The Digital Twin as a Design Tool in Industry 4.0: A Case Study

Authors:
Ivan Arturo Renteria-Marquez, Ph.D
Anabel Renteria, M.S.
Tzu-Liang (Bill) Tseng, Ph.D

Presenter:
Anabel Renteria, M.S.
University of Texas at El Paso
E-mail: arenteriamarquez@miners.utep.edu

THE UNIVERSITY OF TEXAS
AT EL PASO

AUTHOR BIOGRAPHIE

- **ANABEL RENTERIA** received a Master of Science in Industrial Engineering at The University of Texas at El Paso. She is currently a PhD student in Mechanical Engineering in the same institution.
- Her research interest is in modeling and simulation of supply chain and manufacturing systems using discrete events, and Industry 4.0 technologies.

Introduction

Industry 4.0 has the potential to transform and reactivate manufacturing industry in USA.

Industry 4.0: It is the general term used to describe the vision of manufacturing systems integrated by processes with a high degree of automation, which are fully connected between them.

Technologies:

Internet of things	Cloud computing	Additive manufacturing
Robotics	Cybersecurity	Simulation
Automation	Data analytics	

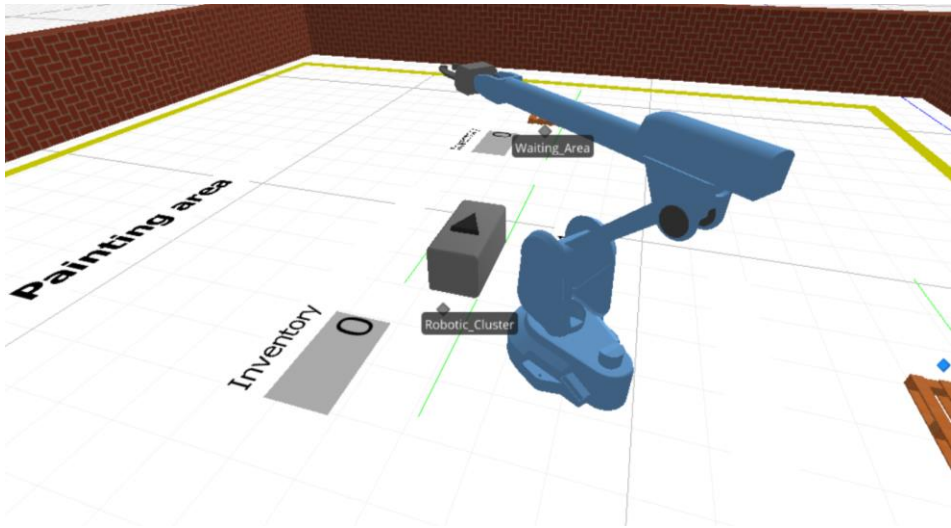
Introduction

- The government of the USA is being leading different initiatives to develop and implement smart manufacturing technologies.
- Clean Energy Smart Manufacturing Innovation Institute (CESMII)
- A considerable number of manufacturing companies across the USA are trying to move from a traditional production floor to a smart production floor.
- The introduction of Industry 4.0 technologies on the production floor is a challenging task.

Introduction

Main objective

Report the methodology followed and the findings of a project deployed in an assembly manufacturing company located in the USA that focused on the implementation of a manufacturing digital twin to predict the effects of introducing robotic systems in their production process.



Literature review

Digital twin

The concept was originally established by a NASA team, in this context, they defined the digital twin as a simulation model of a vehicle that integrates multi-physics, multi-scale, and probabilistic models.

