

Modular Bioterror Response Planning

... or How to Avoid Jammed Parking Lots, Long Lines, Civil Disorder, and Unnecessary Loss of Life

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CERA

The Center for Emergency Response Analytics

**is applying best practices from
business, manufacturing, and defense
to bioterror response.**

Bioterror Response Planning

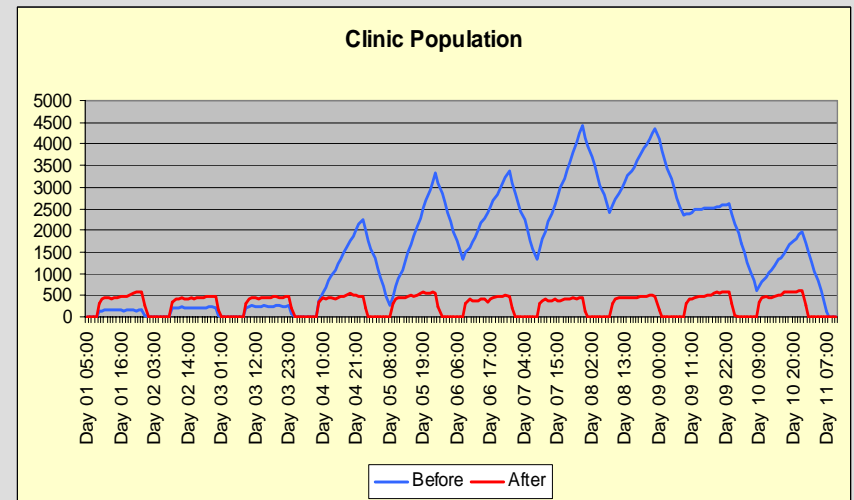
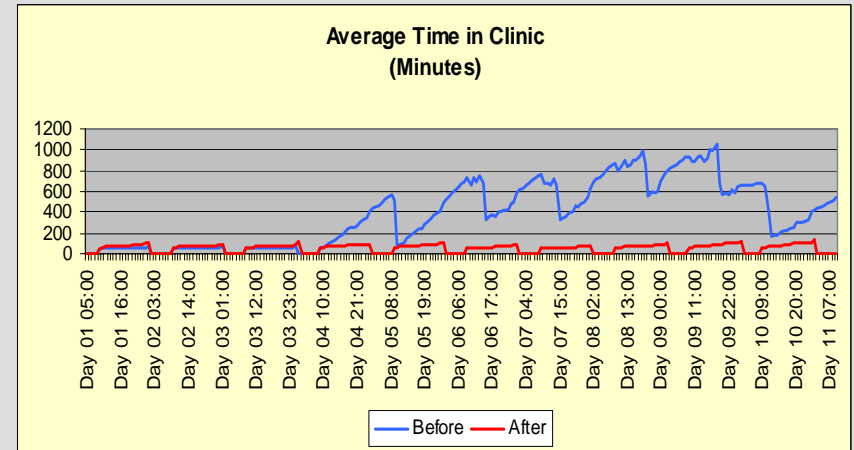
- **Conducted at federal, state, and local levels**
- **Planning dispensing operations may be the most difficult part of response planning**
- **Dispensing is a local responsibility**
- **Few local officials have experience designing large-scale processes**

Local Dispensing Plans

- **We've looked at dozens of local dispensing plans**
- **Almost all are seriously flawed**
 - Many are incomplete
 - Often contain errors and inconsistencies
 - Usually understate resource requirements
- **Carrying out some of these plans would be disastrous**
- **We've been able to help many communities fix their emergency response plans**

Example “Before and After” Performance

- We worked with a community of 45,000 to identify problems with their 10-day smallpox vaccination plan and suggest improvements.
- The community had intended to operate their clinic only 16 hours per day, but by Day-4 they were open 24 hours per day
- *Average Time in Clinic* shows that without our improvements, families would wait as long as 17 hours to be vaccinated. We reduced it to under 1 hour.
- *Clinic Population* shows that without our improvements, clinic population would reach 4,500. We reduced it to 500.



Why is Planning Difficult?

- **Threat is vague, “wide”, and ill-defined**
- **Each community has unique conditions, requirements, resources, and expectations—so general guidelines**
- **Requires coordination of 3 complex processes**
 - **Client transportation**
 - **Supply chain management**
 - **Clinical operations**
- **Balancing service level, cost, and safety is too complicated for mathematical models or spreadsheets**

CERA Approach

- **Modular Planning**
 - Identify major attack scenarios
 - Define process building blocks for clinic, client logistics, supply chain operations
 - Configure building blocks to address specific threats

- **Simulate to measure/improve plan effectiveness**
 - Improve service levels
 - Reduce cost
 - Increase safety

