

# Business Process Simulations

From **GREAT!** to GOOD

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# PICTURE THIS...

**TriAgilus** (fictitious spin-off subsidiary of large global CRO\*)

Challenge:

Reduce RFP/Proposal+Start-up processes from 30 to 15-days

Some of the MANY variables:

- Huge stakes:
  - Sponsor: **\$600K to \$8M** loss per delayed-day
  - CRO: **WIN** (if profitable) **or DIE** (if miscalculating operational timelines and/or costs)!
- Large number & diversity of players
- Many AND very complex processes
- Aggressive competition
- Global operations
- Complex Regulatory environment

\* CRO: Clinical Research Organization

How would we (YOU) handle that?

Could it be... “Hmm” ...?!?

Another approach...

Can it be...

“Yeap, why not?,

**LET’S TRY”**

...?

# WHY: **Reasons** (past - experience)

## The world without Simulations:

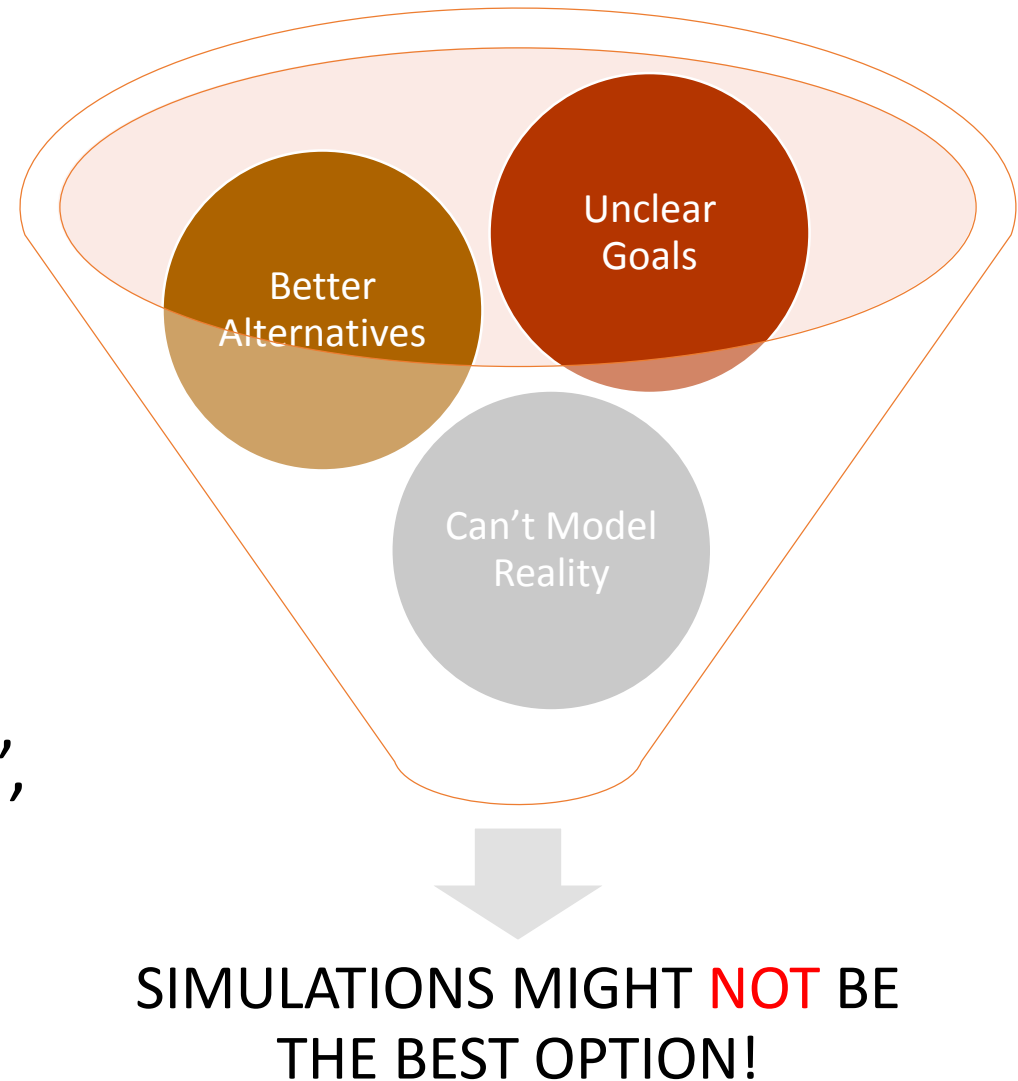
- Complexity
- Uncertainty
- Interdependencies
- Myths of the No-Sim world...

# WHY: **Purposes** (future - expectations)

- What are we trying to achieve?
  - Understand & Communicate
  - Validate the Process Model(s)
  - Exploration & Experimentation
  - Facilitate Decisions:
    - Design choices
    - Managing Operations
- Seek to explain the UNEXPECTED
- Rule out the UNEXPLAINED

# WHEN **NOT** TO DO IT...

- Alternative methods that are...
  - Better
  - Cheaper
  - Easier to implement/execute
- Not sure why we [want to] do it...
- Risks too high if tinkering with something that looks like “reality”, BUT it is not
- More...



# WHAT IS IT?

Part of a larger process...

