“DES-ign”: Integrating DES into the Architectural Design Process

Sean Carr + Olivia Pewzer + Zhanting Gao

May 7th 2018

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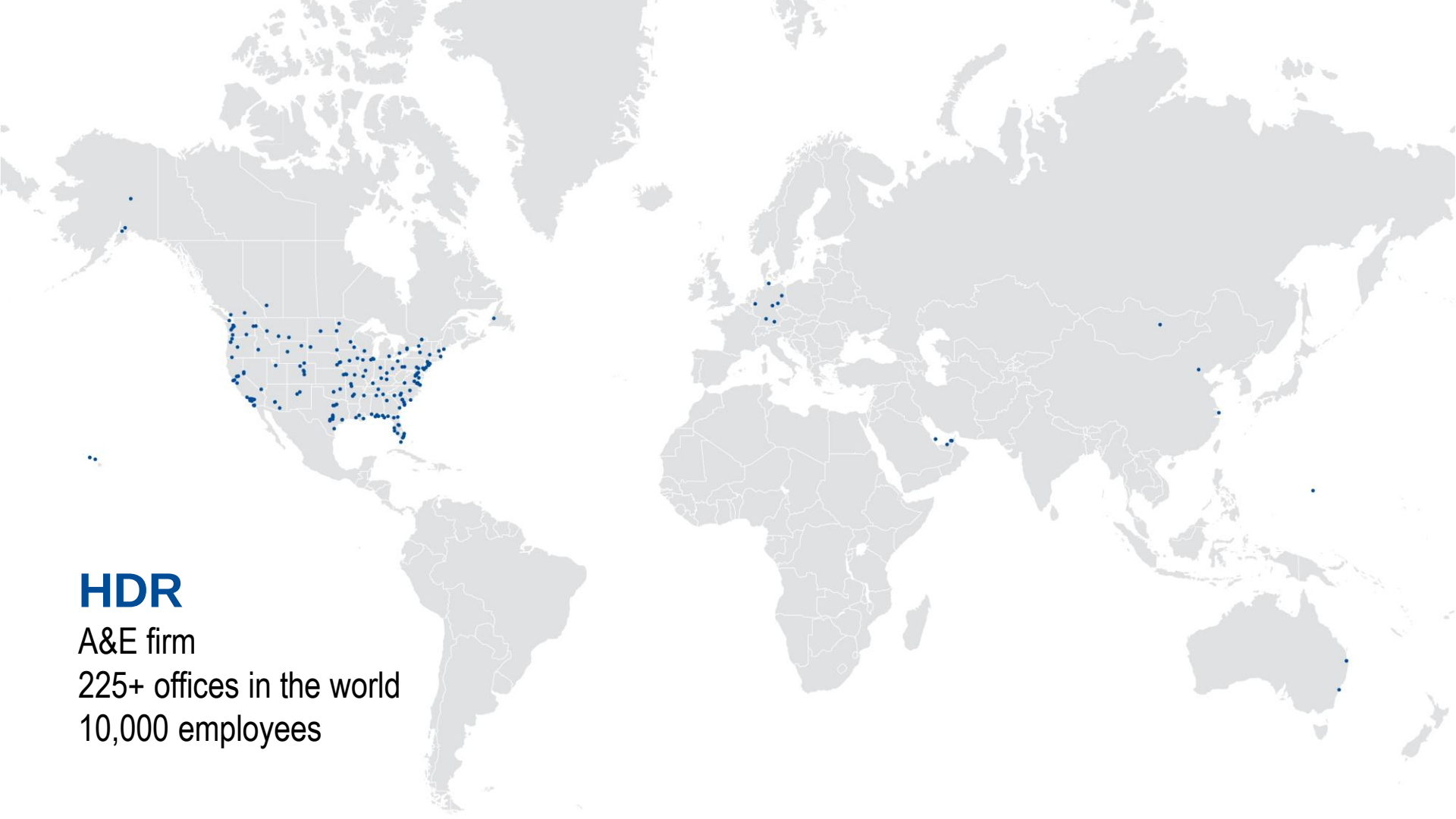
01 HDR & Operations Design

02 Problem Statement

03 Approach

04 Results & Solution

01 HDR & Operations Design

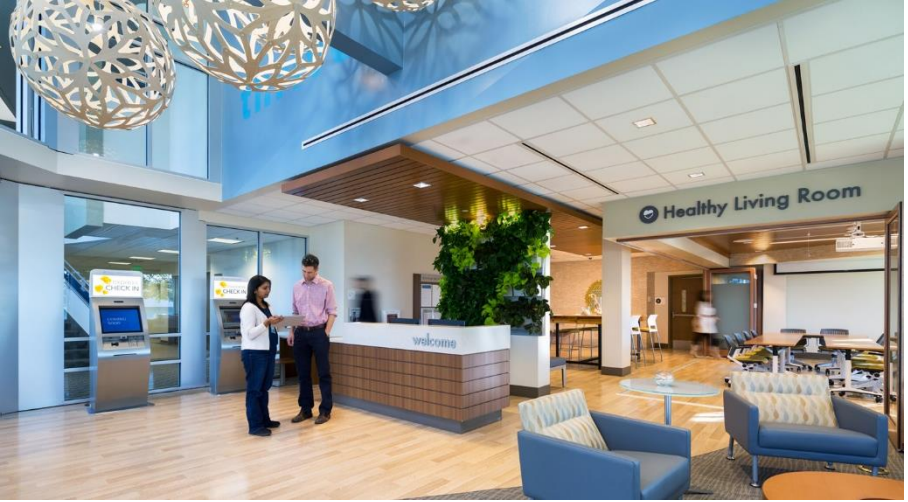


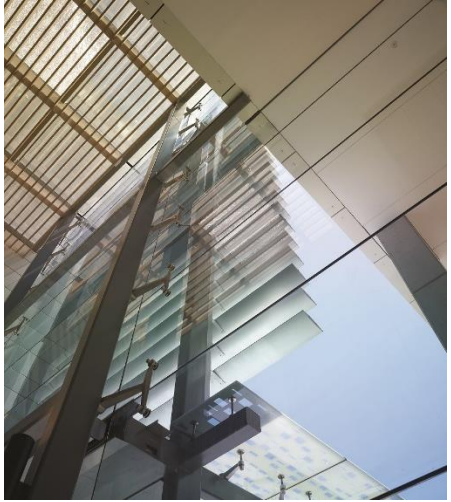
HDR

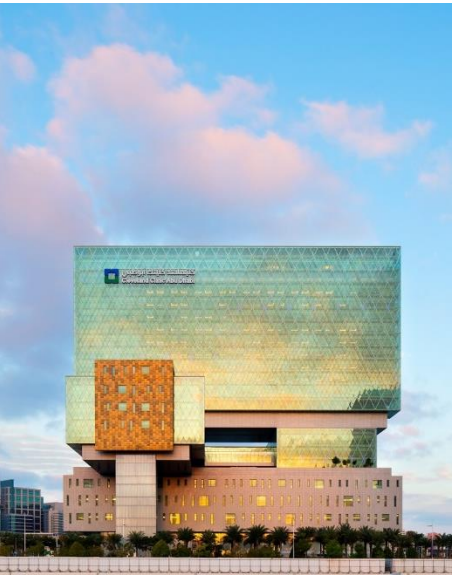
A&E firm

225+ offices in the world

10,000 employees







Our Portfolio

Manhattan Beach Health Hub Clinic (US)

Beijing University of Traditional Chinese Medicine (China)

Liverpool Hospital (Australia)

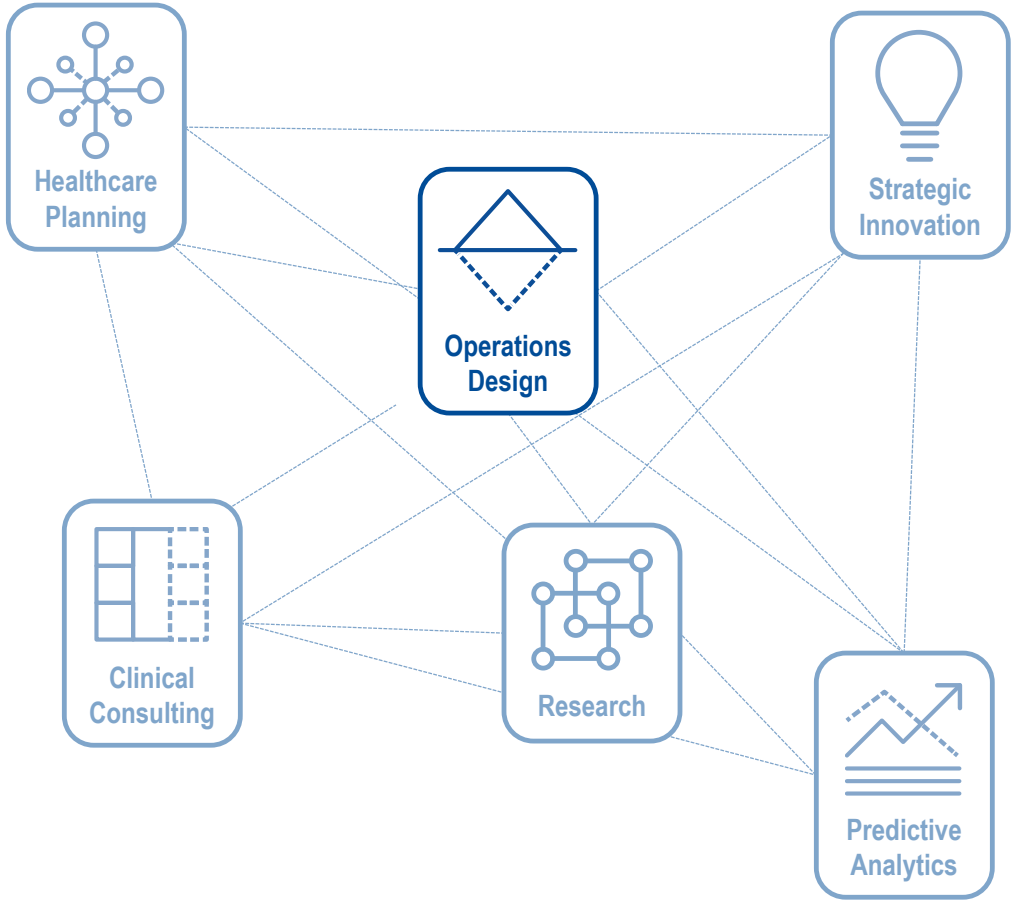
Dortmund Hospital (Germany)