Identify Major Attack Scenarios

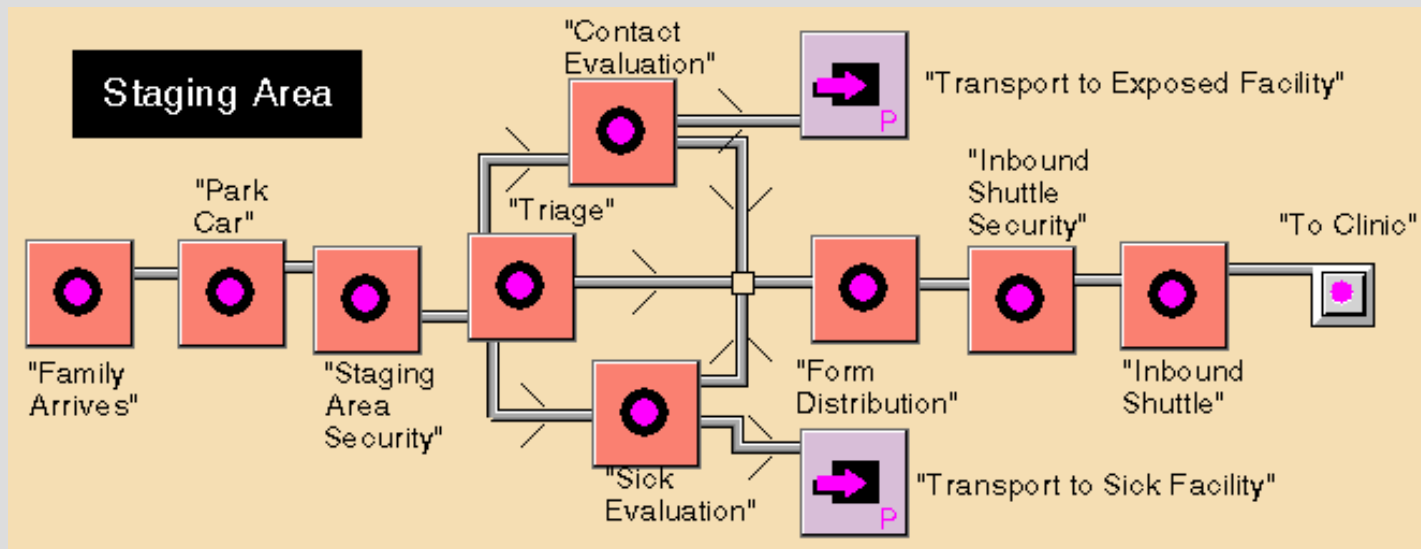
	<u>Emergency Type</u>	
<u>Clinic Type</u>	Contagious	Non-Contagious
Administer/Treat	Smallpox	Blast Trauma
Dispense	Plague	Anthrax

Define Process Building Blocks

Example Process Building Blocks		
Transportation	Clinical	Supply Chain
Car Arrivals Car Departures Shuttle Arrivals Shuttle Departures Security Screening Transport Exposed Transport Sick	Triage Contact Evaluation Sick Evaluation Form Distribution Orientation Form Review Counseling Prophylaxis Update Client Record	Place Order for Supplies Track Inventory Receive Materials Unpack Materials