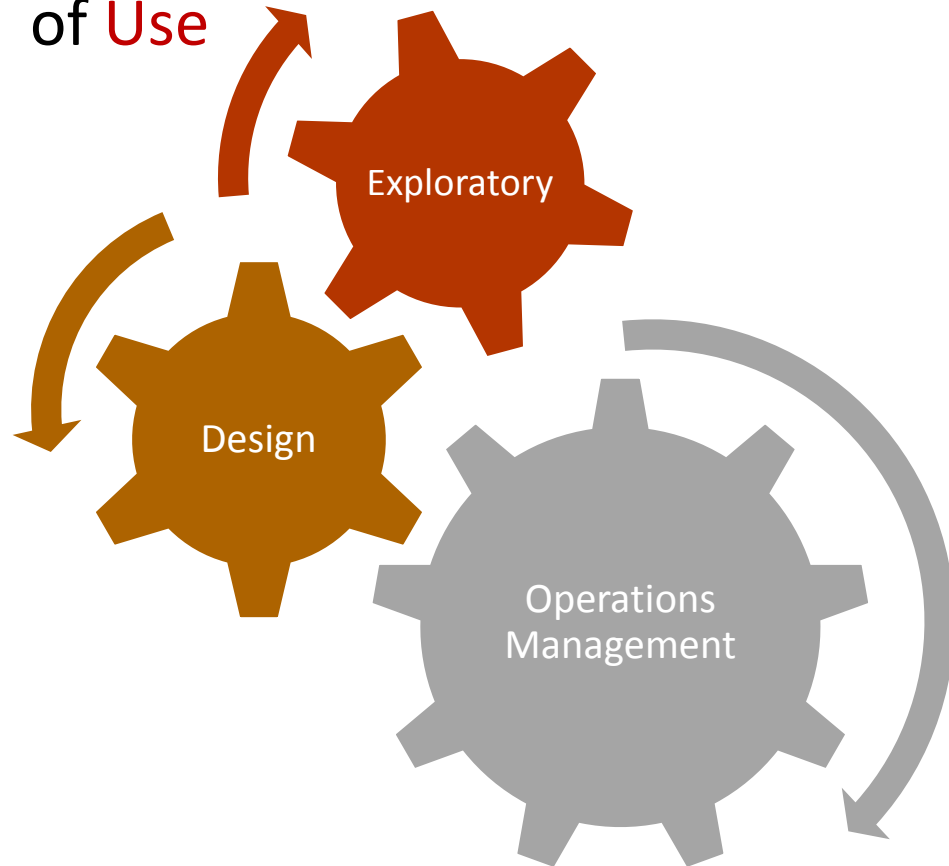




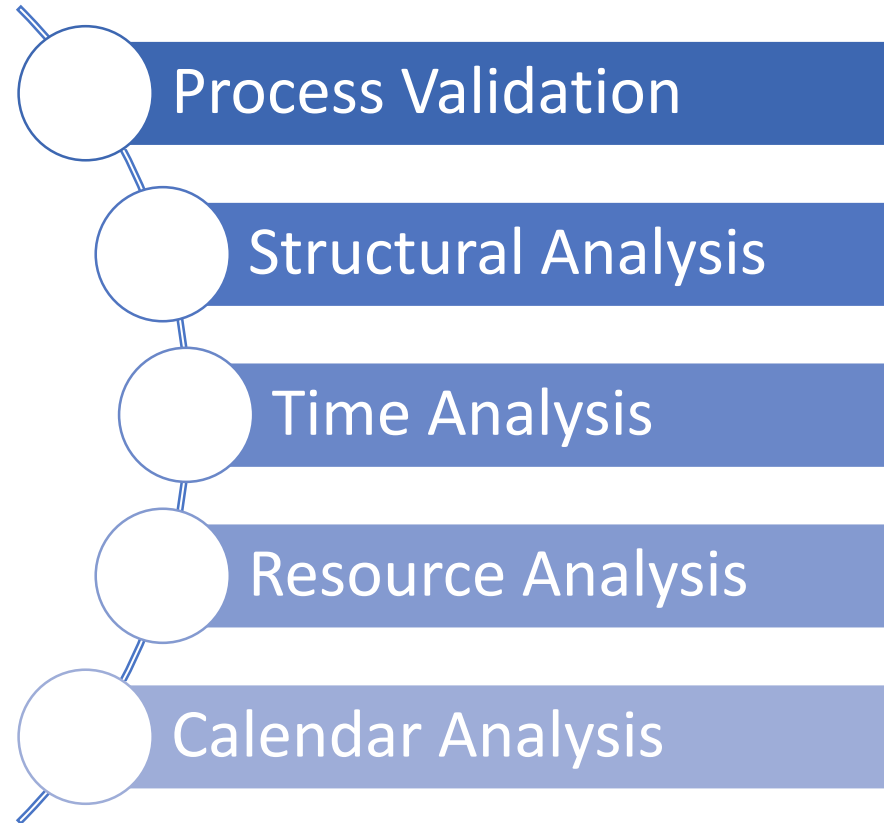
# WHAT IS IT?