Mubadala Healthcare (Abu Dhabi)

Who We Are

To the client

- Patient experience designers
- Operational efficiency improvers
- Value hunters
- Flow designers
- Troubleshooters
- Problem solvers



Our Tools

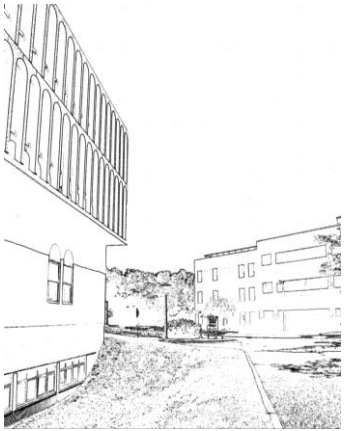
- DISCRETE EVENT SIMULATION (DES)
- 2P/3P (full-scale mockups)
- Value Stream Mapping
- Process Mapping
- Interactive Data Visualization
- Root Cause Analysis
- Personas/Scenario Modeling
- 5S

02 Problem Statement

Architectural Environment

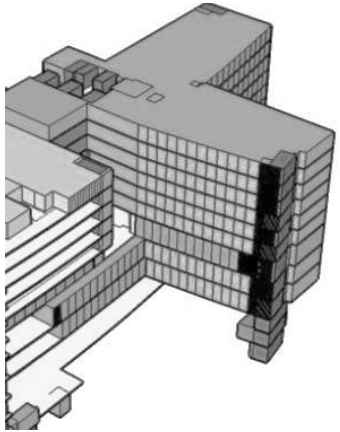
Typical Design Process

Pre Design



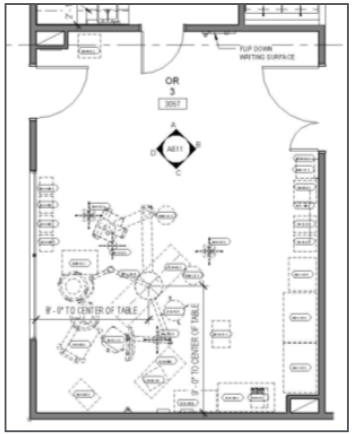
Team Structure
Orientation
Detailed Programming
Cost Management
Land-use Development

Schematic Design



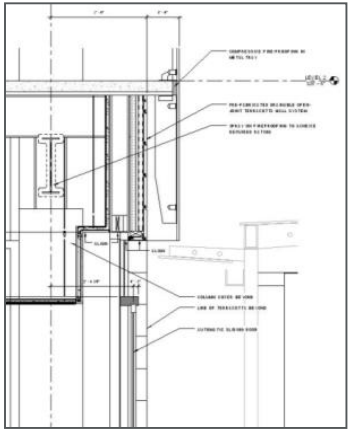
Massing
Character
Design
Room Layout
Cost Models

Design Development



Detail
Phasing
Delivery
Finishes
Cost Models

Construction Document



Design Intent
Quality
Process
Verification
Cost Models

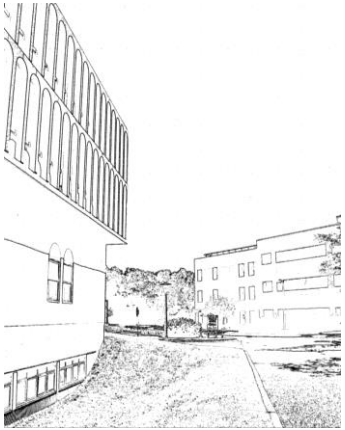
Construction

Design Intent
Quality
Process
Verification
Cost Models

Architectural Environment

Typical Design Process

Pre Design



Team Structure
Orientation
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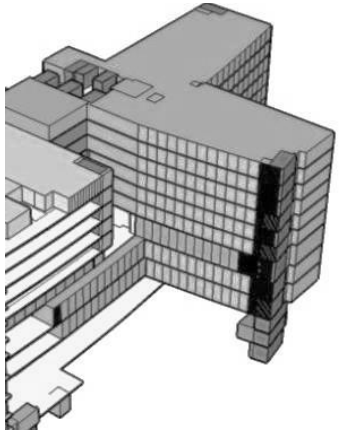
Land-use Development

Schematic Design



Massing
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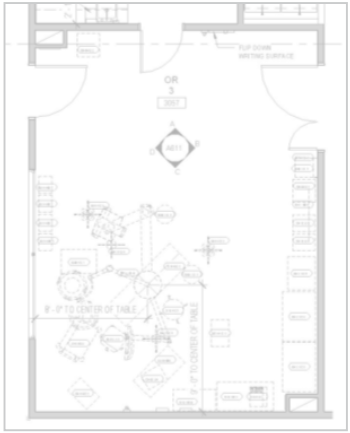

Detail
Phasing
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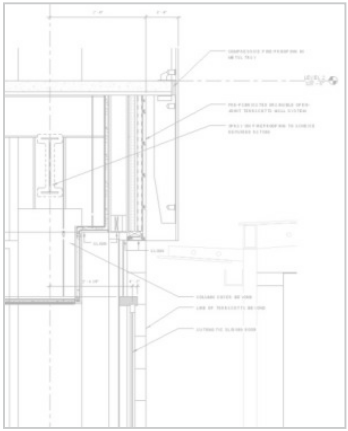
Finishes
Cost Models

Construction Document



Design Intent
Quality
Process
Verification
Cost Models

Construction

Design Intent
Quality
Process
Verification
Cost Models

Architectural Environment

Common Challenges & Implications

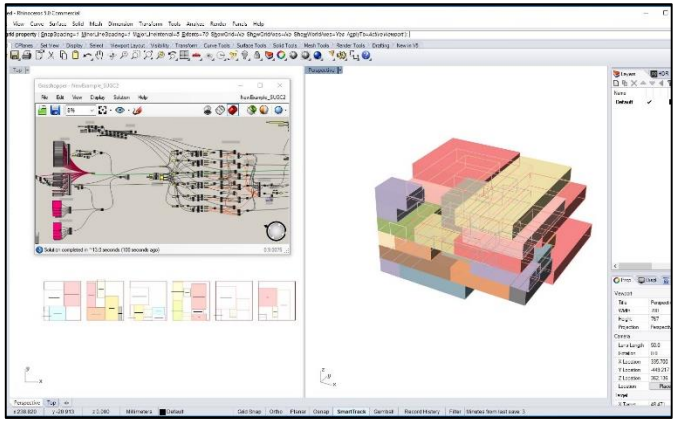
- Multiple **Layout Options**
- **Tight** Design **Timeline**
- **Large-Scale** Project Scope
- **Heavy competition** for planning services
- Dynamic **client priorities** and **strategy**

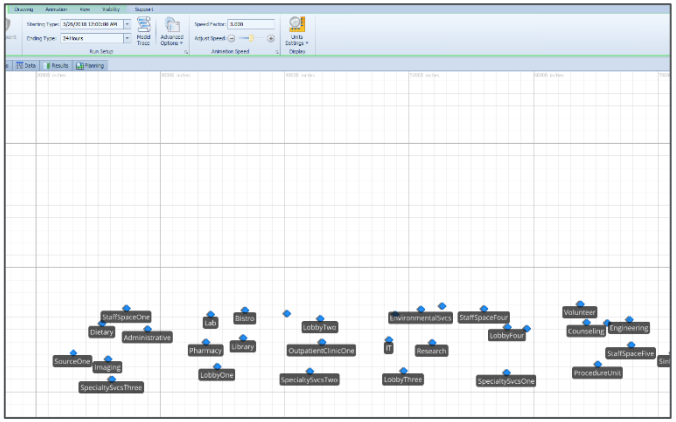
Modeling efficiency is very important in order to:

- provide time for investigating multiple design options and,
- remain competitive on the market

Architectural Environment

Design vs. Operational Applications





Building and Space Efficiency

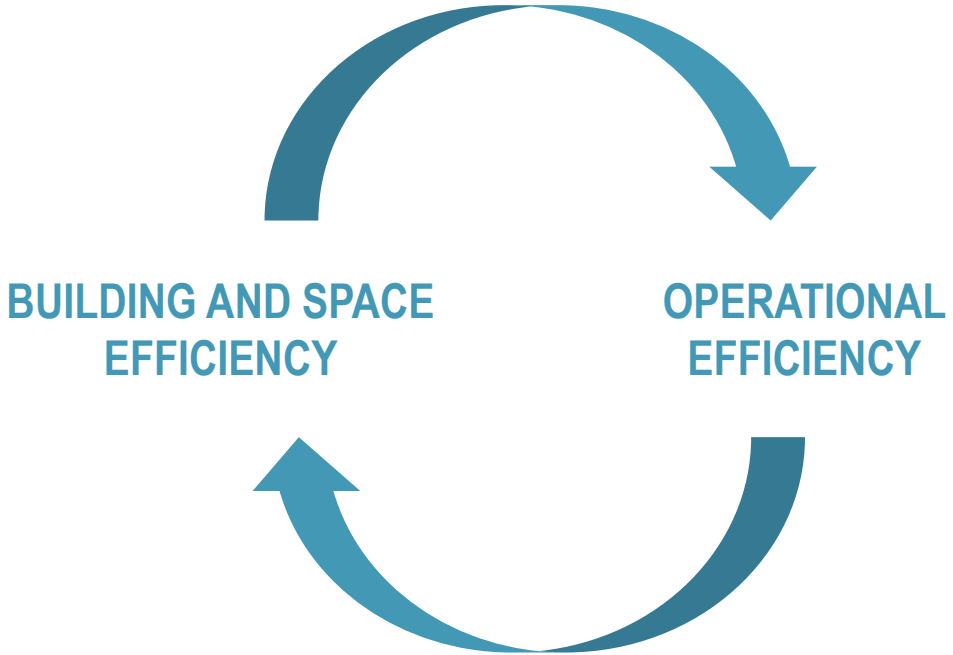
- Sunlight Exposure
- Noise Exposure
- Façade/Envelope Development
- Energy Consumption
- Site and Building Layout
- Building Material Selection

Operational Efficiency

- Staff and patient travel distance
- Room utilization
- Patient throughput
- Patient value added time
- Staff Utilization

Architectural Environment

Design vs. Operational Applications



Problem Statement

How can we improve simulation development efficiency in order to achieve a more effective design process?