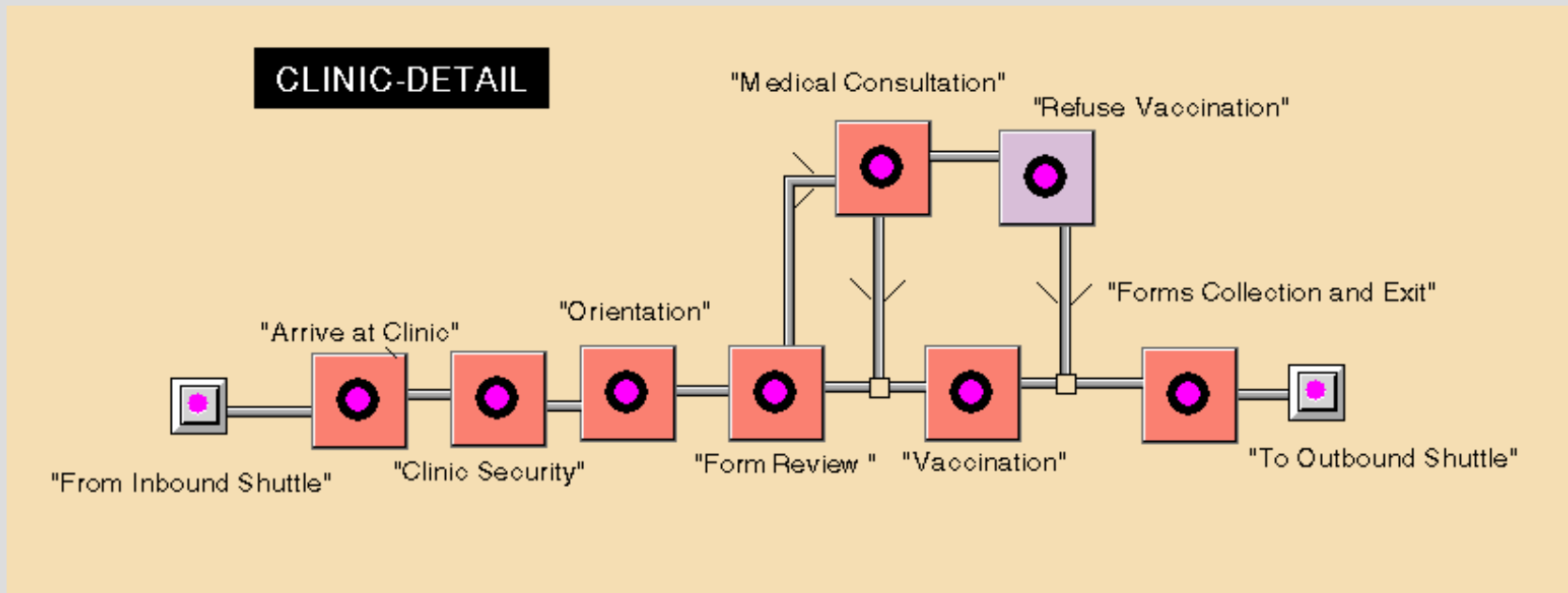
Configure Specific Responses

Smallpox vaccination—client logistics



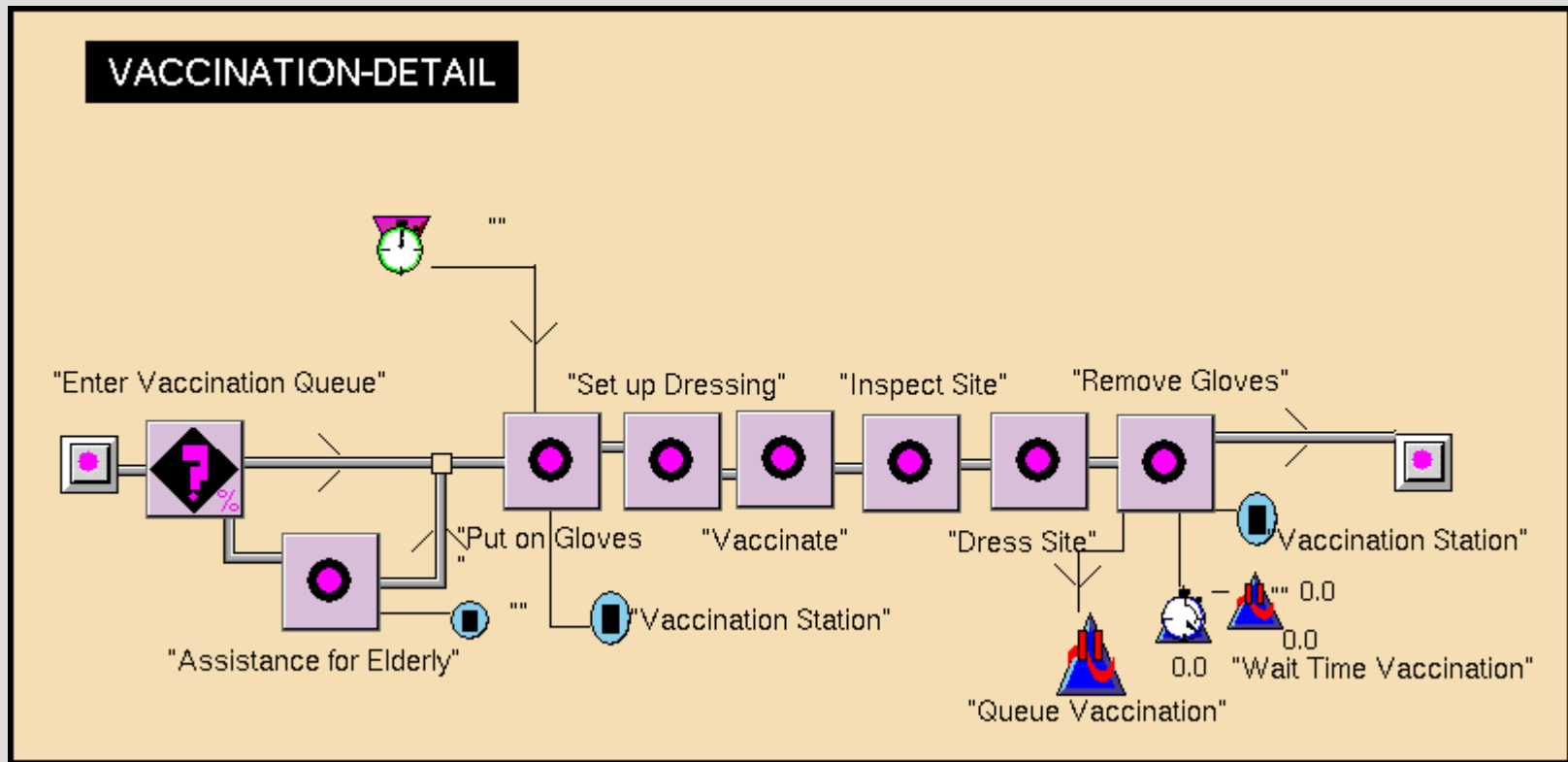
Configure Specific Responses

Vaccination clinic—high level process



Configure Specific Responses

Vaccination clinic—low level process

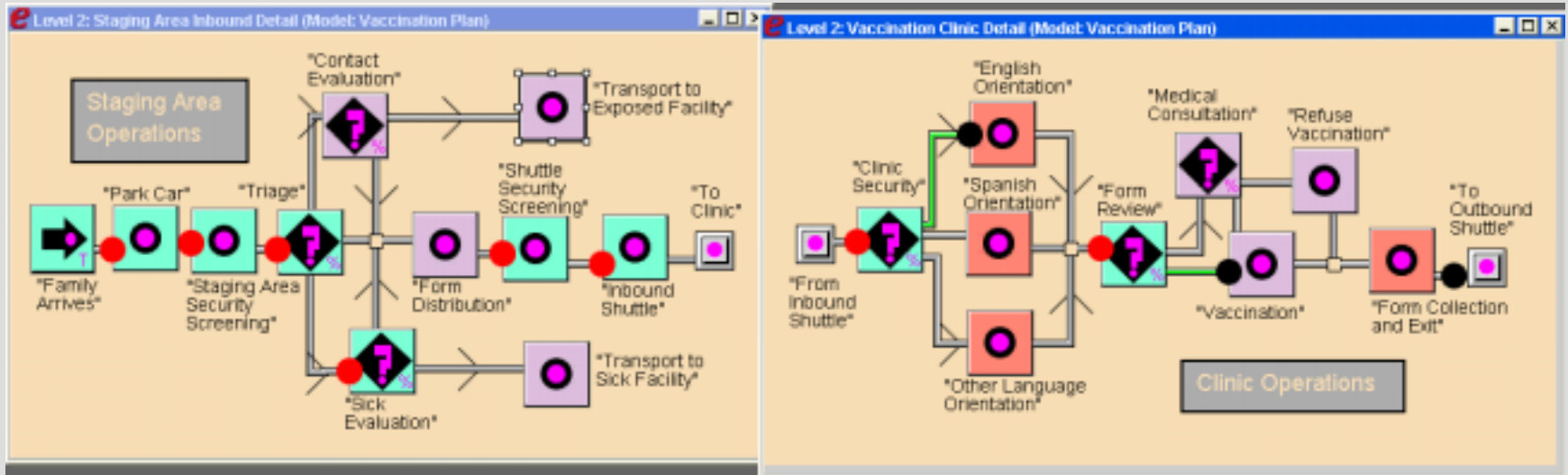


Modeling and Simulation

- **A model is a “virtual laboratory”**
- **Simulation enables us to see how well a process works under a variety of likely scenarios**
 - **Population size, language groups, arrival patterns**
 - **Proximity to “Ground Zero”**
 - **Staffing plan**
 - **Transportation system**
 - **Physical layout of clinic, parking lots, roads**

Simulation

- We simulate a POD process by moving “families” through the schematic



Why Simulation?

