production. With this "digital copy" of production it can be further optimize and innovate the process of real production without having a need to implement the proposals even before it has been found its reality, sensuality and economic efficiency. One of the issues that the digital factory is involved, is the power consumption in the production.

**Keywords:** digital factory, PLM, power consumption

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## 1. Introduction

Nowadays the production planning focuses on simplicity of production, production rate, the possibility of changes in production and cost of production. The latter depends on many aspects. One of those is the power consumption of the enterprise. This parameter contributes a sizable percentage of the economy of production and with its optimization it occurs automatically process improvement in manufacturing. The actual layout design of workplaces, the use of equipment and machinery with regard to energy consumption can be performed manually, respectively with the help of simple tools such as Microsoft Excel, but the results of such of planning does not always show the real state of the future workplace. A more accurate method is to use sophisticated software modules that with the help of algorithms zooms the future production with the largest precision.

## 2. Power Consumption Measurement in the Production Company

Siemens software, module Tecnomatix Plant Simulation is a tool designated to simulate, through which we can create digital models of logistic systems (order processing, storage warehouses, packaging and containers, transport). Module Plant Simulation allows to study characteristics of the system and based on the results it optimizes its performance. It performs an analysis of all obstacles, evaluate statistics and graphs, the value of which the best of production scenarios under which the enterprise should produce optimal and most preferred.

Advantages of Plant Simulation are:

- utilization of resources for production,
- positive results and identification of errors,
- reduction in cost of production,
- carrying out the tests in the software before real production,
- reduce the cost of expensive technology.

Further use of this software tool is the measurement and optimization of energy consumption. The following section describes the basic procedure for analyzing power consumption and possible outcomes, respectively potential outputs of Plant Simulation.

The very first step after modeling workcell or whole plant, is the definition of power consumption of all devices (Figure 1). After clicking on the object (machine) it is necessary to open the tab "Energy".

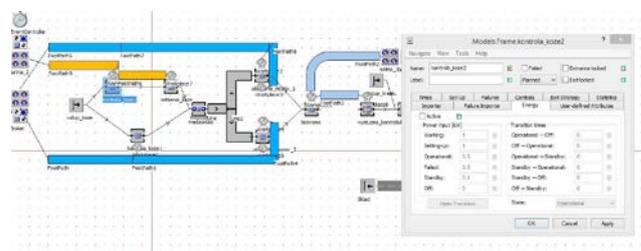


Figure 1. Power consumption definition

To activate the items settings in the Energy tab occurs by checking the "active" option and to clicking "Apply" button. Below is a description of each type of consumption:

- Total consumption - the total power consumption
- Working - total energy consumption of the object at the time worked
- Setting-up - power consumption while setting up the object
- Operation - operational Power Consumption

- Failed - final energy consumption during the object failed
- Standby - total power consumption in "standby" mode
- Off - the energy consumed by the time the object was turned off

The next step in the analysis of energy consumption is the setting of individual consumption values of all objects (Figure 2).