## Types of Simulation

Based on Areas  
of **Use**

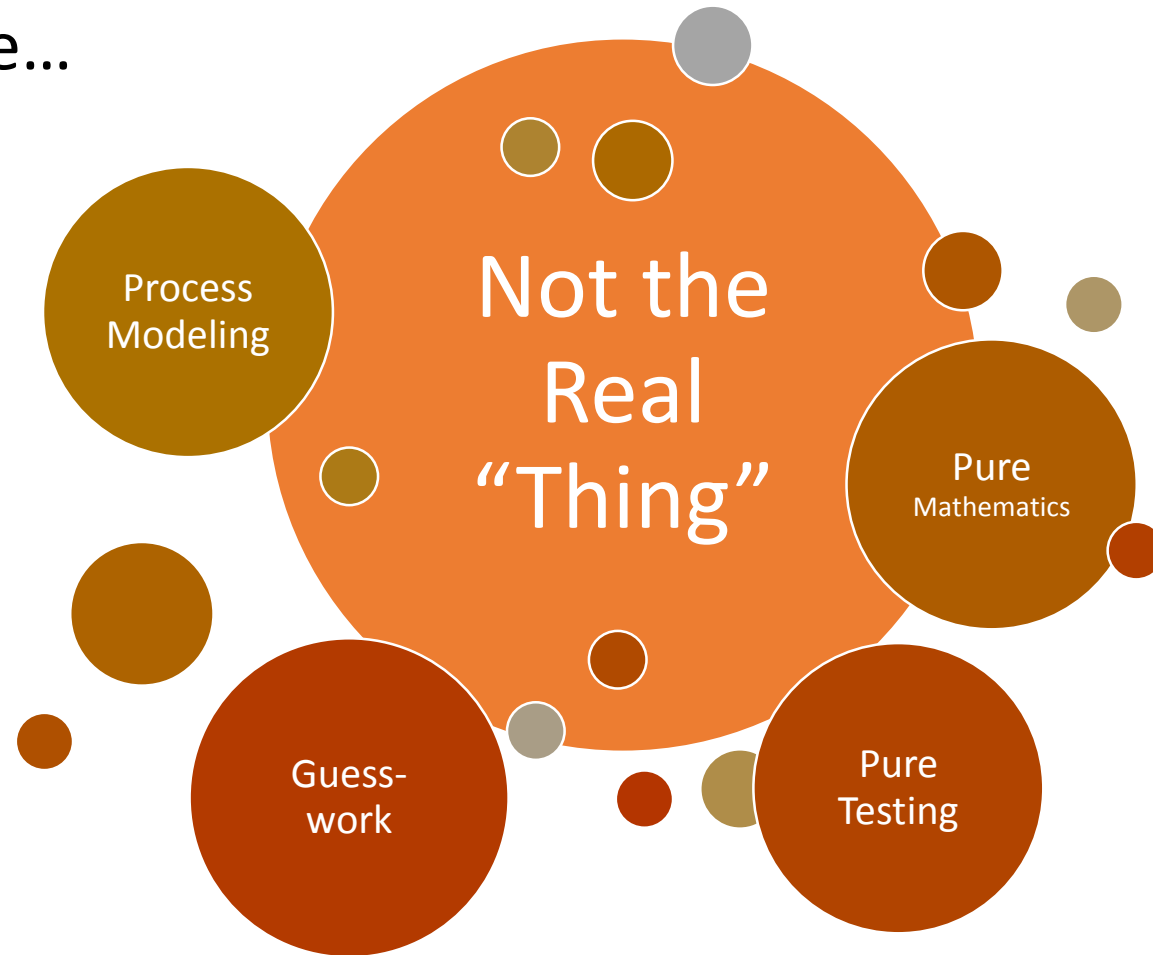


Based on Type of **Analysis**



# WHAT IT IS NOT

Related but not the same...



# MYTHS: WHAT WE FEAR IT IS

“Some” fears/concerns...



# Simulation vs. **Alternatives**

## **Experimenting with the Real Thing/Process:**

- Do we actually have a/the REAL THING?
- Technically/operationally possible?
- Convenient? Any distractions?
- Can we afford it (costs, resources...)?
- Can we control it? Too risky?
- Do we have enough time?
- Too long to even try it?
- Politically/strategically possible?
- Any possible misinterpretations?
- Can competitors find out about it?



# Simulation vs. **Alternatives**

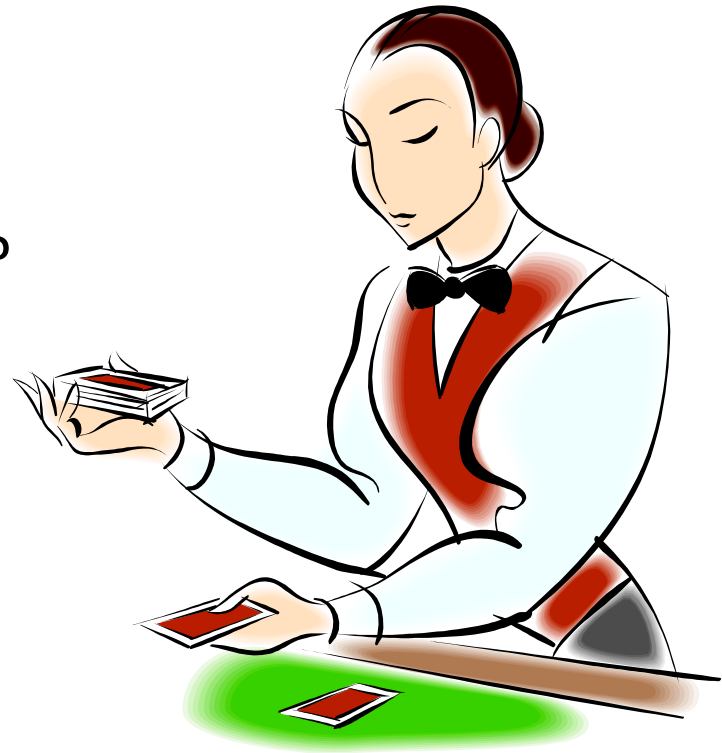
## Using **Mathematical Models**:

- Possible?
  - Do we have the Knowledge?
  - Do we have the “Rocket scientist”?
  - Do we have the Data?
- Too complex?
  - Any moving parts?
  - Any complex interdependencies?
- Predictable? Any uncertainties?
  - Our we certain about these... uncertainties?
  - Do we even understand/model the data behind this model?



# Simulation vs. **Alternatives**

- **Guessing** (“What do we THINK it would happen?”)
  - Is it even possible?
  - How can we tell if we are right?
  - If wrong, how risky is it?
  - Who knows enough (to make a smart guess)?
  - Any differences of opinion? Do we all agree?
  - How many chances do we have (before we get it right)?



# HOW

- Process Modeling
- Data:
  - In: Parameters
  - Out: Results
- Analysis:
  - Multi-level Analysis
  - Scenarios & What-If Analyses
- Interpretation:
  - Unexpected (OK) vs. Unexplained (not OK!)
  - Options/ideas to optimize
- Standards & Best Practices
- Tools

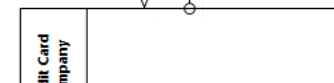
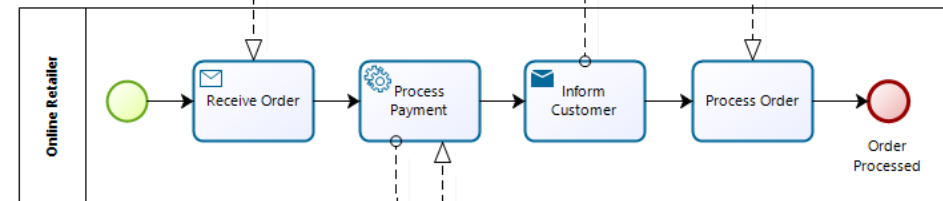
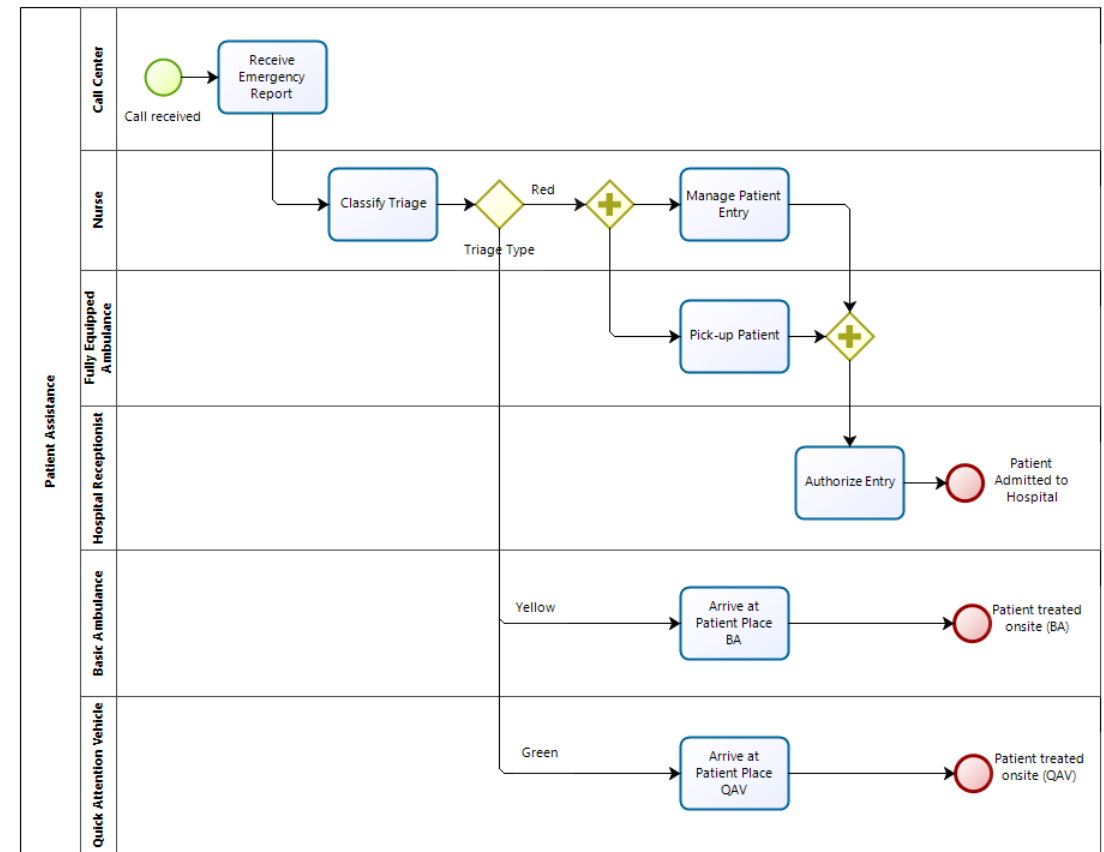
# Process Model(s) [BPMN]

## Core Process Elements:

- Activities:
  - Tasks
  - Sub-Processes
- Decisions/Gateways:
  - Exclusive work (either A or B)
  - Parallel work (A and B)
  - Optional work (A and/or B and/or C)
- Events:
  - Start + Trigger
  - End (Waiting or Terminating)
  - Intermediate (e.g. Delays, Messages, etc.)
  - Interrupting (e.g. Timers, Exceptions, Cancellations, etc.)