- **Static techniques (like spreadsheet modeling) deal with averages**
- **Simulation models capture complexities that spreadsheets cannot:**
 - **Relationships among 3 complex processes: clinic, client transportation, supply chain**
 - **“Family Orientation” of clinic and transportation processes**
 - **Variations in family arrival rates over time**
 - **Variability in task execution times**
 - **Time dependencies**
 - **“Batching effects” from**
 - **Transportation system**
 - **Group orientation sessions**
- **Simulation enables us to measure dozens of process performance indicators and observe how they change over time**

Example Performance Indicators

- **Average time in clinic (for families)**
- **Car-to-car times**
- **Clinic population**
- **Wait times & queue lengths**
- **Resource utilization**
 - **Staff**
 - **Facilities (e.g., orientation rooms, parking lots)**
 - **Transportation system (passengers per vehicle, mileage, fuel consumption)**

Sample Scenario Input

Staging Area Resource Requirements							
Core Staff Requirements					Shuttle Requirements		
Staging Area	Triage Team	CEU Team	Sick Evaluation Team	Form Distribution Team	1-Way Travel Time (Minutes)	Shuttle Frequency (Minutes)	Shuttles Needed
New Franklin	2	1	1	2	12	20	2
Little Harbor	2	1	1	2	12	20	2
Dondero	2	1	1	2	12	20	2
Greenland	1	1	1	1	20	20	3
Newcastle	1	1	1	1	20	20	3
Newington	1	1	1	1	15	20	2
Rye	2	1	1	2	20	20	3
Lafayette	1	1	1	2	7	20	1
Total	12	8	8	13			18

Sample Simulation Output

Shuttle Utilization								
Staging Area	Avg # Passengers	Round Trips	1-Way Distance	Miles Traveled	Gals Gasoline	Cost	Shuttles	Fuelings per Shuttle per Day
New Franklin	12	471	3	2,826	283	\$ 424	2	1
Little Harbor	12	471	3	2,826	283	\$ 424	2	1
Dondero	12	470	3	2,820	282	\$ 423	2	1
Greenland	6	472	7	6,608	661	\$ 991	3	1
Newcastle	3	466	7	6,524	652	\$ 979	3	1
Newington	2	459	5	4,590	459	\$ 689	2	1
Rye	10	476	7	6,664	666	\$1,000	3	1
Lafayette	6	466	1	932	93	\$ 140	1	1
Total				33,790	3,379	\$5,069	18	

Additional Slides

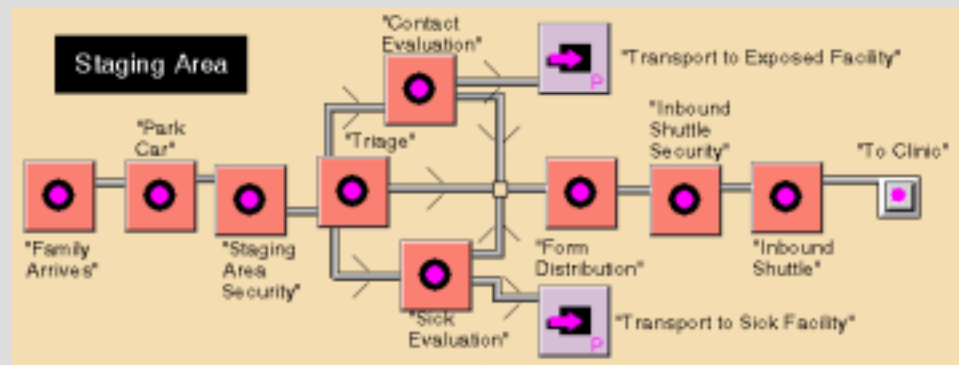
- **Dispensing Center Details**
 - **Modeling**
 - **Simulation**
 - **Methodology**



Simulation Model

CERA models have 3 basic components:

1. Schematic



2. Scenario (Assumptions)

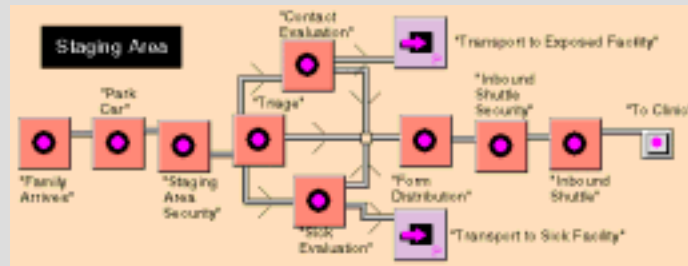
3. Key Performance Indicators (Results)

Simulation

- **Simulation enables us to measure dozens of process performance indicators, study the process, and improve it**
- **We use Gensym Corp's ReThink for model development and simulation**