Digital twin of manufacturing system

A digital twin of a manufacturing system can be defined as a virtual representation of a manufacturing system that allows one to see how the system will perform in the real world; where the digital twin can be used to design, optimize and operate the system.
The digital twin can be connected online through the Industrial Internet of Things (IoT) and access in-real time the Enterprise Resource Planning (ERP) and the Manufacturing Execution System (MES) System

Capacity analysis

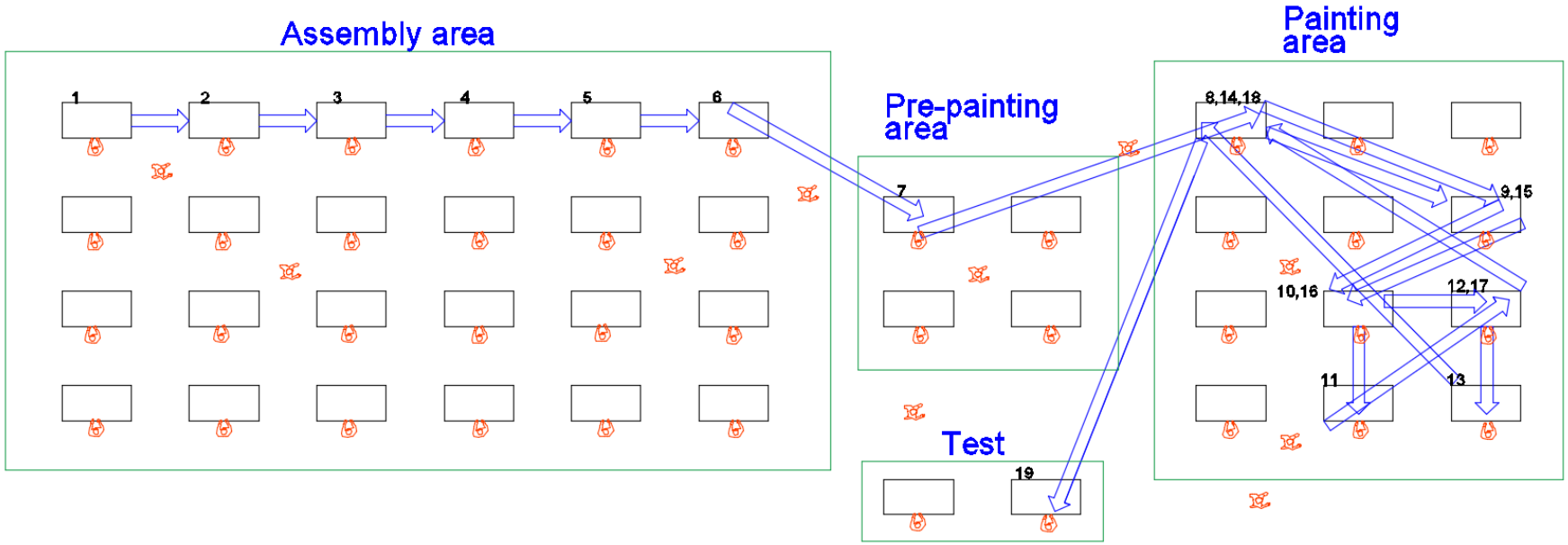
One can define capacity analysis as the process used to measure the capacity of one operation in a manufacturing plant.

Production capacity analysis refers to the maximum number of production orders that can be manufactured under specific conditions.

Overview of the manufacturing system and problem definition

Main groups:

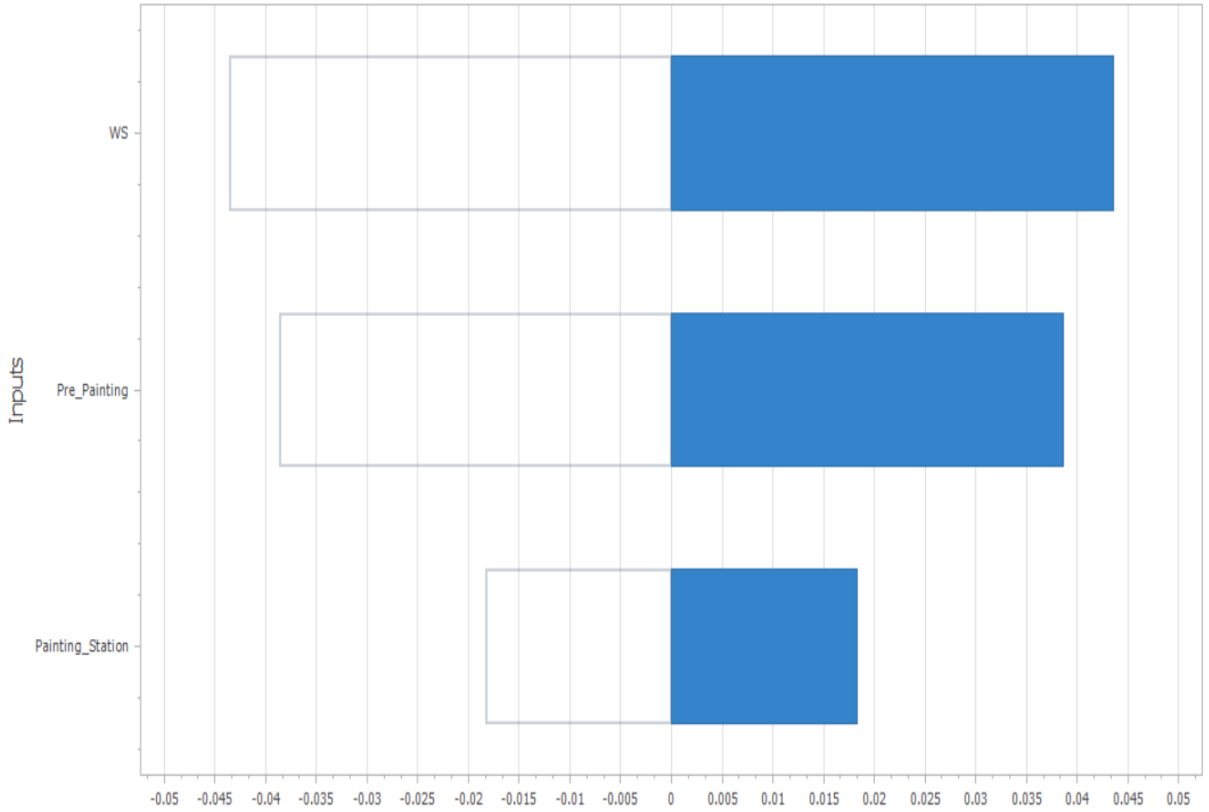
- Assembly
- Pre-painting
- Painting
- Testing



Solution approach

Task 1: Definition of the logical model of the system.
Task 2: Data collection.
Task 3: Programming of the digital twin.
Task 4: Perform the analysis.