## Work coordination:

- Orchestration (within Processes)
- Collaboration (between Processes)





# Multi-Levels of Analysis

## Process Validation:

- Deadlocks
- Infinite loops
- Branches that are never used
- Logic faults (e.g. unexpected work items/tokens)

***"Does it even make sense?"***

***"Can it be done?"***

## Time & Throughput Analysis:

- Processing & Cycle Times

***"How long would it take?"***

## Resources & Constraint Analysis:

- Resource Capacity & Over/Under Utilization
- Delays (due to waiting on available resources)
- Costs (fixed & variable)

***"Can we do it?"***

***"Can we afford it?"***

## Calendar:

- Resources availability by Calendar Periods

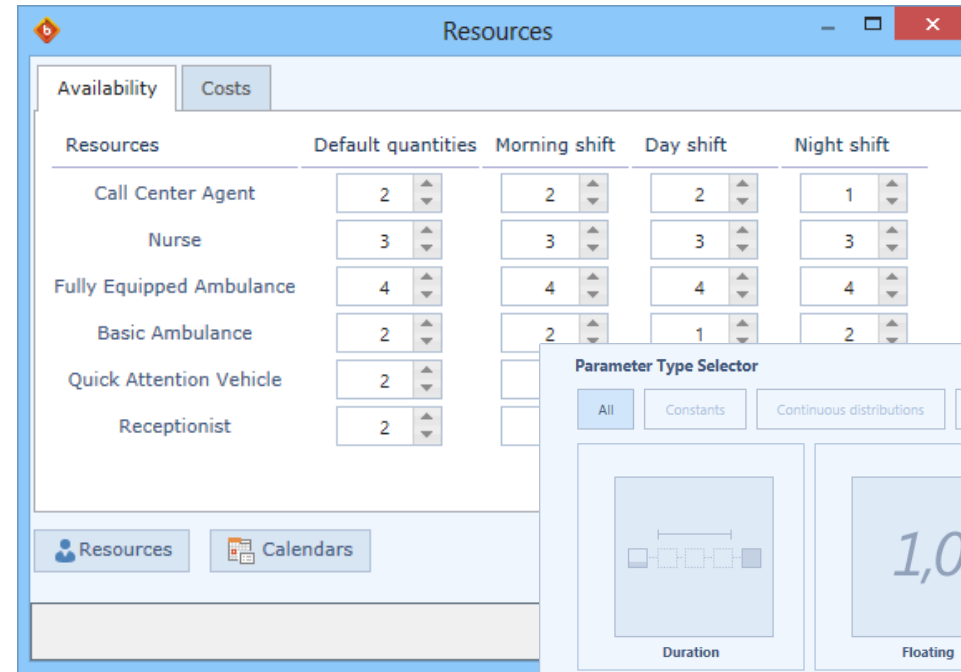
***"Can we do it better?"***

***"What's the best way?"***

# Simulation Data

## Inputs (parameters):

- Historical data
- Estimates (constant)
- Probabilistic/Statistical (distributions)

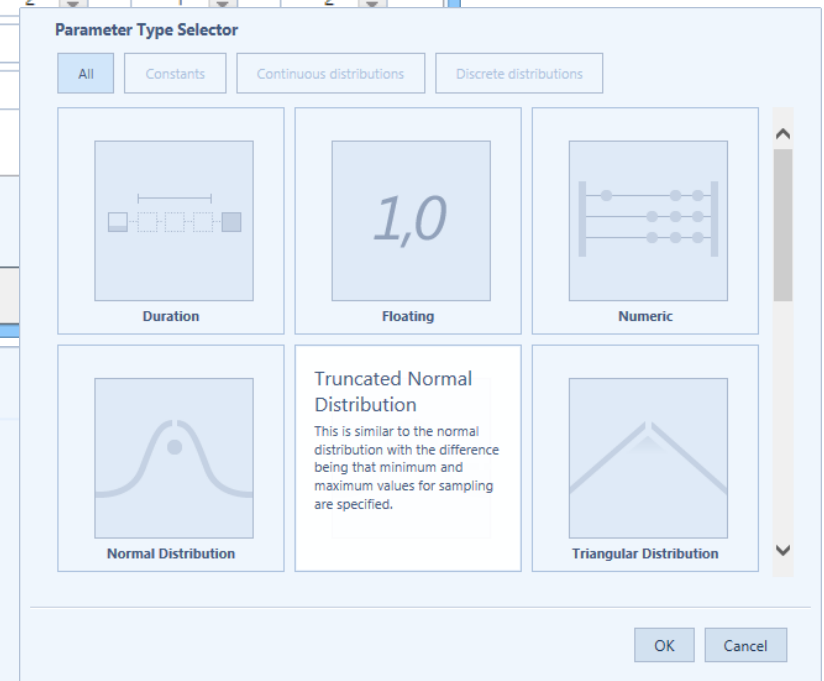


Resources

Availability Costs

Resources	Default quantities	Morning shift	Day shift	Night shift
Call Center Agent	2	2	2	1
Nurse	3	3	3	3
Fully Equipped Ambulance	4	4	4	4
Basic Ambulance	2	2	1	2
Quick Attention Vehicle	2			
Receptionist	2			