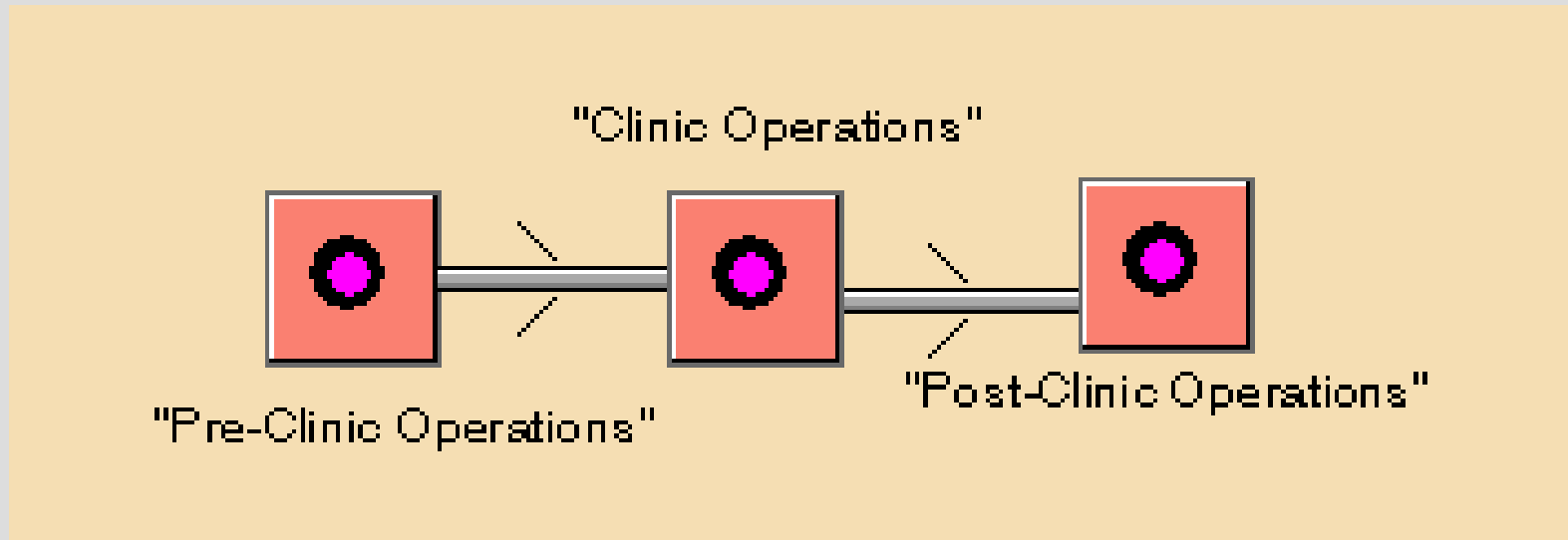
Schematic

- **Blueprint of process layout**

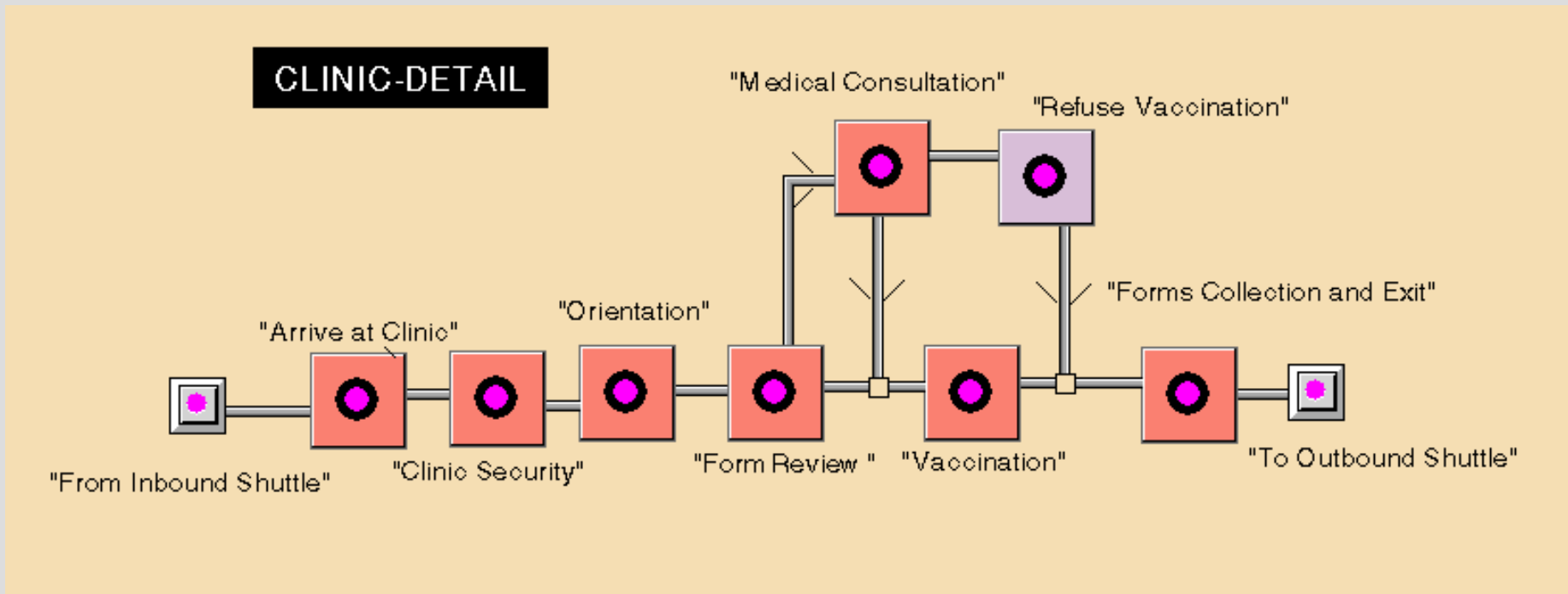


- **Blocks represent tasks and decisions**
- **Blocks are connected by paths**
- **Family objects follow paths**
 - move from block to block
 - wait for resources to perform task
- **Schematics are hierarchical**

