

Generating Simulation Models From CAD-Based Facility Layouts

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Rui Pinto is an Assistant Lecturer at the Faculty of Engineering of the University of Porto and a Ph.D. student of the Doctoral Program in Informatics Engineering at the same school since 2015. Also, he is a researcher on the Research Center for Systems & Technologies since 2013. He received the M.Sc. degree in Electrical and Computer Engineering at FEUP in 2013.

His research focus on introducing intelligence into industrial processes and contribute to the emergence of autonomous factories, by implementing novel approaches of Cyber-Physical Systems. The main objectives of his Ph.D. is to study the problem regarding security, intrusion detection and recovery in Cyber-Physical Systems applied to industrial contexts. To solve this problem, a Self-Immune approach is considered, which will be based on Artificial Immune Systems principles. He also co-authored several publications and recently co-supervised some M.Sc. dissertations in Informatics and Electrical and Computer Engineering.

He participated into several European RTD projects, including “Intelligent Network Devices for fast Ramp-Up” (I-RAMP³), funded by the Factories of the Future programme (FoF-PPP) of the EC FP7, “Innovative Reuse of modular knowledge Based devices and technologies for Old, Renewed and New factories” (ReBorn) and “Innovative strategies for Renovation and Repair in Manufacturing systems” (SelSus) both funded by the Factories of the Future programme (FoF-PPP) of EC FP7. Regarding National RTD projects, currently he's participating in the "PRODUTECH SIF - SOLUÇÕES PARA A INDÚSTRIA DO FUTURO" (PRODUTECH-SIF) and "INDTECH 4.0 - Novas tecnologias para fabricação inteligente", focusing on the development, management and improvement of Cyber-Physical Production Systems, simulation and optimization models and technologies for advanced robotic systems.

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Outline

- Advanced Manufacturing Systems
- Facility Layout Planning
- Problem Definition
- Layout CAD Interface
- Layout CAD Interface Validation
- Conclusion & Future Work

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Context

ADVANCED MANUFACTURING SYSTEMS

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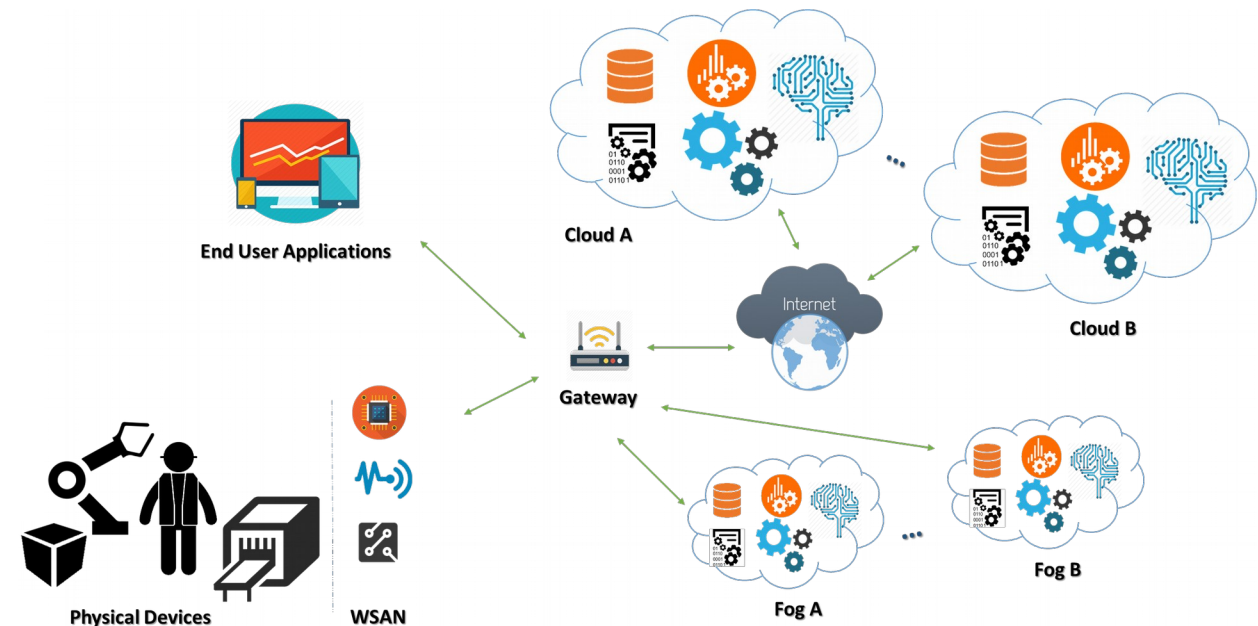