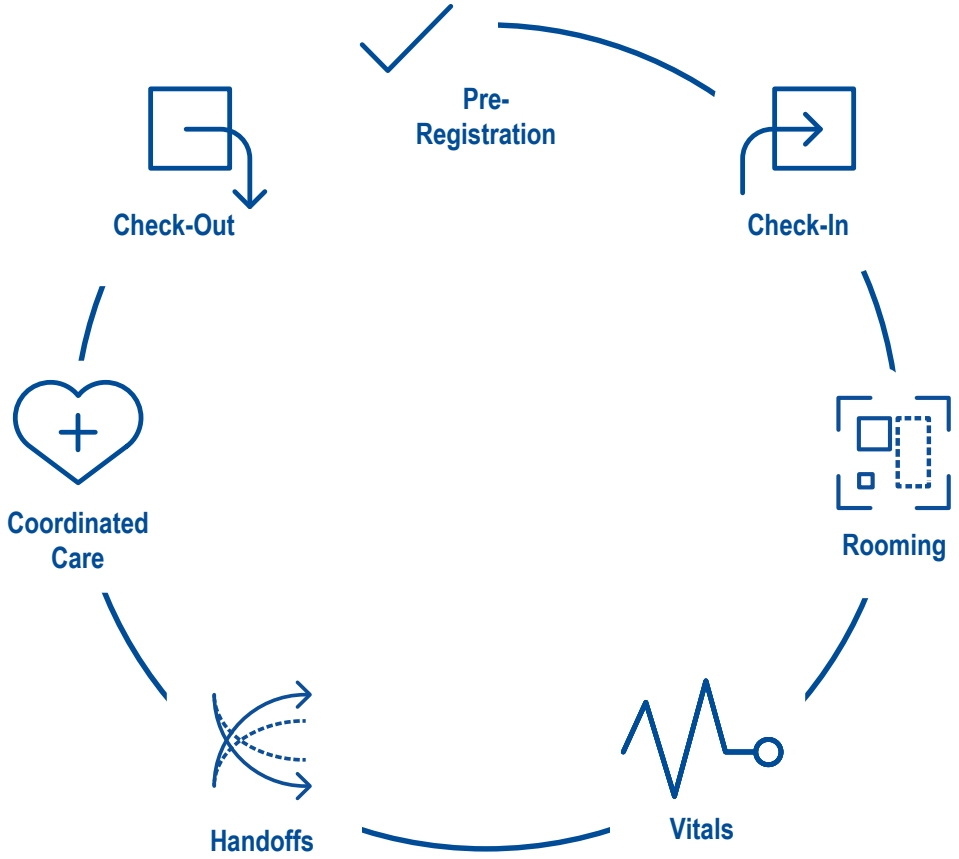
In other words, how can we automate the interaction between Design & DES applications in order to expedite the modeling phase and provide a comprehensive analysis to our client?

03 Approach

Example

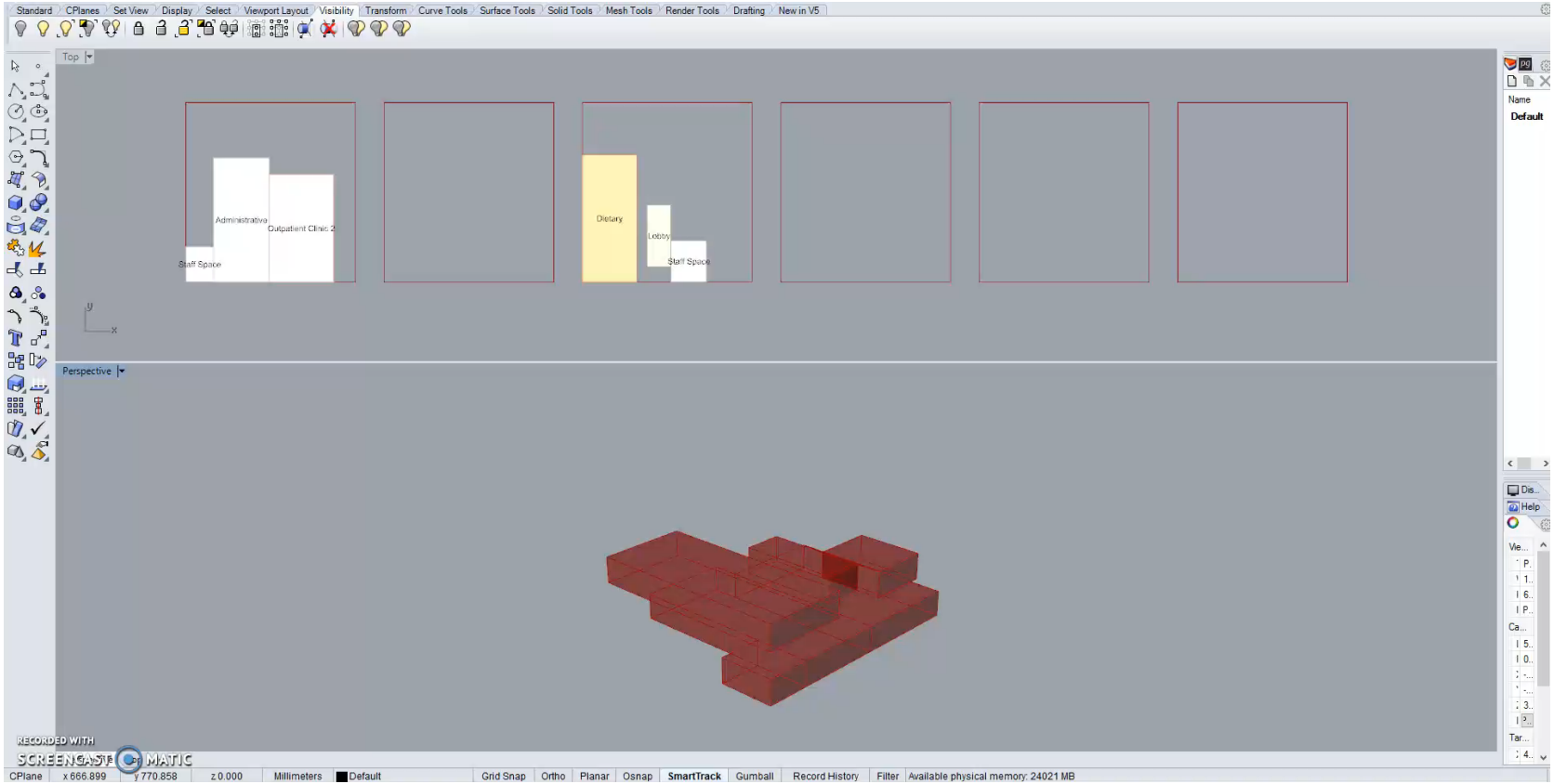
- Environment
  - Large **Outpatient Ambulatory** Healthcare Facility

- Space
  - ~30 Functional Departments over 6 Levels
    - Clinical Space
    - Support Space
    - Administrative



Design Application Example:

Optimal Layout Based On Desired Adjacencies



Our solution

Our solution

Four focused points:

Link Simio to Database

Place Fixed Objects
according to layout

Place Nodes
according to layout

Connect Objects & Nodes with Paths

Customized Solution For Each Focused Point

Link Simio to Database

Place Fixed Objects
according to layout

Place Nodes
according to layout

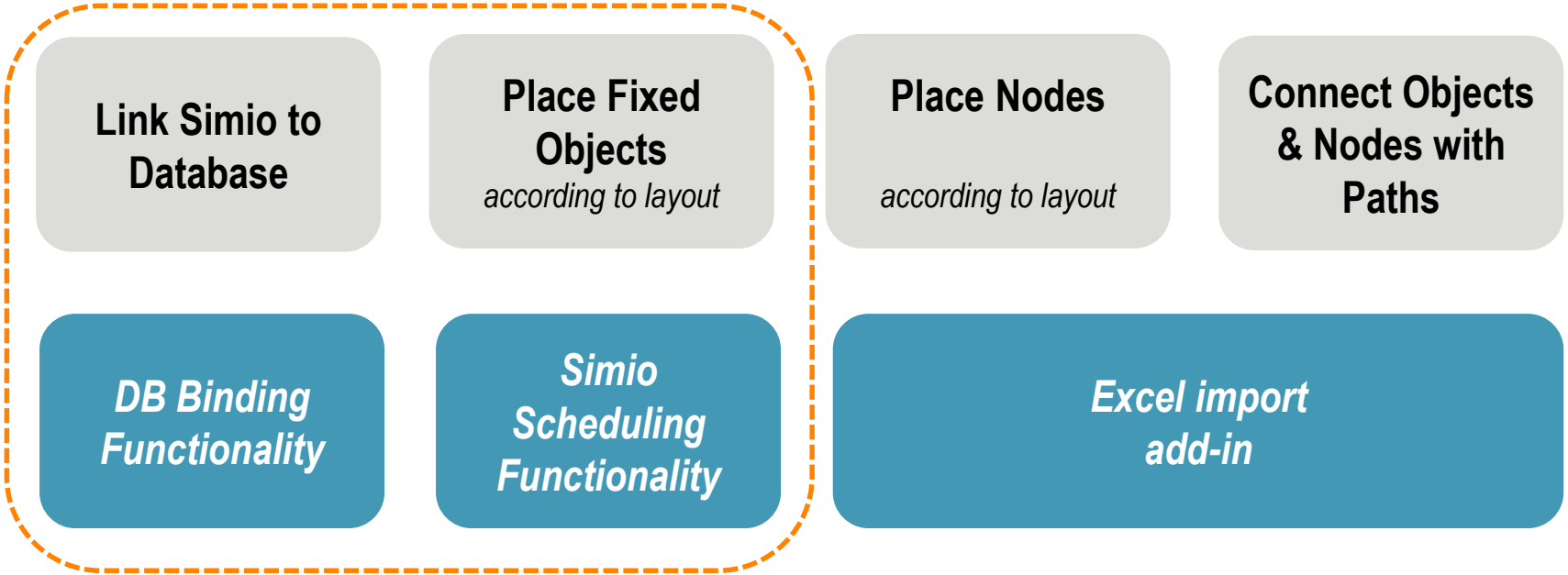
Connect Objects & Nodes with Paths

DB Binding Functionality

Simio Scheduling Functionality

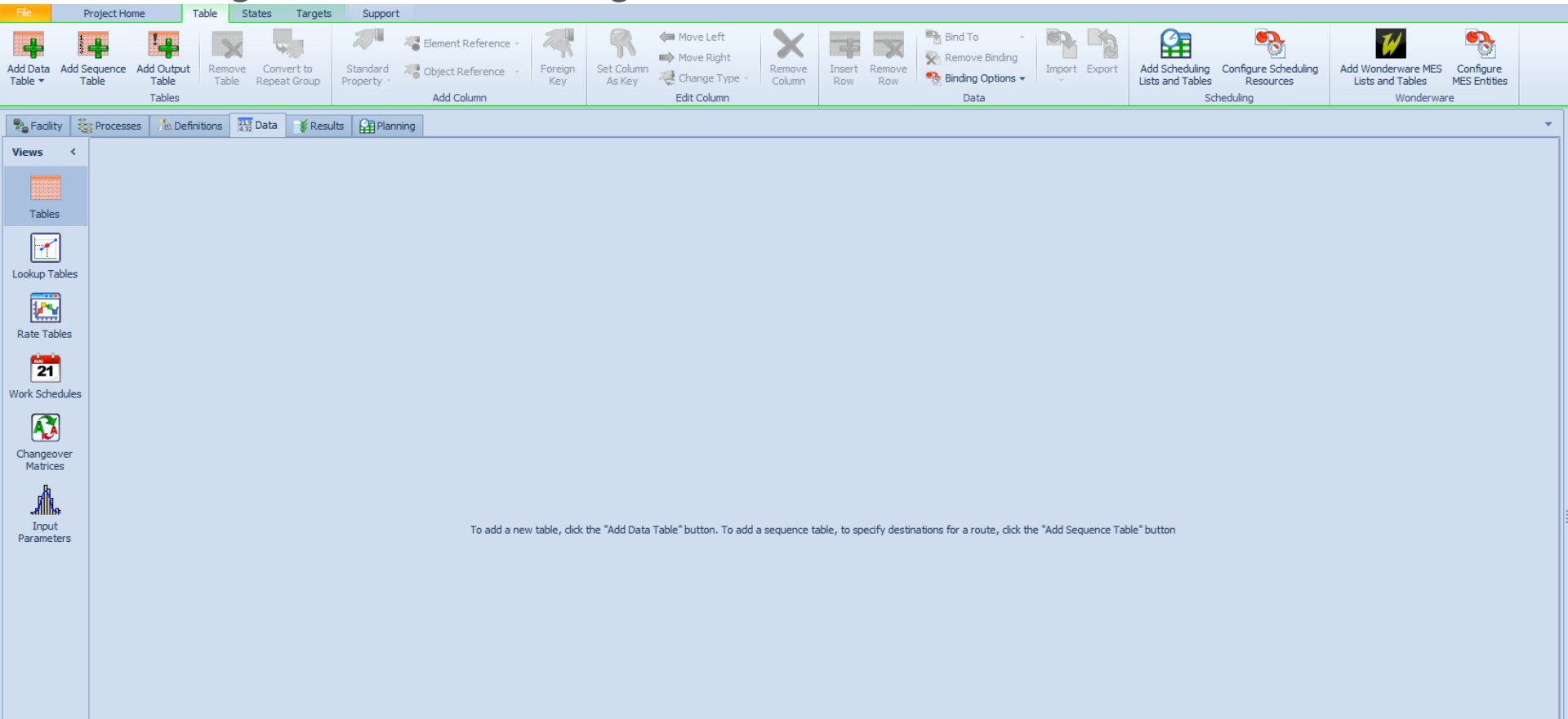
Excel import add-in

Customized Solution For Each Focused Point