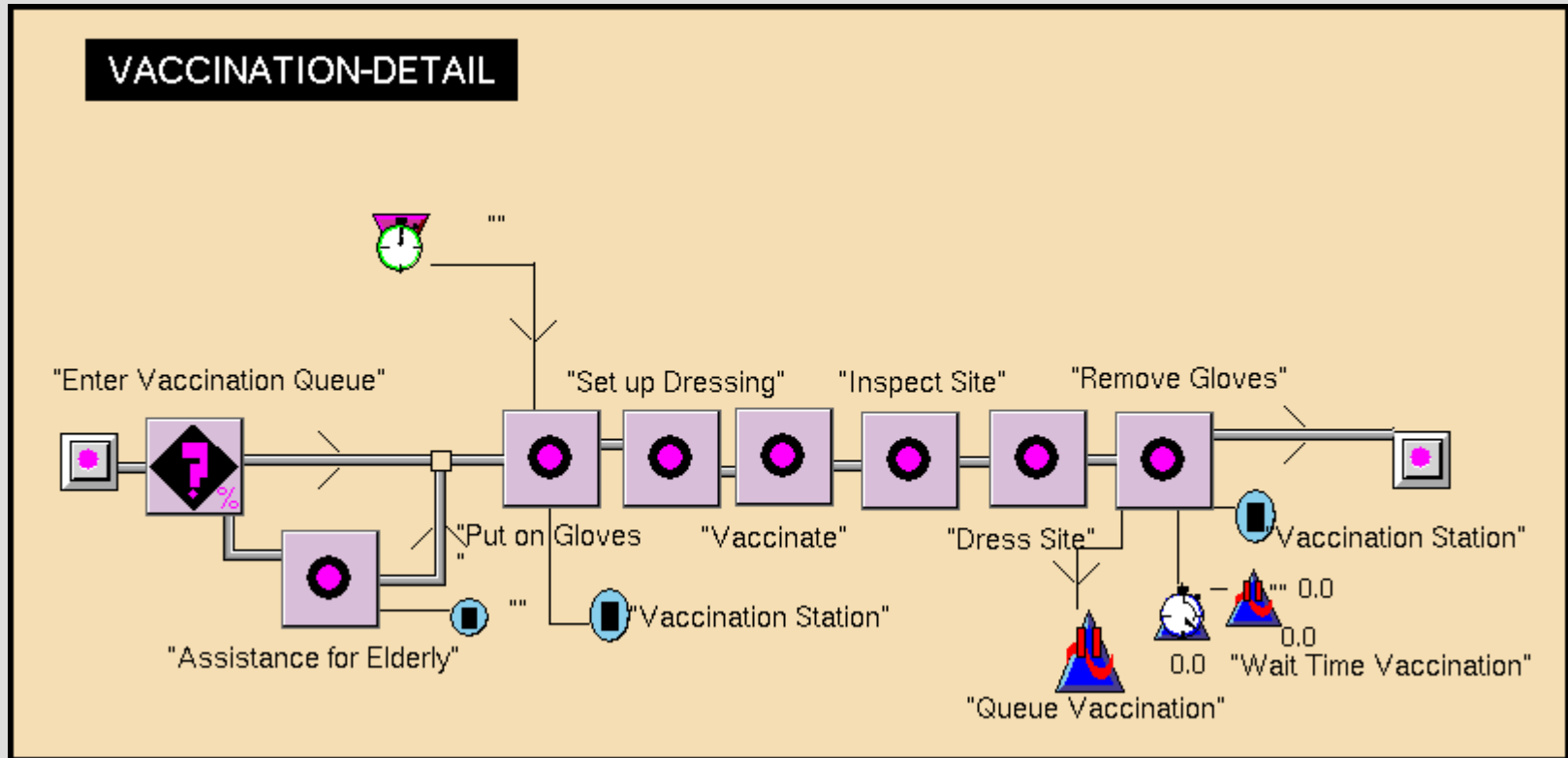
Schematic Level 1



Schematic Level 2 – Clinic Ops



Schematic Level 3—Vaccination



Scenario

- **A *Scenario* is a set of assumptions that we use for a “simulation run”**
- **A scenario provides operational details like:**
 - Client arrivals—how many, when, languages?
 - Staging area and clinic operating schedules
 - Transportation system—number, capacity of vehicles, frequency of departures
 - Tasks—how long, how many resources?
 - Client routings—which paths to follow?
- **We use Excel workbooks to store and manipulate scenarios**

Scenario—Staging Area Ops

Staging Area Resource Requirements							
Core Staff Requirements					Shuttle Requirements		
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Scenario—Resources

Clinic Resource Requirements			
	Core Resources	Relief Resources	Total Resources
English Video Orientation Rooms (capacity 25)	5	0	5
Spanish Video Orientation Rooms (capacity 25)	0	0	0
"Other Language" Video Machines	2	0	2
Form Reviewer Team	5	1	6
Medical Counseling Team	3	1	4
Vaccination Team	11	2	13
Form Collection Team	11	2	13

Scenario—Task Times

Task Times (Minutes)				
Task	Min	Mode	Max	Average
Clinic Security Screening	0.5	1	4	1.83
Orientation	30	30	30	30.00
Review Forms	0.5	1	2	1.17
Medical Counseling	4	7	10	7.00
Vaccination	1.5	3	4.5	3.00
Form Collection	1.25	2.5	3.75	2.50

Scenario—Family Routings

Family Path Percentages					
Path	%	Path	%	Path	%
Triage to Sick-Evaluation	1	Triage to CEU	2	Triage into Mainstream	98
CEU To Exposed Facility	20	CEU-into-Mainstream	80		0
Sick-Evaluation-To-Sick-facility	20	Sick Evaluation into Mainstream	80		0
Orientation To Refuse Vaccination	5	Orientation into Mainstream	95		0
Form Review To Vaccination	80	Form Review To Med Eval 1	20		0
Medical Counseling to Vaccination	50	Medical Evaluation to Refuse Vaccination	50		0