Resources Calendars



Parameter Type Selector

All Constants Continuous distributions Discrete distributions

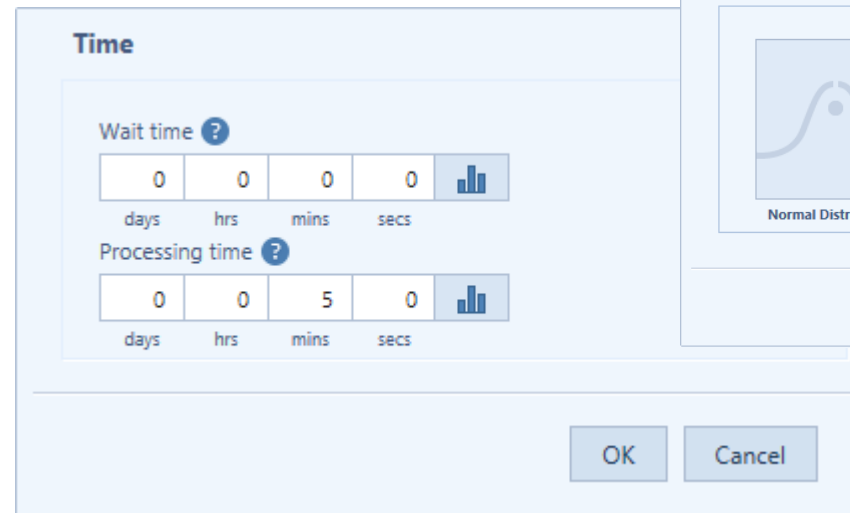
Duration Floating Numeric

Normal Distribution

Truncated Normal Distribution  
This is similar to the normal distribution with the difference being that minimum and maximum values for sampling are specified.

Triangular Distribution

OK Cancel



Time

Wait time ?