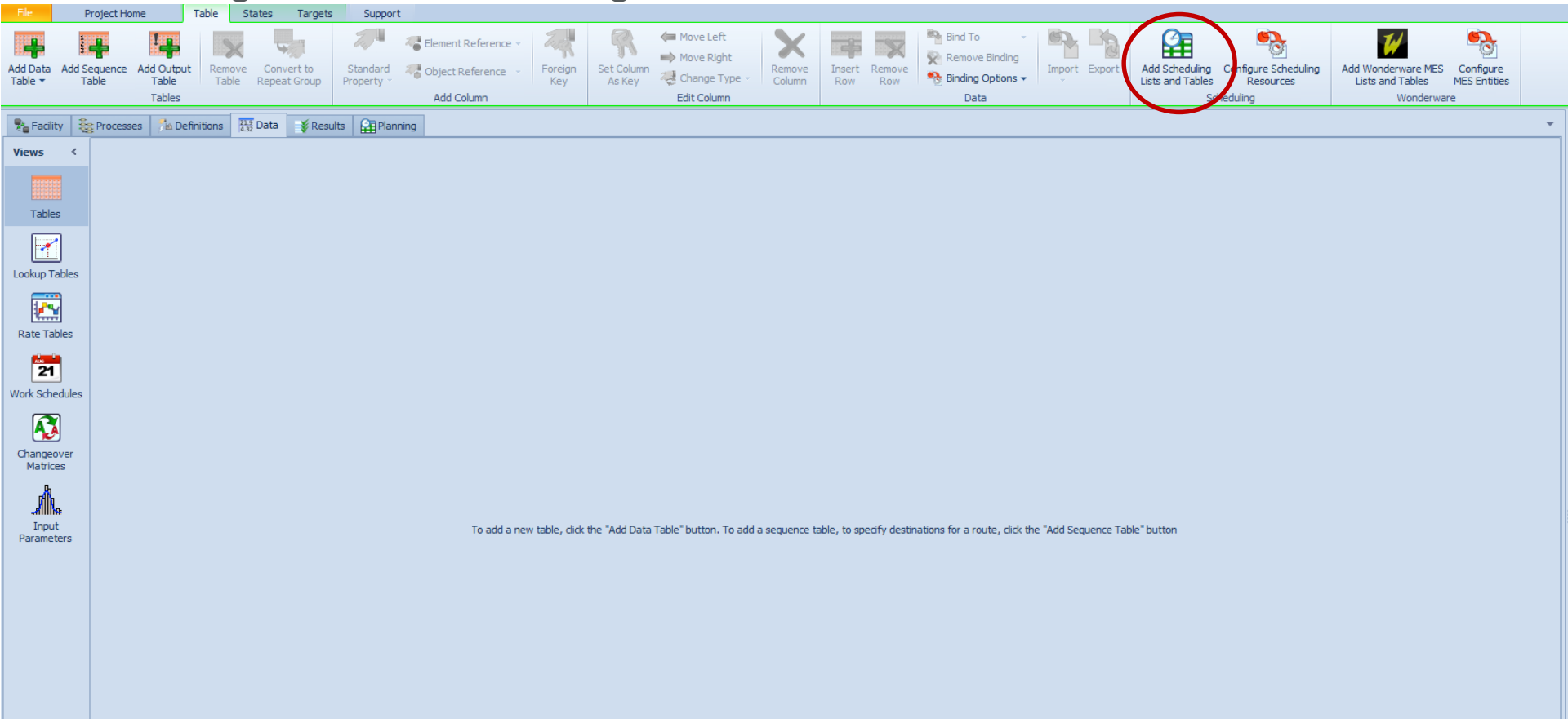
Focused Points

DB Binding & Simio Scheduling Functions



Focused Points

DB Binding & Simio Scheduling Functions



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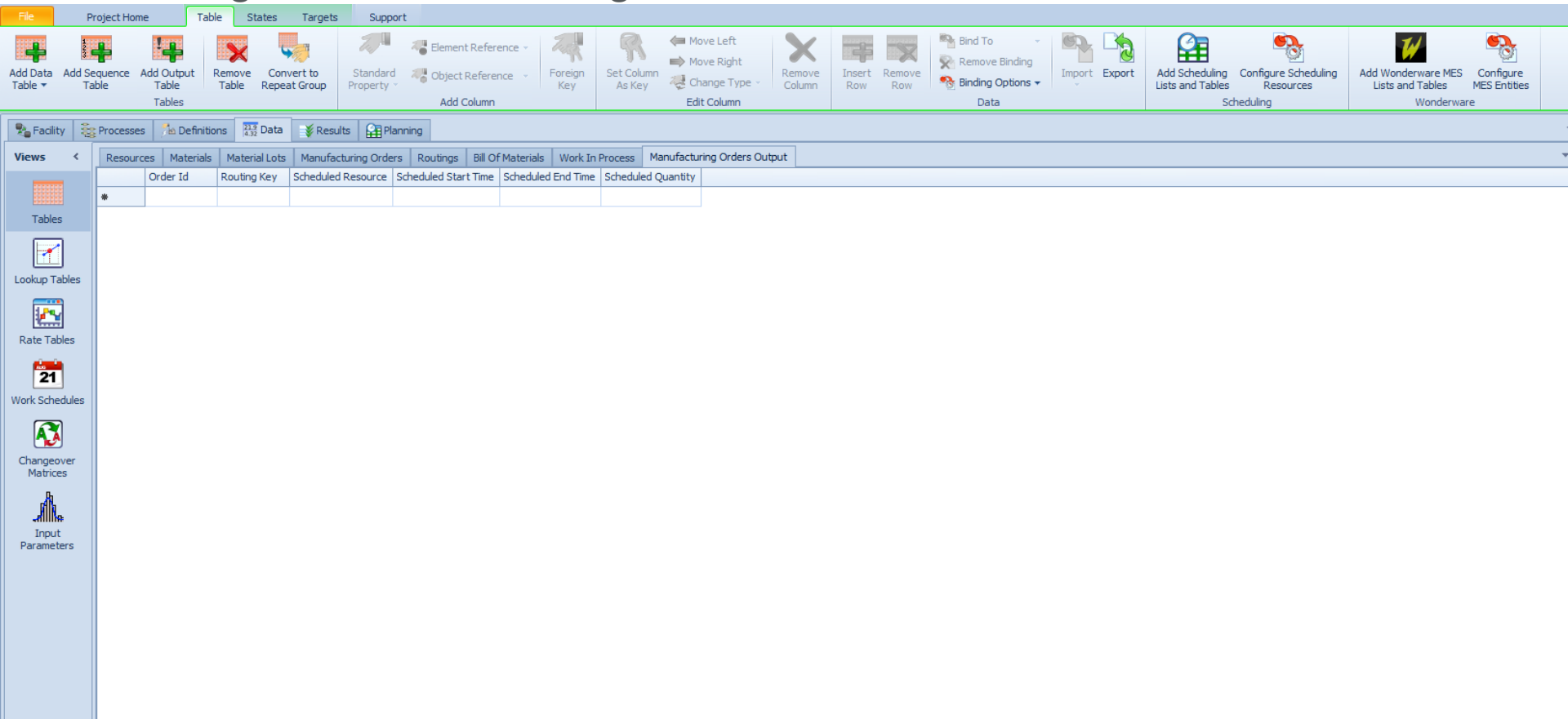

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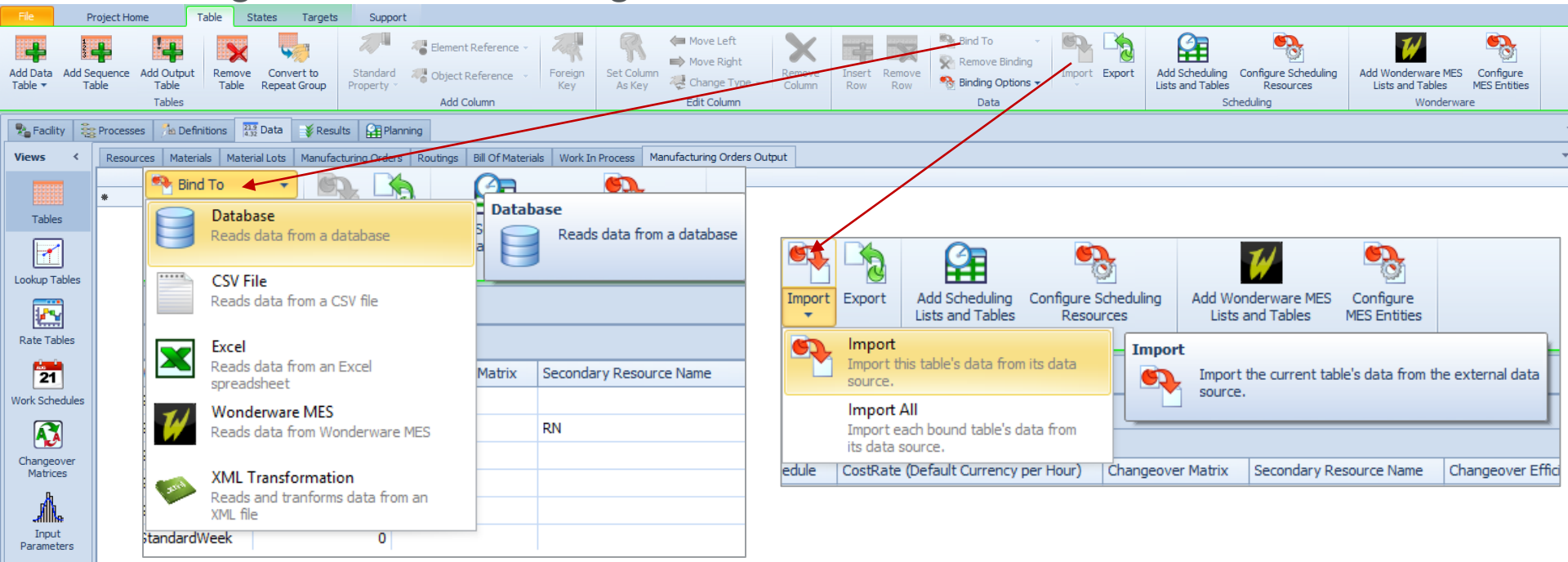

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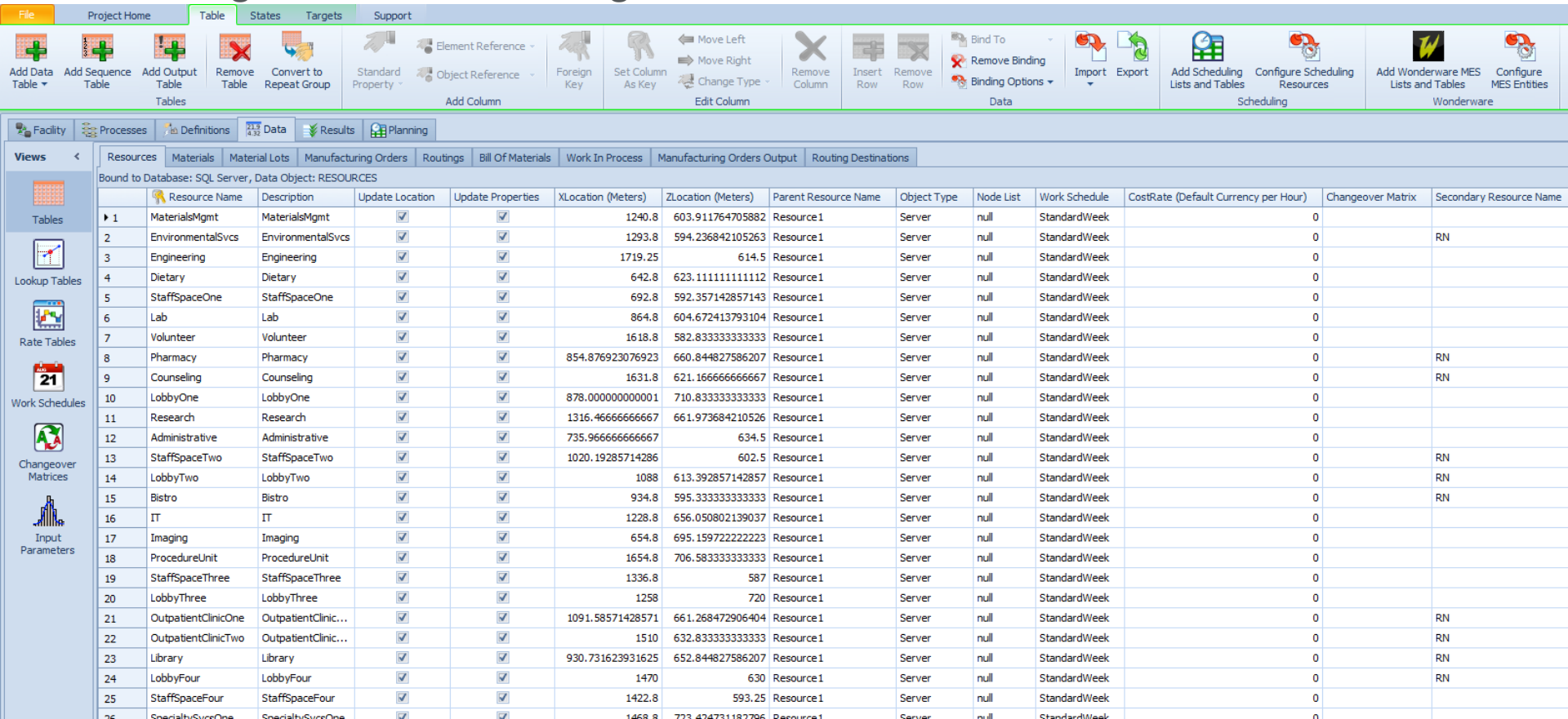
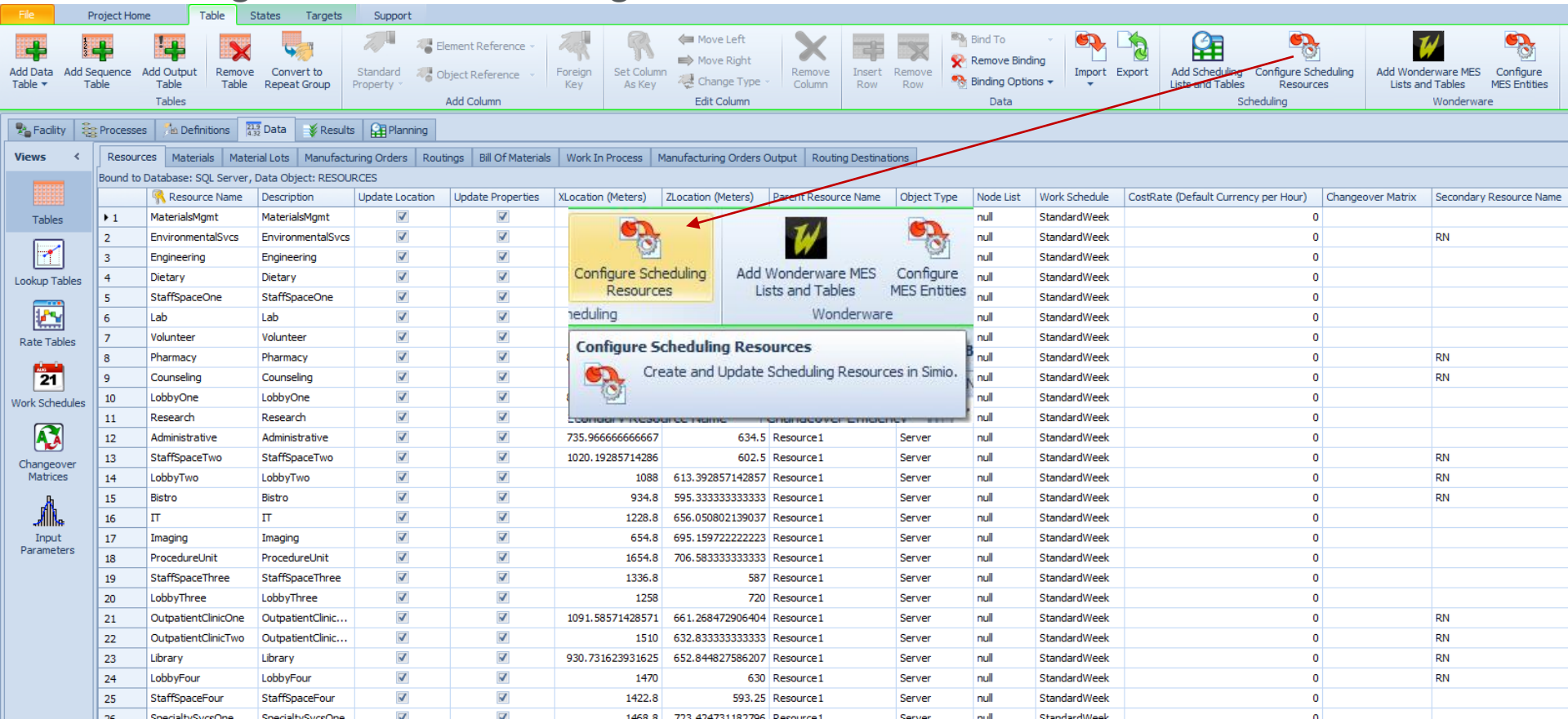