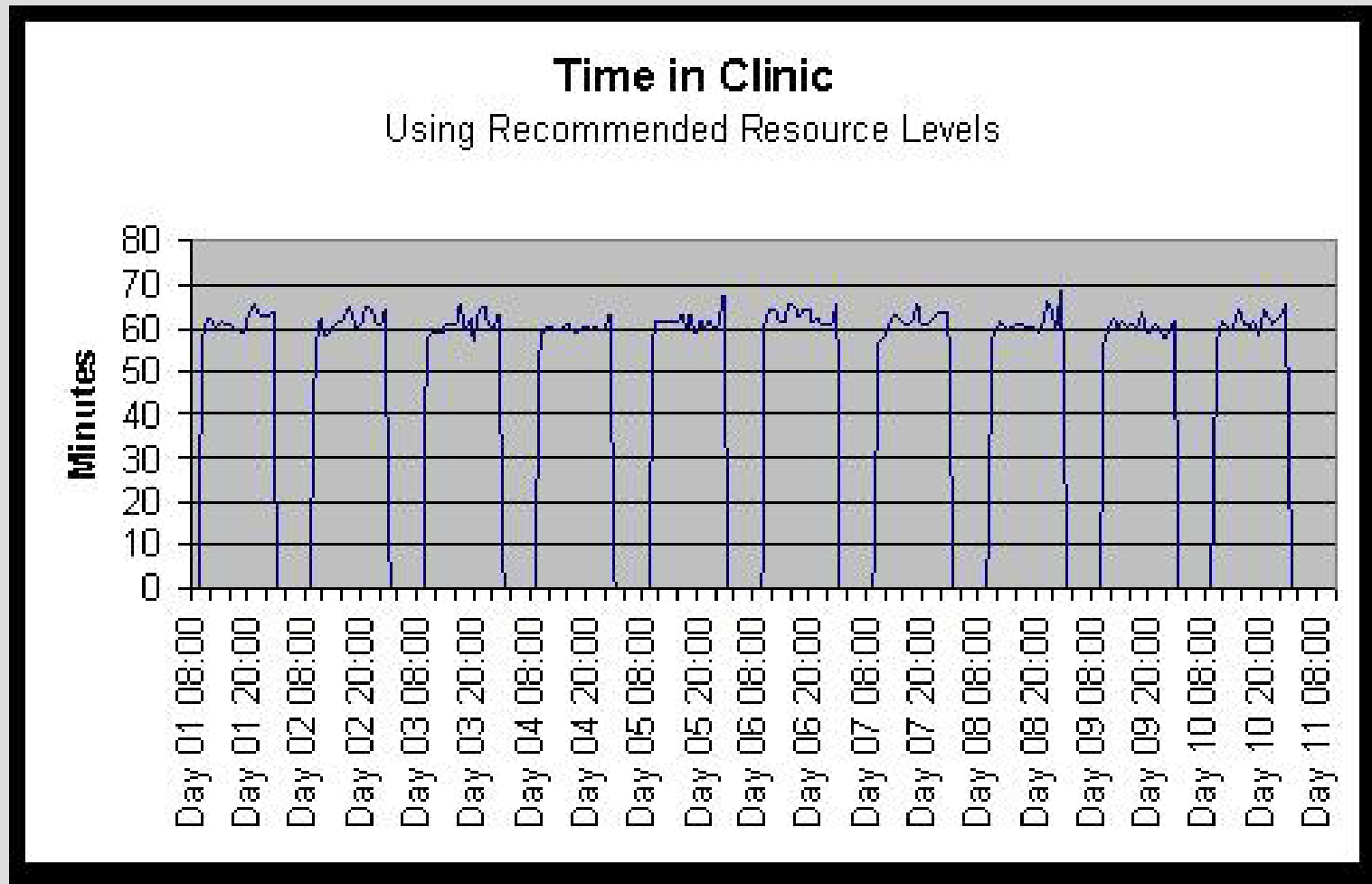
Key Performance Indicators

- **Given a schematic and a scenario, the simulator tracks and calculates key performance indicators (KPIs)**
- **KPIs describe how well the process works under likely operating conditions**
- **The simulator is able to track KPIs over time**
- **The simulator writes the KPIs to an Excel workbook where we can use Excel's analysis tools on them (mostly pivot tables and charts)**