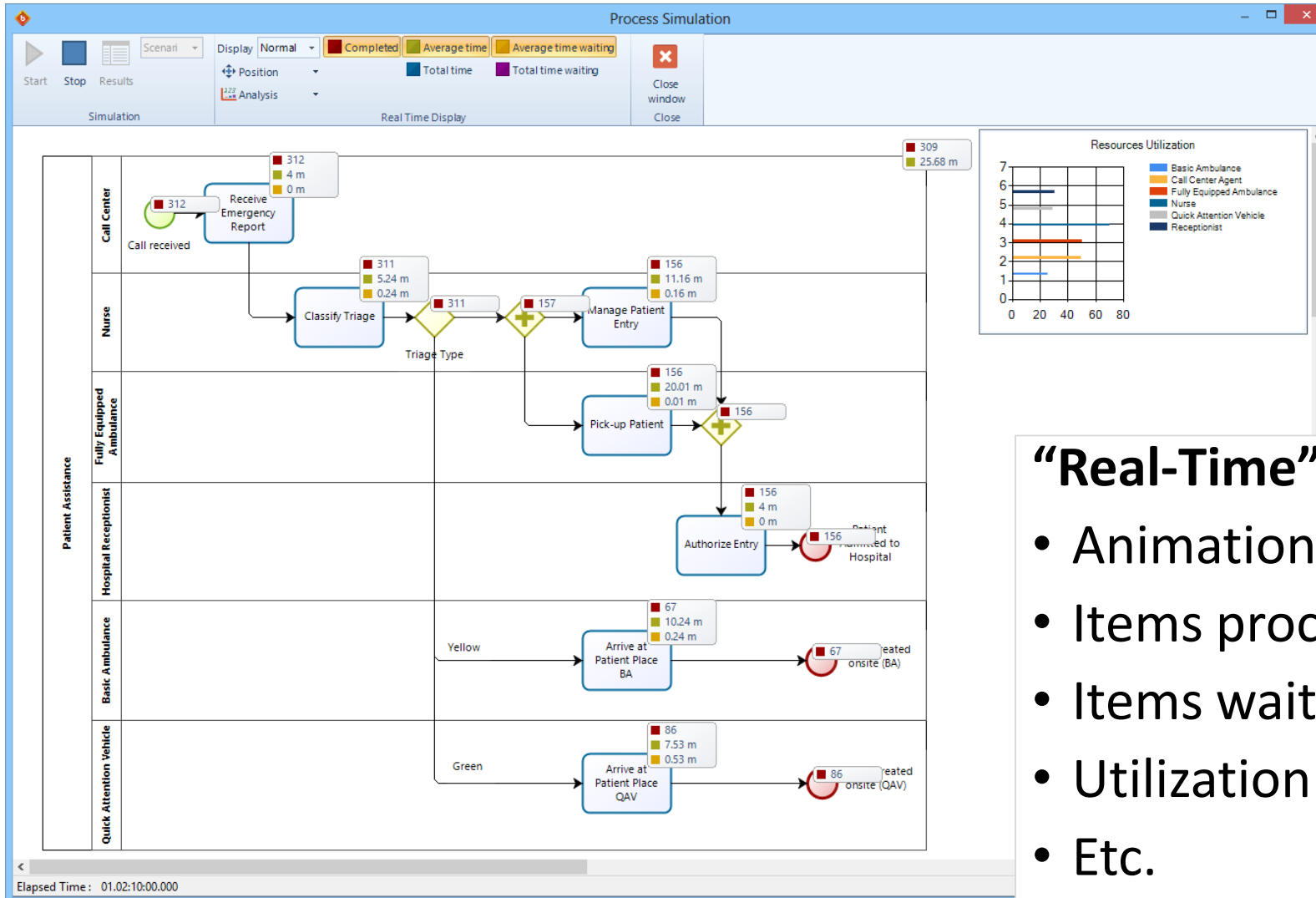
0	0	0	0	
days	hrs	mins	secs	

Processing time ?

0	0	5	0	
days	hrs	mins	secs	

OK Cancel

# Visualizing the Data/Results



## “Real-Time” (accelerated) data:

- Animation
- Items processed
- Items waiting (to be processed)
- Utilization Graphs
- Etc.

# Outputs/Results:

- Time Estimates
- Resource Estimates
- Capacity Estimates

Name	Type	Tokens completed	Tokens started	Min. time	Max. time	Avg. time	Total time	Min. time waiting
Patient Assistance	Process	1,000	1,000	16 m	369 m	160.78 m	30,614 m	
Call received	Start event	1,000						
Receive Emergency Report	Task	1,000	1,000	4 m	4 m	4 m	4,000 m	0
Classify Triage	Task	1,000	1,000	5 m	192 m	98.35 m	98,353 m	0
Triage Type	Gateway	1,000	1,000					
ParallelGateway	Gateway	499	499					

Resource	Utilization	Total fixed cost	Total unit cost	11 m	196 m	103.96 m	51,877 m	0
Call Center Agent	5.56 %	3000	0	20 m	30 m	20.37 m	10,164 m	0
Nurse	12.14 %	7495	0					
Fully Equipped Ambulance	5.78 %	14970	3992					
Basic Ambulance	2.97 %	5350	642					
Quick Attention Vehicle	3.49 %	5166	441.98					
Receptionist	3.47 %	1497	0					

# Scenarios & What-If Analyses (“2 or 3 Nurses?”)

Name	Scenario	Type	Tokens completed	Tokens started	Min. time	Max. time	Avg. time	Total time	Min. time waiting resource	Max. time waiting resource	Avg. time waiting for resource	Standard deviation waiting resources
Patient Assistance	2 Nurses	Process	1,000	1,000	16 m	419 m	155.37 m	30,535 m				
Patient Assistance	3 Nurses	Process	1,000	1,000	16 m	35 m	25.28 m	30,535 m				
Call received	2 Nurses	Start event	1,000									
Call received	3 Nurses	Start event	1,000									
Receive Emergency Report	2 Nurses	Task	1,000	1,000	4 m	4 m	4 m	4,000 m	0	0	0	0
Receive Emergency Report	3 Nurses	Task	1,000	1,000	4 m	4 m	4 m	4,000 m	0	0	0	0
Classify Triage	2 Nurses	Task	1,000	1,000	5 m	217 m	94.23 m	94,227 m	0	212 m	89.23 m	62.12 m
Classify Triage	3 Nurses	Task	1,000	1,000	5 m	7 m	5.22 m	5,220 m	0	2 m	0.22 m	0.44 m
Triage Type	2 Nurses	Gateway	1,000	1,000								
Triage Type	3 Nurses	Gateway	1,000	1,000								
ParallelGateway	2 Nurses	Gateway	498	498								
ParallelGateway	3 Nurses	Gateway	498	498								
Manage Patient Entry	2 Nurses	Task	498	498	11 m	227 m	101.8 m	50,696 m	0	216 m	90.8 m	60.46 m
Manage Patient Entry	3 Nurses	Task	498	498	11 m	14 m	11.06 m	5,508 m	0	3 m	0.06 m	0.32 m
Pick-up Patient	2 Nurses	Task	498	498	20 m	30 m	20.23 m	10,077 m	0	10 m	0.23 m	1.08 m
Pick-up Patient	3 Nurses	Task	498	498	20 m	21 m	20 m	9,961 m	0	1 m	0	0.04 m
Authorize Entry	2 Nurses	Task	498	498	4 m	4 m	4 m	1,992 m	0	0	0	0

**Timing**

# Scenarios & What-If Analyses (“2 or 3 Nurses?”)

## Resources

Resource	Scenario	Utilization	Total fixed cost	Total unit cost
Call Center Agent	2 Nurses	37.84 %	3000	0
Call Center Agent	3 Nurses	39.82 %	3000	0
Nurse	2 Nurses	99.13 %	7490	0
Nurse	3 Nurses	69.53 %	7490	0
Fully Equipped Ambulance	2 Nurses	47.11 %	14940	3984
Fully Equipped Ambulance	3 Nurses	49.57 %	14940	3984
Basic Ambulance	2 Nurses	18.64 %	4925	591
Basic Ambulance	3 Nurses	19.61 %	4925	591
Quick Attention Vehicle	2 Nurses	20.20 %	5490	469.7
Quick Attention Vehicle	3 Nurses	21.25 %	5490	469.7
Receptionist	2 Nurses	18.85 %	1494	0
Receptionist	3 Nurses	19.83 %	1494	0