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Advanced Manufacturing Systems

Cyber-Physical Systems

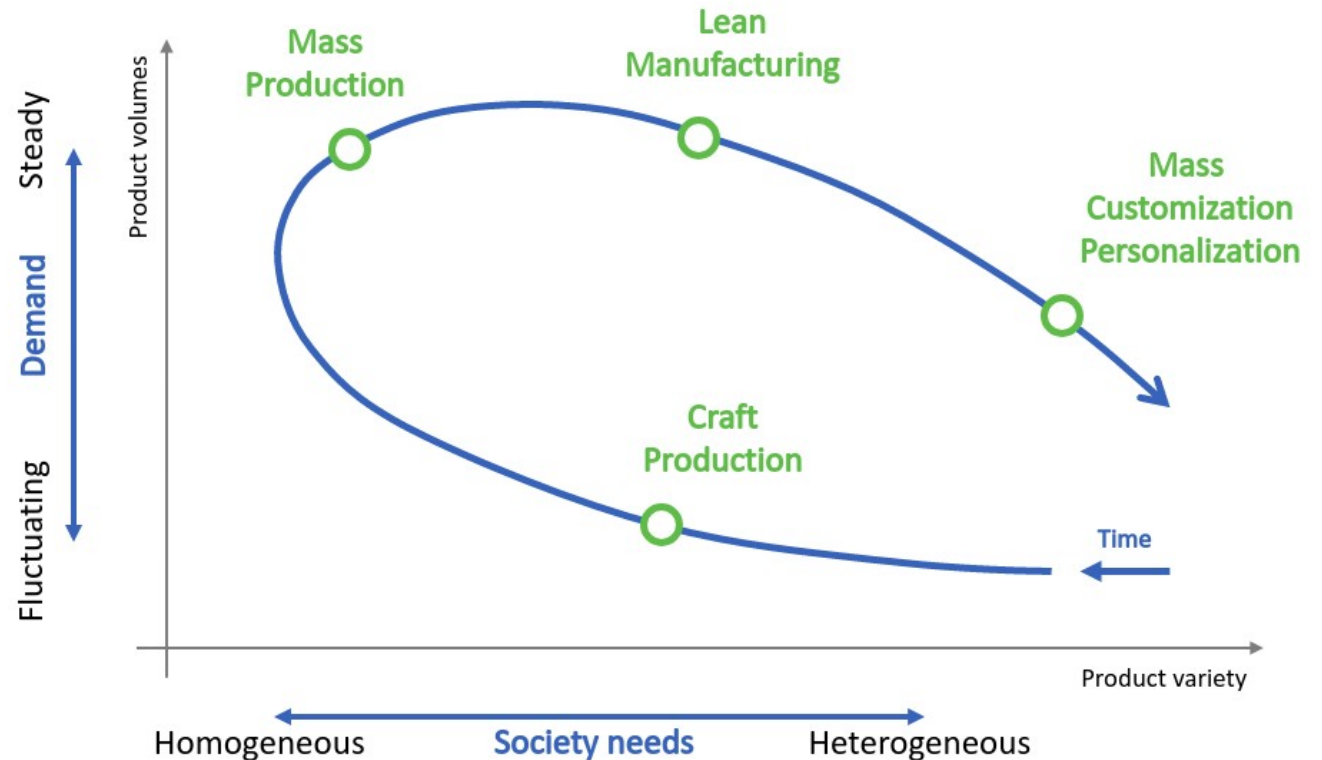
- ▶ Asset digitalization
- ▶ Supports vertical and horizontal integration
- ▶ M2M communication
- ▶ Autonomous machine decision and smart industrial applications



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Mass Customization & Personalization

- CPPS are paving the way for this new production paradigm.
- Characterized for flexibility and interoperability to produce low volumes and high variety of customized products, according to customer demand.
- This requires real-time evaluation of the operational and safety characteristics of the real system, achieved by virtual environments based on optimization and simulation models.