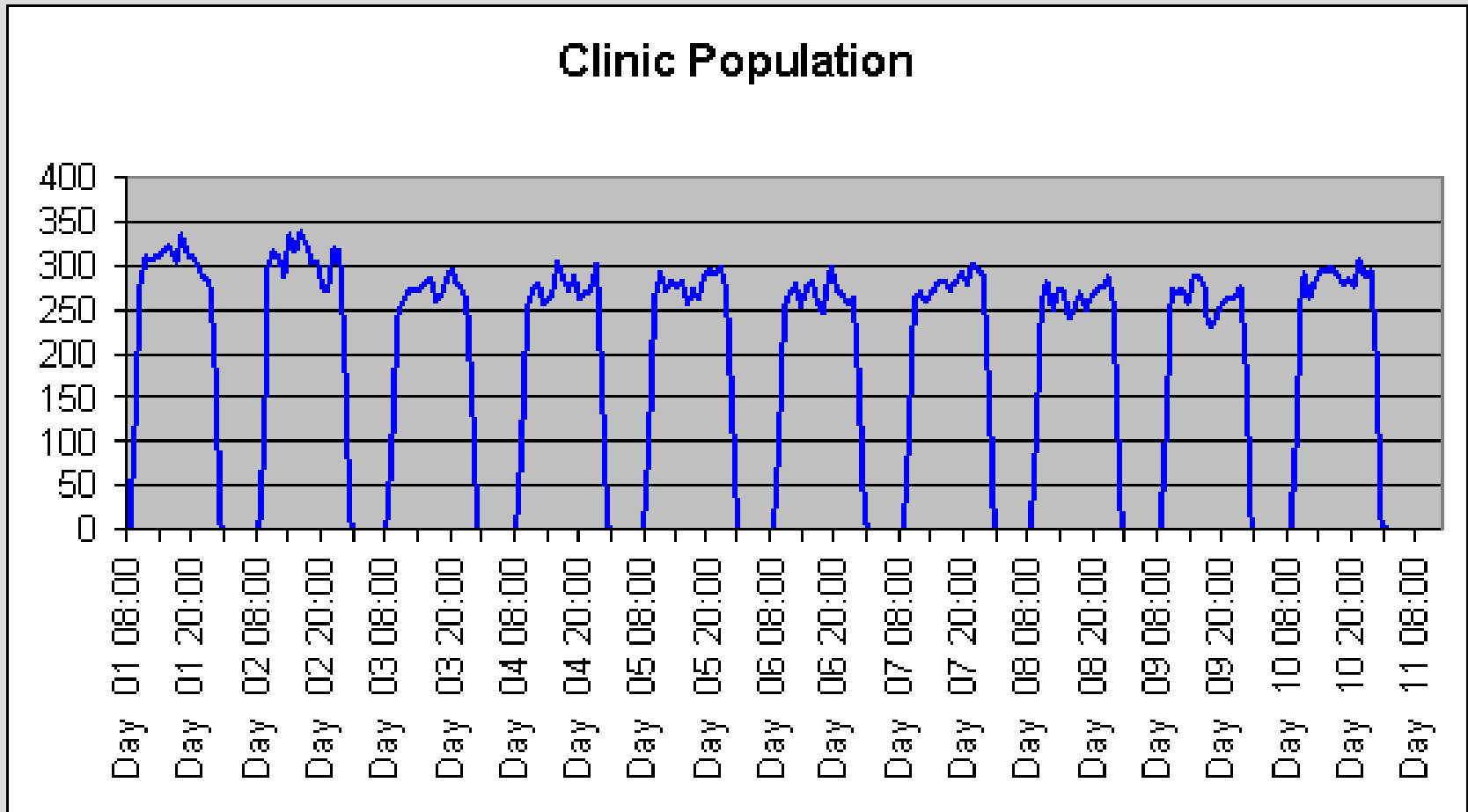
KPIs

- **Average time in clinic**
- **Car-to-car times**
- **Clinic population**
- **Wait times & queue lengths**
- **Resource utilization**
 - **Staff**
 - **Facilities (e.g., orientation rooms, parking lots)**
 - **Transportation system (passengers per vehicle, mileage, fuel consumption)**

Example KPIs



Example KPIs (2)



Example KPIs (3)

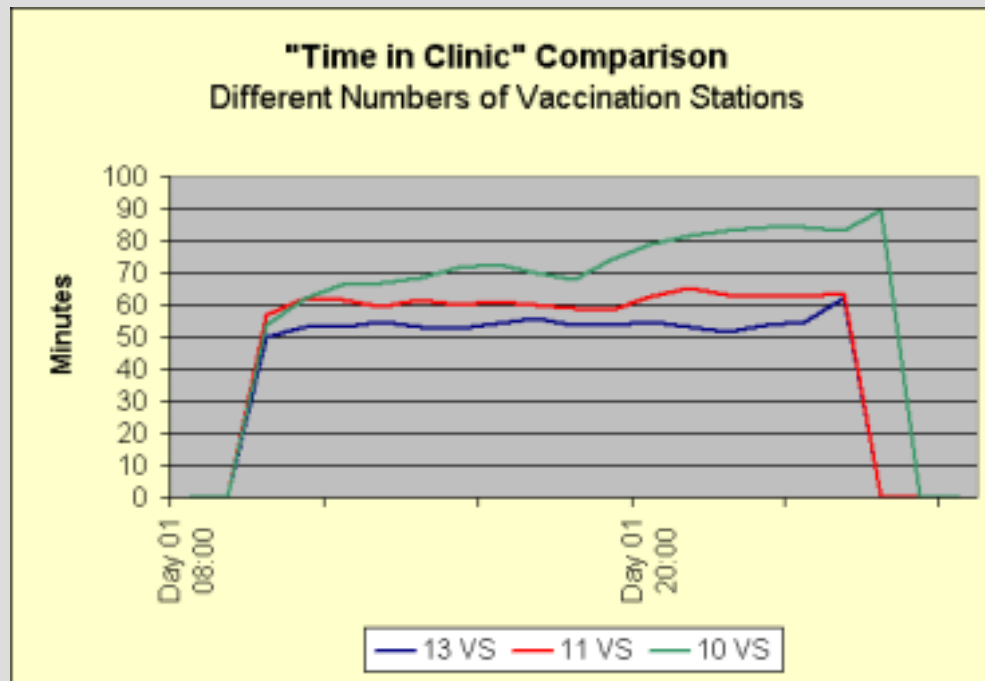
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Methodology

1. Determine best possible process performance (by conducting a run with infinite resources)
2. Reduce most critical resources (usually vaccination stations) to reflect local plans or constraints
3. Evaluate KPIs resulting from resource reduction (next slide)
4. If performance is no longer acceptable:
 - Find a way to relax resource constraint or
 - explore process design alternatives (example—reassign some vaccination station tasks to less skilled volunteers)
5. Adjust upstream and downstream resource levels

Constraining Vaccination Stations

- **Constraining the number of vaccination stations:**
 - Increases the amount of time families spend in the clinic
 - Can increase the length of the clinic's day



- **These analyses enable planners to make deliberate trade-offs**