# Remember this?

## Refine the inputs:

From:

- Estimates (constant)

To:

- Historical data
- Probabilistic/Statistical (distributions)

The image shows a software interface with two main components. The top component is a 'Time' input field with two rows: 'Wait time' and 'Processing time'. Each row has four input boxes for 'days', 'hrs', 'mins', and 'secs', followed by a small bar chart icon. The 'Wait time' row has values 0, 0, 0, 0. The 'Processing time' row has values 0, 0, 5, 0. The bottom component is a 'Parameter Type Selector' dialog box. It has four tabs: 'All', 'Constants', 'Continuous distributions', and 'Discrete distributions'. Below the tabs are six selection options: 'Duration' (with a bar chart icon), 'Floating' (with the text '1,0'), 'Numeric' (with a scatter plot icon), 'Normal Distribution' (with a bell curve icon), 'Truncated Normal Distribution' (with a bell curve icon and a text box explaining it is similar to the normal distribution with specified minimum and maximum values), and 'Triangular Distribution' (with a triangle icon). At the bottom right of the dialog are 'OK' and 'Cancel' buttons.

# Standards and Best Practices

- BPMN: <http://www.bpmn.org/>
- BPSim: <http://www.bpsim.org/>
- Patterns and Anti-Patterns



# Tools

Many available tools:

- Commercial
- Open-source\*

But, be aware...

... look for **GOOD** tools, not “just” **GREAT!**

\* The tool and some of the examples used in this presentation were from Bizagi ([Bizagi.com](http://Bizagi.com))

# LEVEL 0: **BPMN** VALIDATION

What are we looking for?

- Verify BPMN Specification conformity

***"Are we even communicating  
in the same language?"***

# LEVEL 1: PROCESS LOGIC/STRUCTURE

What are we looking for?

- Deadlocks
- Infinite loops
- Branches that are never used
- Logic faults (e.g. unexpected work items/tokens):
  - Anti-patterns

***"Have we modeled it in a way that makes sense?"***

## LEVEL 2: **TIME** ANALYSIS

### **Assumptions:**

Level 1 assumptions +

- Unlimited resources
- No Costs associated with either Resources or Activities

### **What are we looking for?**

Level 1 results (i.e. valid BPMN & Logic) +

- Cycle-Time
- Processing Time
- Preliminary “Critical Path”

*“How much **time** will it take?”*

# LEVEL 3a: TIME + **RESOURCES** ANALYSIS

## **Assumptions:**

Level 2 assumptions +

- Resources ARE limited
- Resources are either People or other kind of Resources (e.g. systems, materials)

## **What are we looking for?**

Level 2 results +

- Waiting times (delays) due to Resources not being available, Critical Path
- Resource Over and Under-Utilization

***"Can we do it?"***

# LEVEL 3b: TIME, RESOURCES + **COST** ANALYSIS

## **Assumptions:**

Levels 2, 3a assumptions +

- Variable-Costs associated with Resources (e.g. hourly rate)
- Fixed-Costs associated with Activities (e.g. materials)

## **What are we looking for?**

Levels 2, 3a results +

- Costs to perform the process

***"Can we afford it?"***

# LEVEL 4: RESOURCES, TIME, COSTS + **CALENDAR** ANALYSIS

## **Assumptions:**

Level 3 assumptions +

- Resources Availability varies by Calendar Periods (e.g. Shifts)

## **What are we looking for?**

Level 3 results +

- Optimizing Costs & Resource Utilization
- Identify Critical Time/Calendar Periods

***Again...***

***"Can we do it?"***

***"Can we afford it?"***

# LEVEL 5: **SCENARIOS** & **WHAT-IF** ANALYSIS

## **Assumptions:**

Level 4 assumptions +

- Some scenarios may work better (or worse) than others

## **What are we looking for?**

Level 4 results +

- Optimization:
  - Compare various alternate scenarios
  - Chose **BEST** alternative/option

***“Can we do it **Better?**”***

***“What’s the **Best way?**”***



# DEMOS & EXAMPLES

- "Simple" case: Patient Assistance Process\*
- Complex cases: just imagine (see next)

\* Source: Bizagi.com

Now,  
(re)IMAGINE  
THIS...  
“Remember us?”

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**Challenge:**

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Some of the MANY variables:

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SO...

What does all this mean to you?

Business Process Simulation and:

- **Business Analysis**
- **Risk Management**
- **Project Management**
- More (e.g. Innovation, Business Intelligence, Knowledge Management, Feasibility Studies...)

# Some bits of **ADVISE**

- Start SMALL
- Start SIMPLE
- EXPERIMENT, SHARE, INTERPRET
- ADJUST
- Expand SCOPE
- Add more PATTERNS, more COMPLEXITY...
- REPEAT

... use **ITERATIVE & INCREMENTAL** approach  
(for PMs: progressive elaboration)

Q&A

# THANKS & CONTACT INFO

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