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Facility Layout Planning

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Facility Layout Planning

- Facility Layout Planning is an allocation of facilities in space, such that a set of criteria are met and some objective optimized.
- Main goal is to minimize material transport costs, work-in-progress, costs with space, among others...
- A facility is a resource on a manufacturing system that facilitates the performance of any job:
 - Machine tool
 - Work center
 - Manufacturing cell
 - Department
 - Warehouse

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Problem Definition

CAD-BASED FACILITY LAYOUT PLANNING

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Problem Definition

- Modern practice is to use CAD and simulation in the planning stage of facility layout design. The main goal is to enable factory managers to try different layout scenarios for system analysis.
- The investment required to build accurate simulation models, such as time to learn the languages and human effort to put together the model is very high.
- There is the need of approaches that automatically generate simulation models, specifically structural approaches.

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Proposed Tool

LAYOUT CAD INTERFACE

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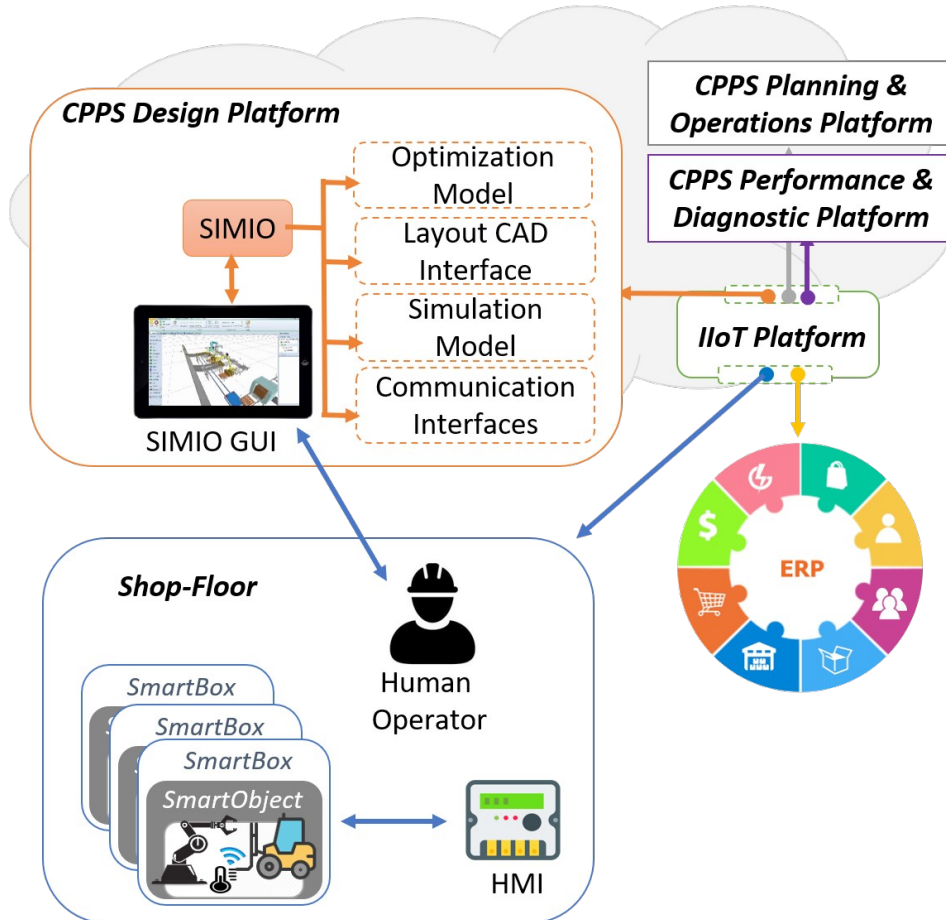
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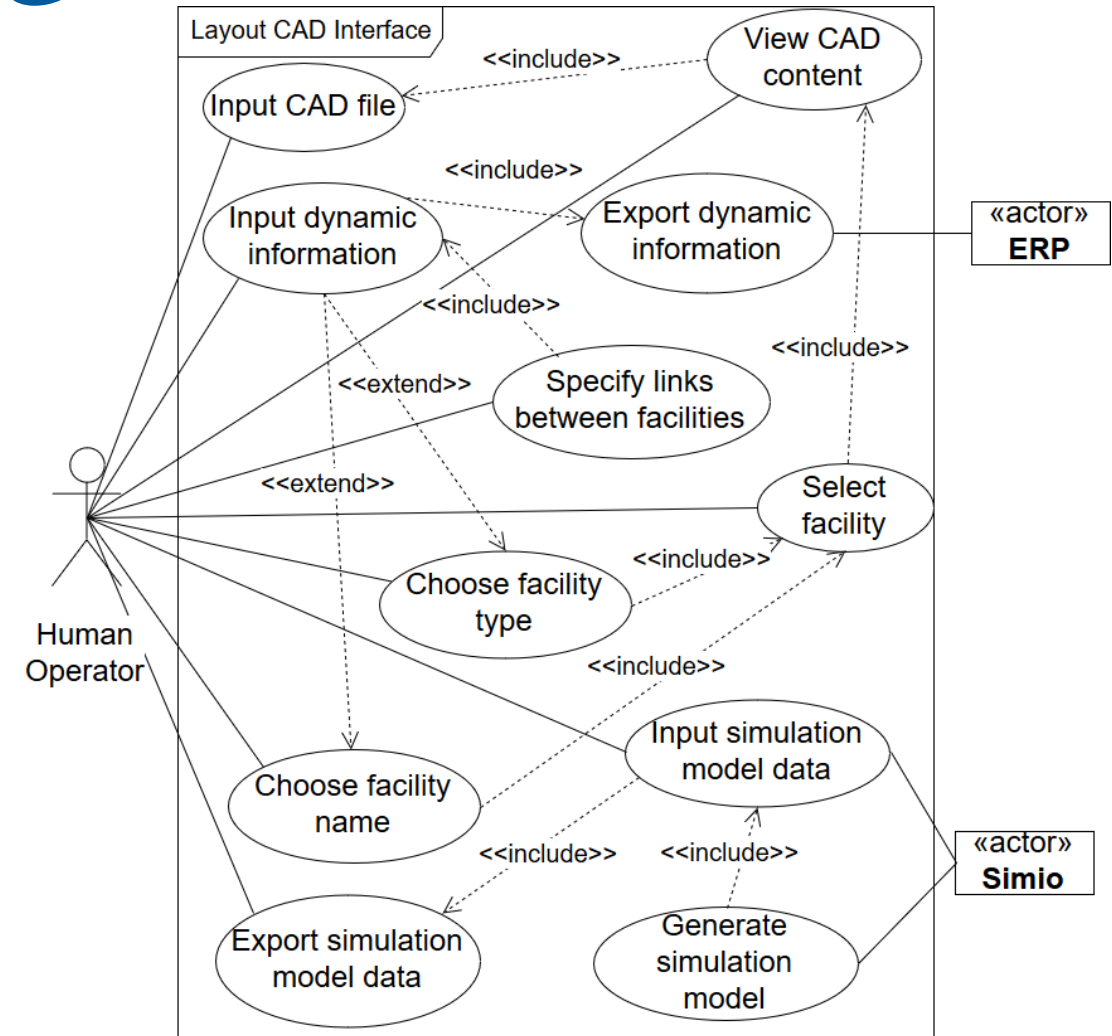
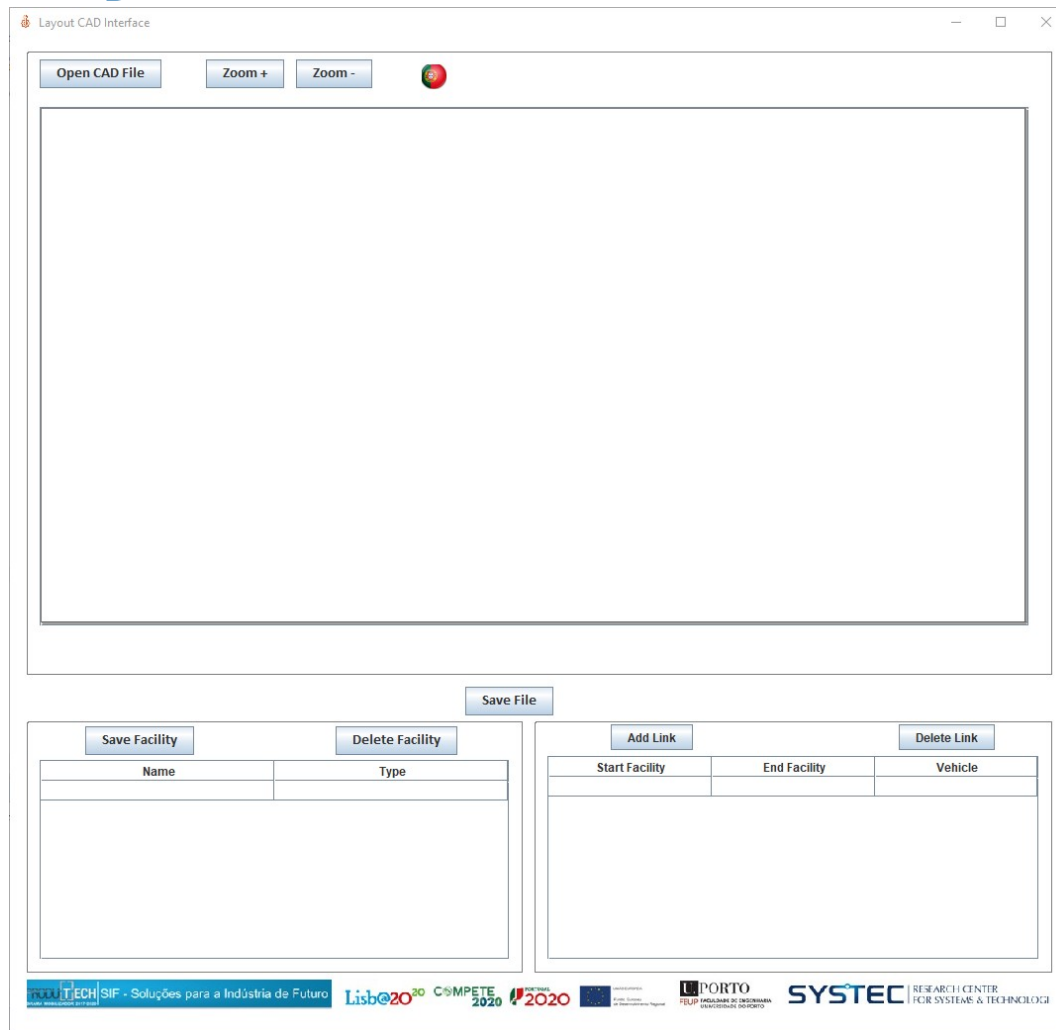
CPPS Design Platform