	Resource Name	Description	Update Location	Update Properties	XLocation (Meters)	ZLocation (Meters)	Parent Resource Name	Object Type	Node List	Work Schedule	CostRate (Default Currency per Hour)	Changeover Matrix	Secondary Resource Name
1	MaterialsMgmt	MaterialsMgmt	☑	☑	1240.8	603.911764705882	Resource1	Server	null	StandardWeek	0		
2	EnvironmentalSvcs	EnvironmentalSvcs	☑	☑	1293.8	594.236842105263	Resource1	Server	null	StandardWeek	0		RN
3	Engineering	Engineering	☑	☑	1719.25	614.5	Resource1	Server	null	StandardWeek	0		
4	Dietary	Dietary	☑	☑	642.8	623.111111111112	Resource1	Server	null	StandardWeek	0		
5	StaffSpaceOne	StaffSpaceOne	☑	☑	692.8	592.357142857143	Resource1	Server	null	StandardWeek	0		
6	Lab	Lab	☑	☑	864.8	604.672413793104	Resource1	Server	null	StandardWeek	0		
7	Volunteer	Volunteer	☑	☑	1618.8	582.833333333333	Resource1	Server	null	StandardWeek	0		
8	Pharmacy	Pharmacy	☑	☑	854.876923076923	660.844827586207	Resource1	Server	null	StandardWeek	0		RN
9	Counseling	Counseling	☑	☑	1631.8	621.166666666667	Resource1	Server	null	StandardWeek	0		RN
10	LobbyOne	LobbyOne	☑	☑	878.000000000001	710.833333333333	Resource1	Server	null	StandardWeek	0		
11	Research	Research	☑	☑	1316.46666666667	661.973684210526	Resource1	Server	null	StandardWeek	0		
12	Administrative	Administrative	☑	☑	735.966666666667	634.5	Resource1	Server	null	StandardWeek	0		
13	StaffSpaceTwo	StaffSpaceTwo	☑	☑	1020.19285714286	602.5	Resource1	Server	null	StandardWeek	0		RN
14	LobbyTwo	LobbyTwo	☑	☑	1088	613.392857142857	Resource1	Server	null	StandardWeek	0		RN
15	Bistro	Bistro	☑	☑	934.8	595.333333333333	Resource1	Server	null	StandardWeek	0		RN
16	IT	IT	☑	☑	1228.8	656.050802139037	Resource1	Server	null	StandardWeek	0		
17	Imaging	Imaging	☑	☑	654.8	695.159722222223	Resource1	Server	null	StandardWeek	0		
18	ProcedureUnit	ProcedureUnit	☑	☑	1654.8	706.583333333333	Resource1	Server	null	StandardWeek	0		
19	StaffSpaceThree	StaffSpaceThree	☑	☑	1336.8	587	Resource1	Server	null	StandardWeek	0		
20	LobbyThree	LobbyThree	☑	☑	1258	720	Resource1	Server	null	StandardWeek	0		
21	OutpatientClinicOne	OutpatientClinic...	☑	☑	1091.58571428571	661.268472906404	Resource1	Server	null	StandardWeek	0		RN
22	OutpatientClinicTwo	OutpatientClinic...	☑	☑	1510	632.833333333333	Resource1	Server	null	StandardWeek	0		RN
23	Library	Library	☑	☑	930.731623931625	652.844827586207	Resource1	Server	null	StandardWeek	0		RN
24	LobbyFour	LobbyFour	☑	☑	1470	630	Resource1	Server	null	StandardWeek	0		RN
25	StaffSpaceFour	StaffSpaceFour	☑	☑	1422.8	593.25	Resource1	Server	null	StandardWeek	0		
26	SpecialtySvcsOne	SpecialtySvcsOne	☑	☑	1468.8	723.424731182796	Resource1	Server	null	StandardWeek	0		