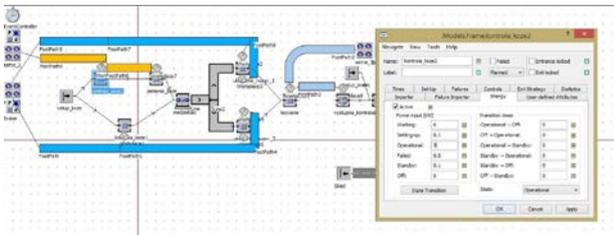


Figure 2. Setting up the values of power consumption

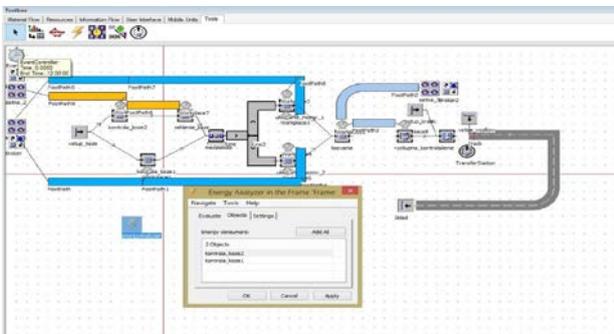


Figure 3. Energy analyzer

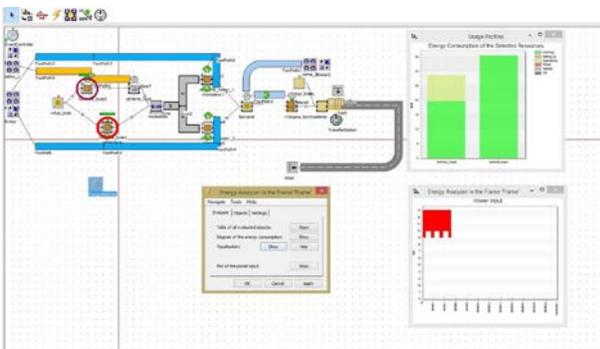


Figure 4. Power consumption during the running simulation

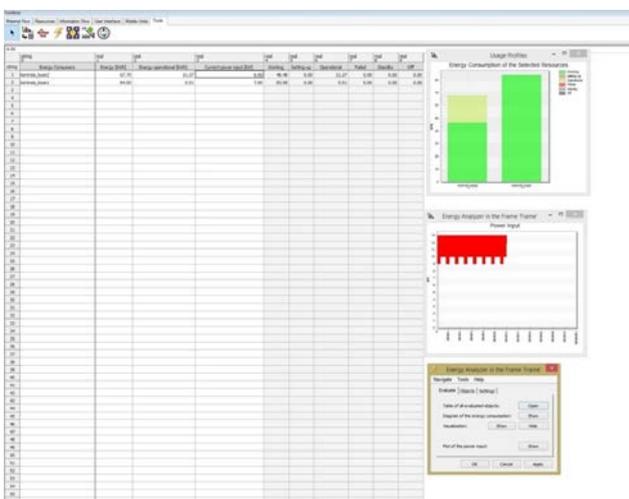


Figure 5. Final results of power consumption

By inserting "Energy Analyzer" and allocating of objects (machinery and equipment), the activation of analysis of the energy consumption occurs (Figure 3).

To the graphics window is no longer necessary to add, respectively open a window showing the energy consumption for its actual monitoring. The actual measurement of power consumption while running the simulation is illustrated in the following diagram (Figure 4).

View of the final results after the end of all simulation cycles of production refers to the total consumed energy of production cell or in the production area (Figure 5).

### 3. Power Consumption of Robots

Tecnomatix Process Simulate is designed for building new or modifying existing production processes. On the base of simulation you can imagine the future picture of the real production system. 3D Simulation can reflect the actual status and conditions on the running system and of course, after some improvements, it can show the possible figure of the production system. The question about creation of simulation is simple. Engineers need to know, if the created simulation will be managed by time sequence (time based) or controlled by signals (event based).

The main functions Process Simulate software module are:

- 3D simulation,
- Static and dynamic collision detection,
- measurement in 3D dimension,
- mapping operations,
- robotic assembly and production planning of roads,
- resource modeling (3D and kinematics),
- simulation of the human tasks,
- simulations of discrete and continuous manufacturing processes,
- virtual commissioning.

During a simulation of production processes, especially during the robot operations, the Power Consumption panel is showing energy data from the robot controller and displays a graph of a robot power consumption. This panel is only available and visible for robots. It means, there is no possibility to measure power consumption of the other devices in the module Tecnomatix Process Simulate. The following scheme (Figure 6) shows the current Power Consumption of a robot during simulation in units of kW (kilowatts).

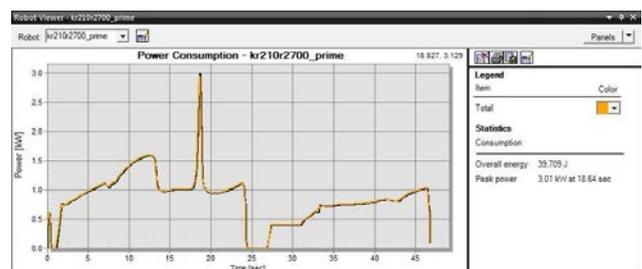


Figure 6. Meranie spotreby energie robota

The Robot viewer window in the power consumption part shows next to graph output the following parameters:

- Overall energy - The total energy consumption of the robot during the simulation.

- Peak power - The peak power consumption (in kilowatts) as sampled during the simulation. The system also notes the time at which the peak energy consumption occurred.

Important is, that we can monitor and analyze the power consumption of the robots only from Kuka KRC robots with controller version 8.3 and higher.

The RCS (Robot Controller Software) controller has a different time interval than the simulation, therefore it is necessary to adjust the RCS power data to the simulation to average the results. Therefore it is not advisable to use large time intervals for the simulation which could lead to inaccuracies in the Power data displayed in the panel. The data shown in the Statistics area of the panel is independent of the simulation's time interval (taken directly from RCS).

## 4. Conclusion

Energy consumption and its management are among the indispensable aspects of production and its planning. Using a variety of software solutions leads to accurate analysis of the current state of workplaces, but also the design of new production cells in order to achieve the least electricity consumption and therefore contribute to the overall cost of production. Digital factory as a result of the usage of PLM solutions in manufacturing companies clearly contribute to the improvements of processes in the company and become an essential part of philosophy of every engineering company.

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