Results obtained

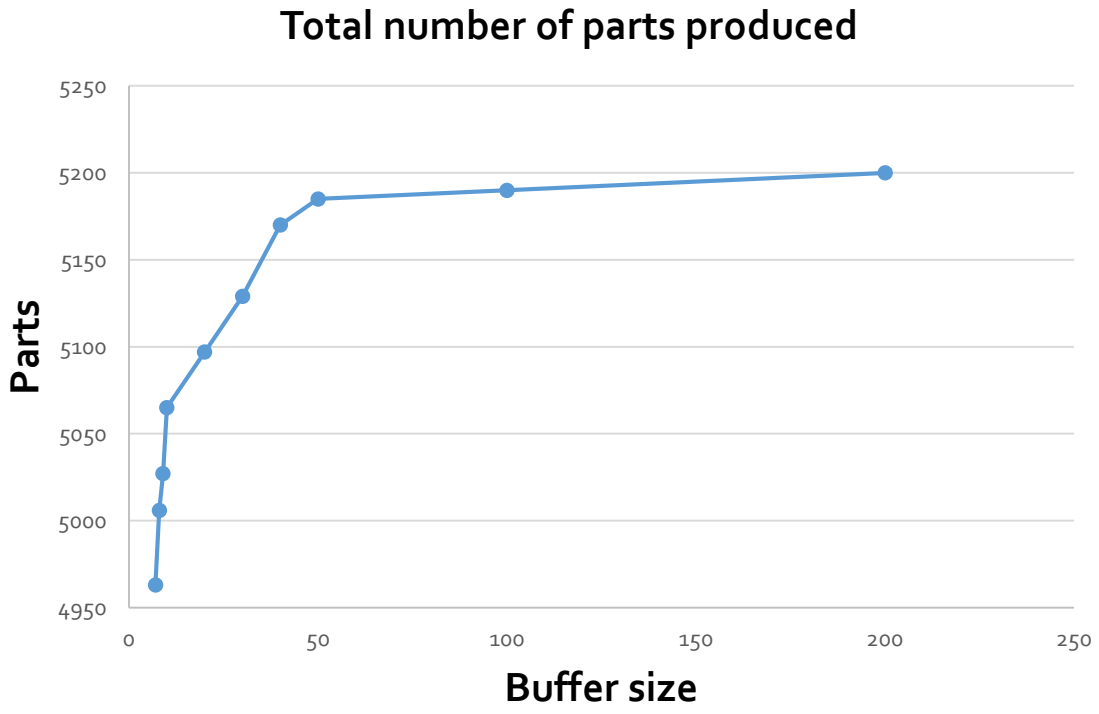


Sensitivity analysis of selected processes.

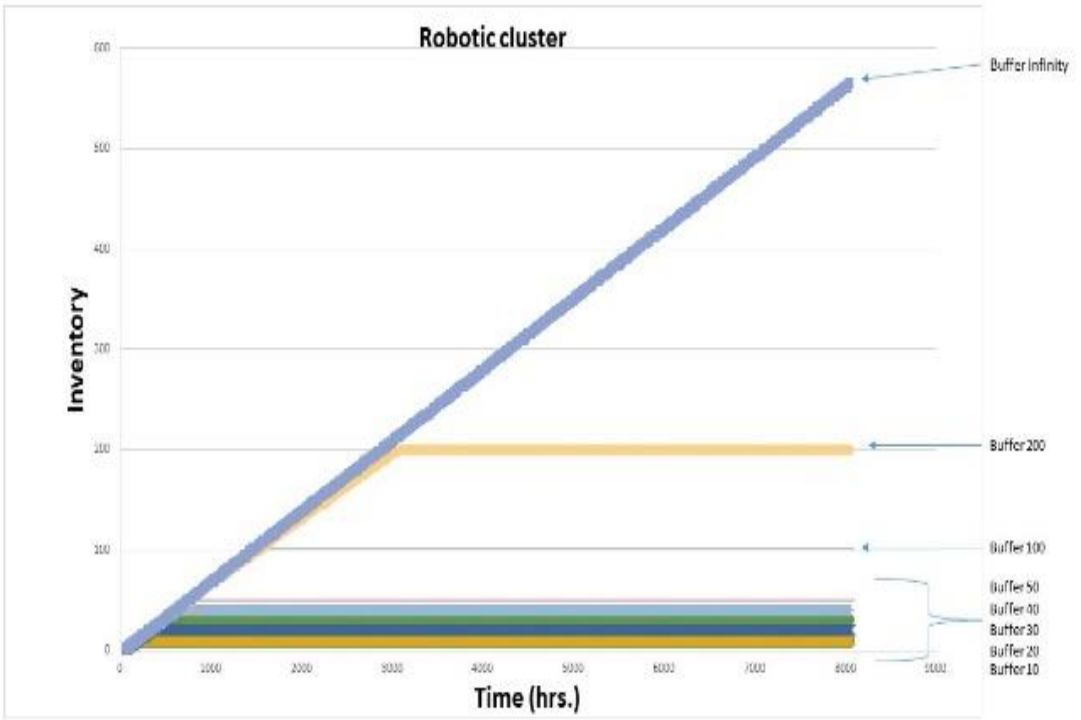
Number of parts produced as a function of the buffer size

Buffer size	Number of parts produced
7	4963
8	5006
9	5027
10	5065
20	5097
30	5129
40	5170
50	5185
100	5190
200	5200
Infinity	5205

Results obtained



Total number of parts produced versus different buffer sizes.



Inventory of the robotic cluster as a function of time

Conclusions

- Implementation of a digital twin of an entire manufacturing assembly plant for design purposes.
- Investigation of the buffer size of the painting shop over the total production capacity for the future state of the manufacturing plant.
- The future state of the company consists on replacing some manual operations of the painting shop with painting robots.
- Quantification of the influence of the painting robots before the insertion of them into the manufacturing system.
- The results show that the system converges at a buffer size of 200.
- A limited buffer size helps to control the inventory on the production floor.


QUESTIONS?
COMMENTS?
CONCERNS?