- The *CPPS Design Platform* is a tool, developed within the R&D *PRODUTECH-SIF* project, for flexible high performance CPPS design, implementation and installation.
- The simulation modeling software is the main component of this platform, which, through the use of simulation models representing the dynamics. *Simio* is used as simulation tool.
- The *Layout CAD Interface* provides to *Simio* automatic generation capabilities of simulation models, or part of them, depending on their complexity and customization, based in facility layout CAD files.

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Layout CAD Interface



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Tool Validation

LAYOUT CAD INTERFACE

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Test Case 1 - Process layout

Design of the shop-floor facilities aims to arrange facilities according to their function

The screenshot displays the Facility Tools software interface. On the left, a 'Libraries' panel lists various facility types such as Source, Sink, Server, Workstation, Combiner, Separator, Resource, Vehicle, Worker, BasicNode, TransferNode, ModelEntity, and Model. The main workspace shows a 3D perspective view of a shop floor layout with several facilities labeled mvc1 through mvc5 and mbj1 through mbj2. A control panel on the right contains several buttons and tables:

- Open CAD File (1)** and **Open Facilities File (2)** buttons at the top.
- Zoom In** and **Zoom Out** buttons.
- Save File (5)** button.
- Save Facility (3)** and **Delete Facility** buttons above a table.
- Add Link (4)** and **Delete Link** buttons above another table.
- A red circle (6) highlights a specific area in the 3D model.

Name	Type
mvc1	Workstation
mvc2	Workstation
mvc3	Workstation
mvc4	Workstation
mvc5	Workstation
mbj1	Server
mbj2	Server

Start Facility	End Facility	Vehicle

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Test Case 2 - Product layout

Assembly line and the facilities are arranged according to a particular production sequence.

The screenshot displays the Facility Tools software interface. On the left, a 'Libraries' panel lists various facility types such as Source, Sink, Server, Workstation, Combiner, Separator, Resource, Vehicle, Worker, BasicNode, TransferNode, Connector, Path, and TimePath. The main workspace shows a production sequence diagram with nodes: Source1, Filler, Cork_screw, Labelling, Packing, Transport1, and warehouse. On the right, a detailed view of the layout is shown with numbered annotations: 1 (Open CAD File), 2 (Open Facilities File), 3 (Save Facility), 4 (Add Link), 5 (Save File), and 6 (Zoom In/Out). Below the detailed view, there are two tables: 'Save Facility' and 'Add Link'.

Name	Type
source1	Source
Filler	Workstation
Cork_screw	Workstation
Labelling	Workstation
Packing	Workstation
Transport1	Vehicle
warehouse	Sink

Start Facility	End Facility	Vehicle
source1	Filler	
Filler	Cork_screw	
Cork_screw	Labelling	
Labelling	Packing	
Packing	warehouse	Transport1

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Facility Tools Support
 My Model Metros2 - Simio Academic Design Edition (COMMERCIAL USE PROHIBITED) - Registered to University of Porto

File Project Home Run Drawing Animation View Visibility Support

Paste Copy New Model New Experiment New Symbol New Texture Load Library Check For Updates Actions Documentation Report Trace Errors Breakpoints Watch Search Profile Properties Reset Render to Oculus Office 2016 Colorful Theme

Clipboard Create Library Add-I... Documentati... Windows

Facility Processes Definitions Data Results

Libraries

- Standard Library:
 - Source
 - Sink
 - Server
 - Workstation
 - Combiner
 - Separator
 - Resource
 - Vehicle
 - Worker
 - BasicNode
 - TransferNode
 - Connector
 - Path
 - TimePath
 - Conveyor
- Flow Library
- [Project Library]
 - Model

Stopped

Browse: Model

Navigation: Model

- My Model Metros2
 - Model
 - Symbols
 - Planta

Properties

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Wrap-Up

CONCLUSION & FUTURE WORK

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Conclusions & Future Work

- The current document refers to the development of a tool, designated as *Layout CAD Interface*, focused in enabling the simulation software *Simio*, with the capability of semi-automatic generation of discrete-event simulation models regarding CPPS.
- Tool validation results show that it is suitable for automatic generation of simulation models, contributing to the static information of the model (shop-floor layout).
- For future work, it will be explored the input of dynamic information (system behavior and production), collected from the ERP systems and directly from the shop-floor equipment.
- Also, the *Layout CAD Interface* may be extended to support 3D designs, which will permit the replacement of the *Simio* default simulation objects for the real design models of the facility.

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Thanks!

Any questions?

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