Focused Points

DB Binding & Simio Scheduling Functions



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1	MaterialsMgmt	MaterialsMgmt	☑	☑					null	StandardWeek	0		
2	EnvironmentalSvcs	EnvironmentalSvcs	☑	☑					null	StandardWeek	0		RN
3	Engineering	Engineering	☑	☑					null	StandardWeek	0		
4	Dietary	Dietary	☑	☑					null	StandardWeek	0		
5	StaffSpaceOne	StaffSpaceOne	☑	☑					null	StandardWeek	0		
6	Lab	Lab	☑	☑					null	StandardWeek	0		
7	Volunteer	Volunteer	☑	☑					null	StandardWeek	0		
8	Pharmacy	Pharmacy	☑	☑					null	StandardWeek	0		RN
9	Counseling	Counseling	☑	☑					null	StandardWeek	0		RN
10	LobbyOne	LobbyOne	☑	☑					null	StandardWeek	0		
11	Research	Research	☑	☑					null	StandardWeek	0		
12	Administrative	Administrative	☑	☑	735.966666666667	634.5	Resource1	Server	null	StandardWeek	0		
13	StaffSpaceTwo	StaffSpaceTwo	☑	☑	1020.1928571428 6	602.5	Resource1	Server	null	StandardWeek	0		RN
14	LobbyTwo	LobbyTwo	☑	☑	1088	613.392857142857	Resource1	Server	null	StandardWeek	0		RN
15	Bistro	Bistro	☑	☑	934.8	595.333333333333	Resource1	Server	null	StandardWeek	0		RN
16	IT	IT	☑	☑	1228.8	656.050802139037	Resource1	Server	null	StandardWeek	0		
17	Imaging	Imaging	☑	☑	654.8	695.159722222223	Resource1	Server	null	StandardWeek	0		
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24	LobbyFour	LobbyFour	☑	☑	1470	630	Resource1	Server	null	StandardWeek	0		RN
25	StaffSpaceFour	StaffSpaceFour	☑	☑	1422.8	593.25	Resource1	Server	null	StandardWeek	0		
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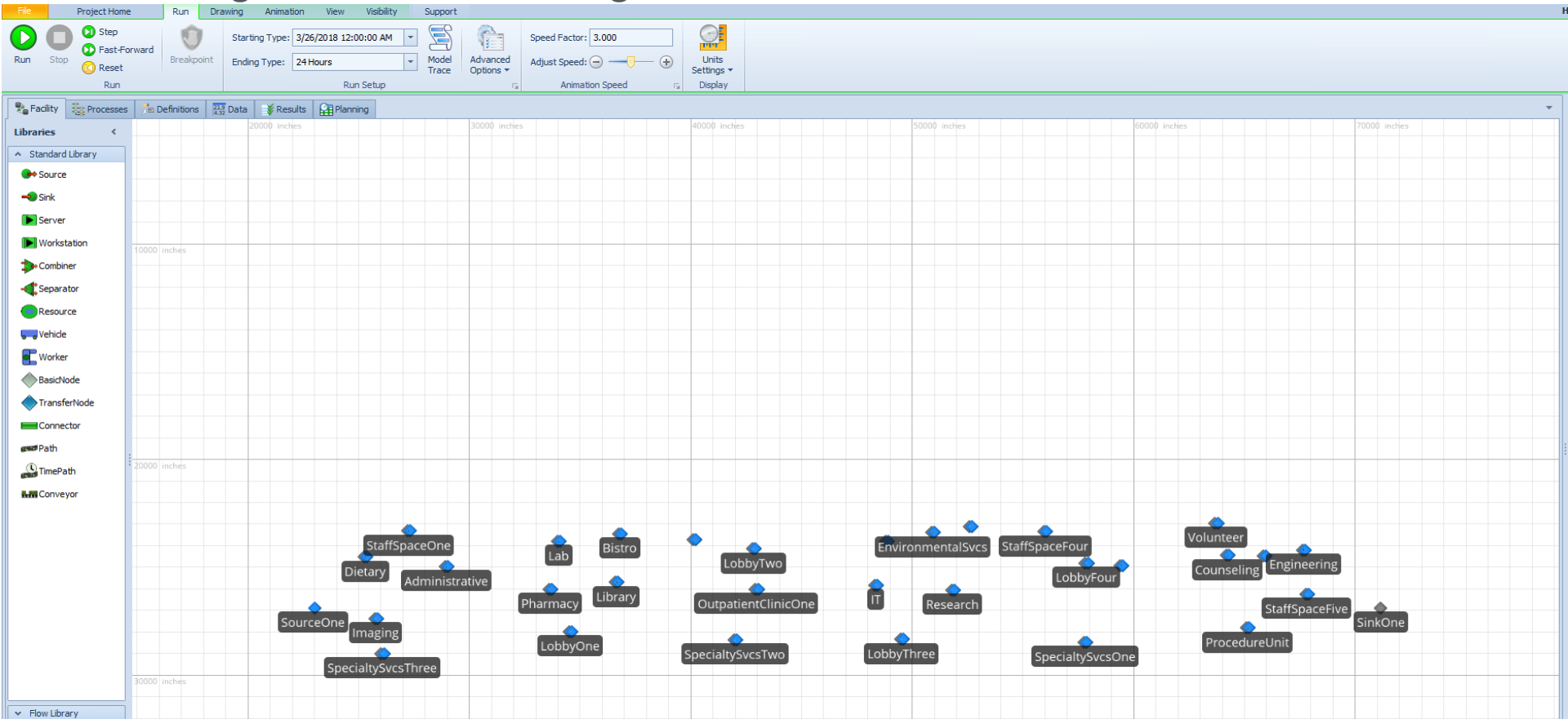
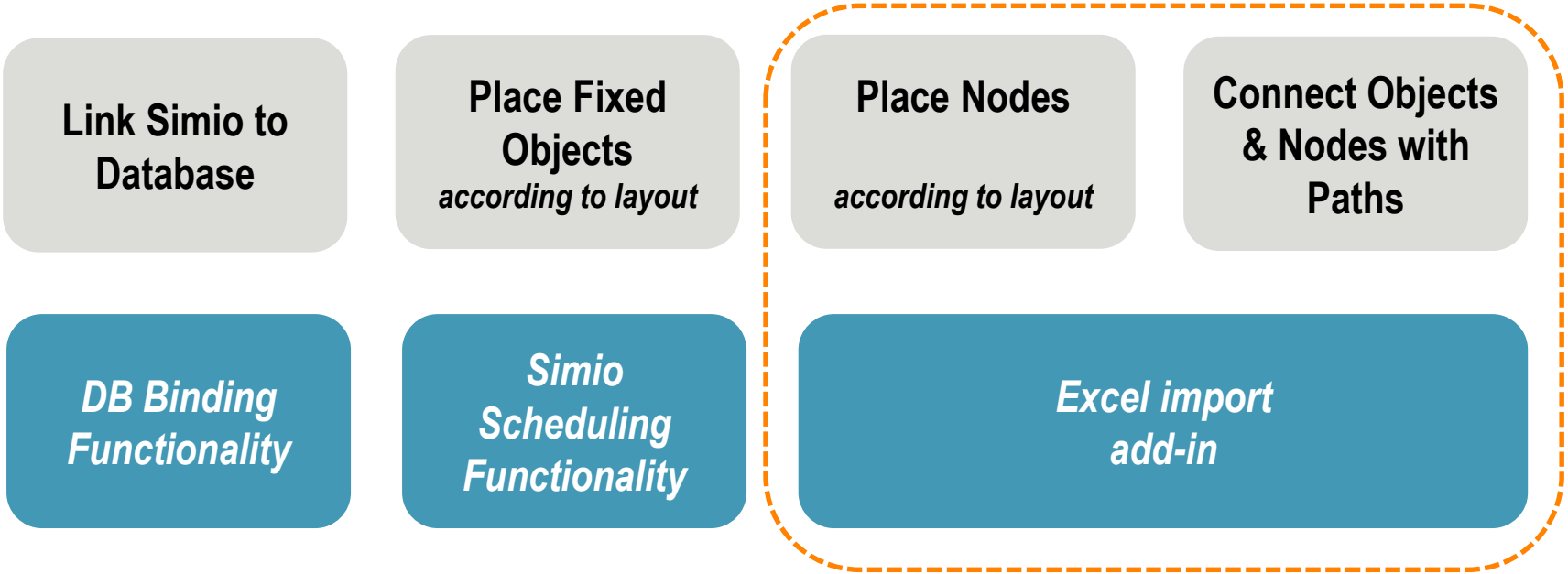
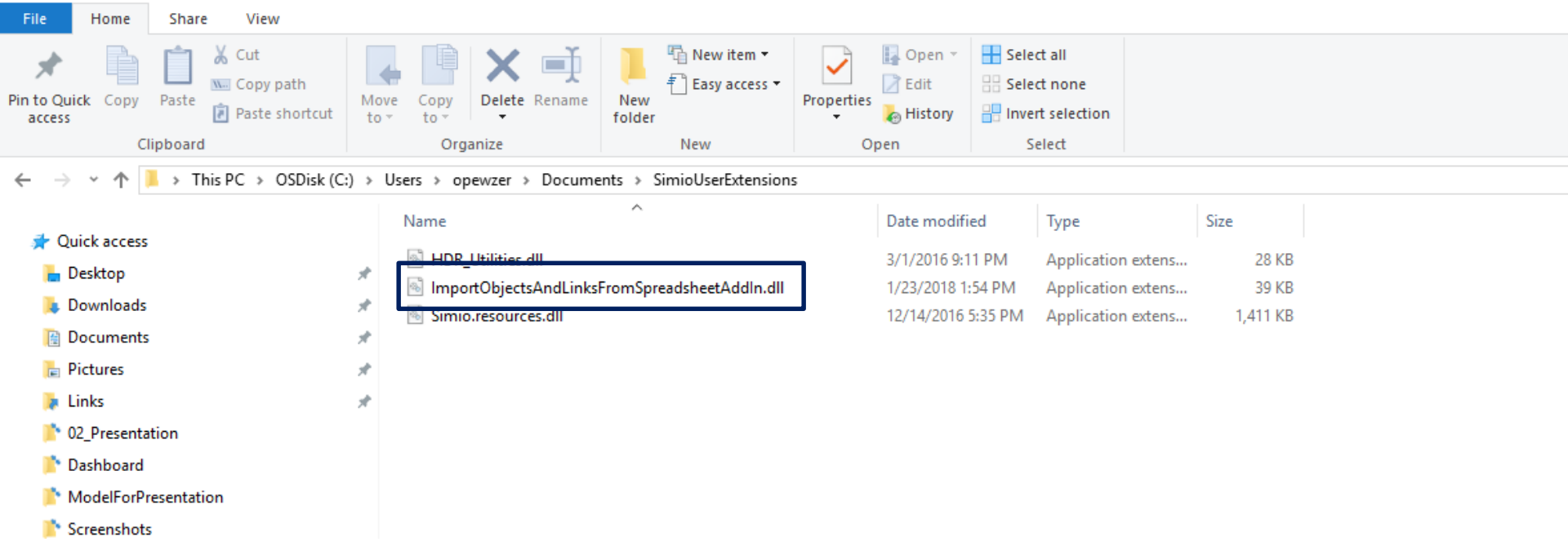


Customized Solution For Each Focused Point



Focused Points

Place & Connect Nodes and Objects



Focused Points

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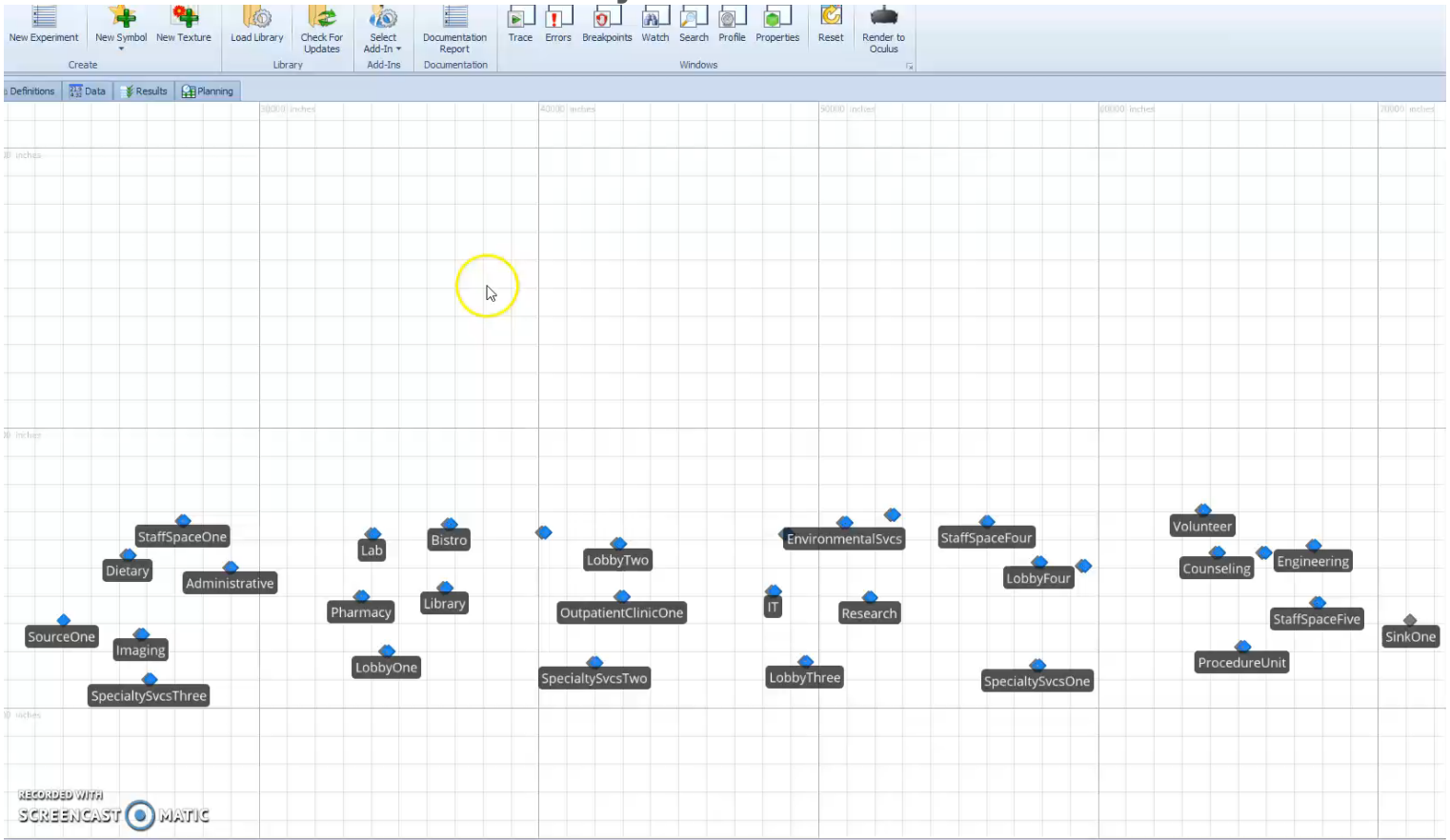


Focused Points

Place & Connect Nodes and Objects

Excel File Tab: Object

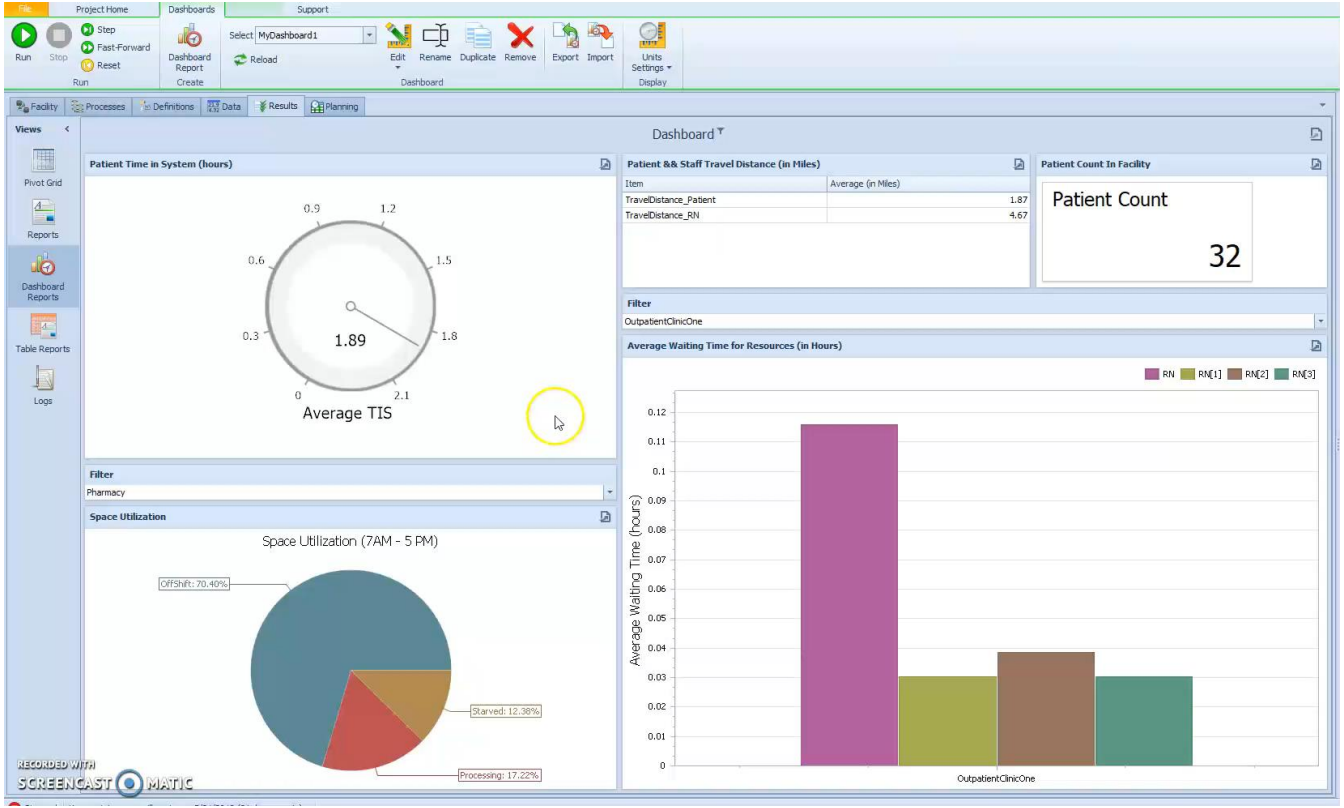
Object Class	Object Name	X	Y	Z
TransferNode	TransferNode1	617.0	8.0	677.0
TransferNode	TransferNode2	670.0	8.0	677.0
TransferNode	TransferNode3	744.0	8.0	677.0
TransferNode	TransferNode4	670.0	8.0	600.0
TransferNode	TransferNode5	670.0	8.0	620.0
TransferNode	TransferNode6	670.0	8.0	729.0
TransferNode	TransferNode7	617.0	8.0	620.0
TransferNode	TransferNode8	744.0	8.0	620.0
TransferNode	TransferNode9	817.0	8.0	620.0
TransferNode	TransferNode10	870.0	8.0	620.0
TransferNode	TransferNode11	944.0	8.0	620.0

Excel File Tab: Paths

Link Class	Link Name	From Node	To Node
Path	Path_1	TransferNode1	TransferNode2
Path	Path_2	TransferNode2	TransferNode3
Path	Path_3	TransferNode4	TransferNode5
Path	Path_4	TransferNode5	TransferNode2
Path	Path_5	TransferNode2	TransferNode6
Path	Path_6	TransferNode7	TransferNode5
Path	Path_7	TransferNode5	TransferNode8
Path	Path_8	TransferNode9	TransferNode10
Path	Path_9	TransferNode10	TransferNode11
Path	Path_10	TransferNode12	TransferNode13
Path	Path_11	TransferNode13	TransferNode14

04 Results & Solution

Outcome


Project Home
Dashboards
Support
Run
Stop
Step
Fast-Forward
Reset
Dashboard Report
Create
Select
MyDashboard1
Reload
Edit
Rename
Duplicate
Remove
Export
Import
Dashboard
Units Settings
Display
Facility
Processes
Definitions
Data
Results
Planning
Views
Pivot Grid
Reports
Dashboard Reports
Table Reports
Logs
Dashboard
Patient Time in System (hours)
0.9
1.2
0.6
1.5
0.3
1.8
0
2.1
1.89
Average TIS
Patient && Staff Travel Distance (in Miles)
Item
Average (in Miles)
TravelDistance_Patient
1.87
TravelDistance_RN
4.67
Patient Count In Facility
Patient Count
32
Filter
OutpatientClinicOne
Average Waiting Time for Resources (in Hours)
RN
RN[1]
RN[2]
RN[3]
Average Waiting Time (hours)
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
OutpatientClinicOne
Filter
Pharmacy
Space Utilization
Space Utilization (7AM - 5 PM)
OffShift: 70.40%
Starved: 12.38%
Processing: 17.22%
RECORDED WITH SCREENCAST MATIC

Outcome

1

Reduce time of development

Ability to align pace and timeline with design-oriented simulation

2

Minimize error

Ability to build robust models limiting manual manipulation and errors

3

Easy to change (Agile)

Ability to modify both space and modeled processes

Next Steps

1. **3D coordinates in Scheduling Functions**

   (Future Simio Sprints?)

2. **Work toward "process step" free SIMIO models**

3. **Investigate information sharing from Simio to Design Application**

4. **Incorporate lighting, sound & heat testing**

Q&A