

Why Queues ? via Dynamic Stochastic PERT/CPM Networks

- Product/Service development
- Project management

Both "enjoy":

- Stochastic environment
- Multi-projects
- Scarce resources

History

- Product Development

- with Adler, P., Nguyen, V., Schwerer, E. (Management Science, HBR)

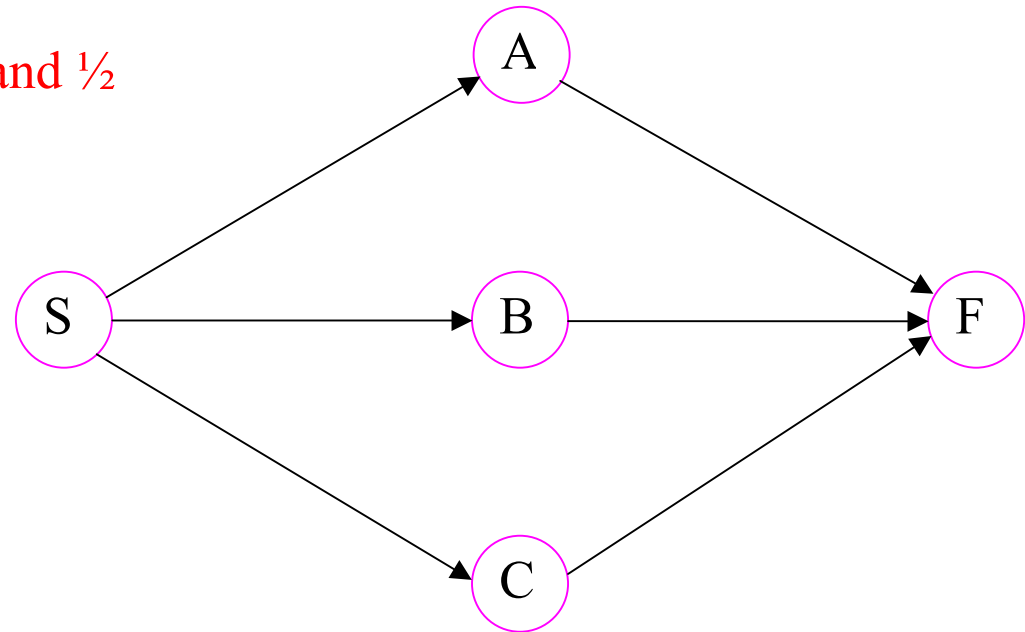
- Project Management

- Lamberg, Y. (M.Sc.) – Israeli Electric
- Baron, Y. (M.Sc.) – Conceptual Framework
- IE&M Projects – Software Development
- Cohen, I. (Ph.D.) – TOC vs. DS-PERT/CPM

- Teaching
 - Static **Deterministic** Models
 - Static **Probabilistic**
 - Dynamic **Stochastic**
- Models: DS-PERTs (Fork-Join, Split-Match, ...).
 - **Important** theoretically and practically.
 - **Intractable** theoretically: simulation, approx.

Stochastic PERT / CPM

Activities	A	B	C
Avg. Duration	3	4	5
Distribution	3	4	1 or 9
			wp 1/2 and 1/2

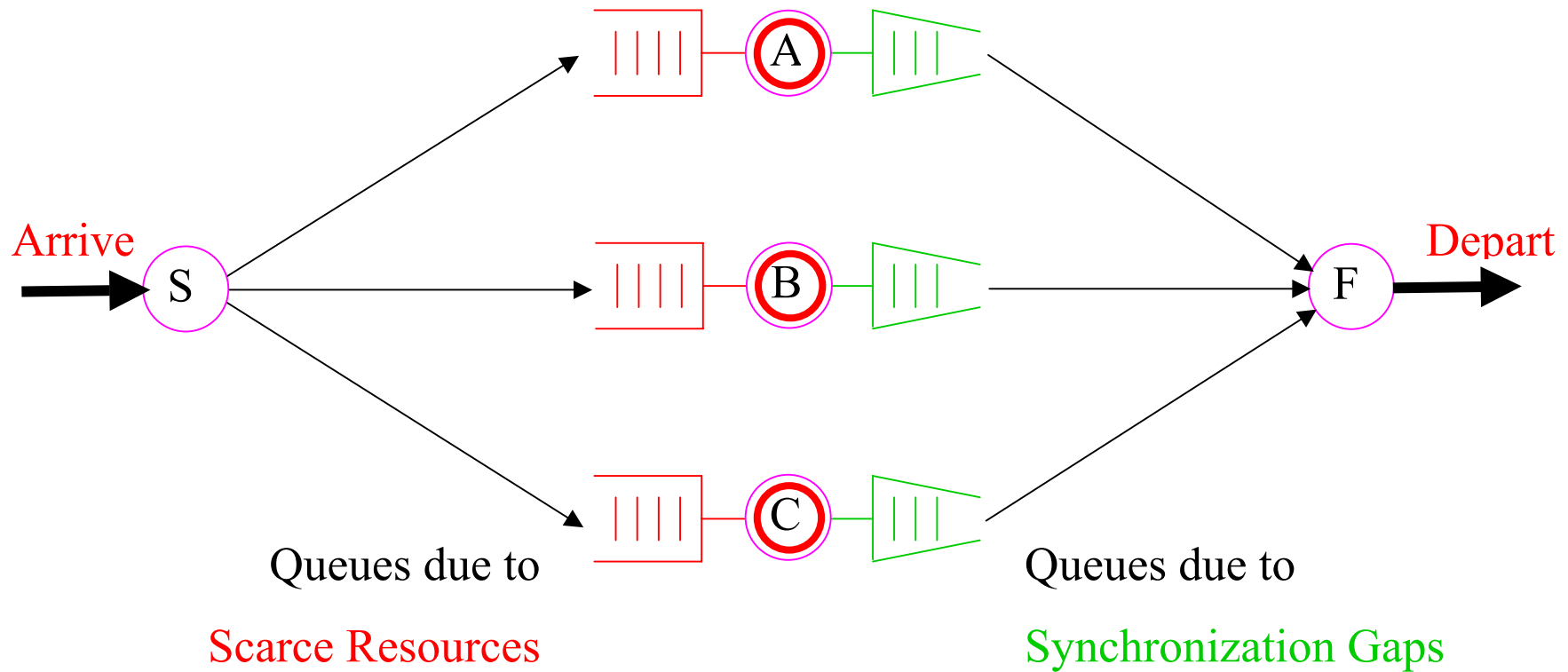


Project time = $\max \{3, 4, 1\} = 4$ wp 1/2
 $\max \{3, 4, 9\} = 9$ wp 1/2

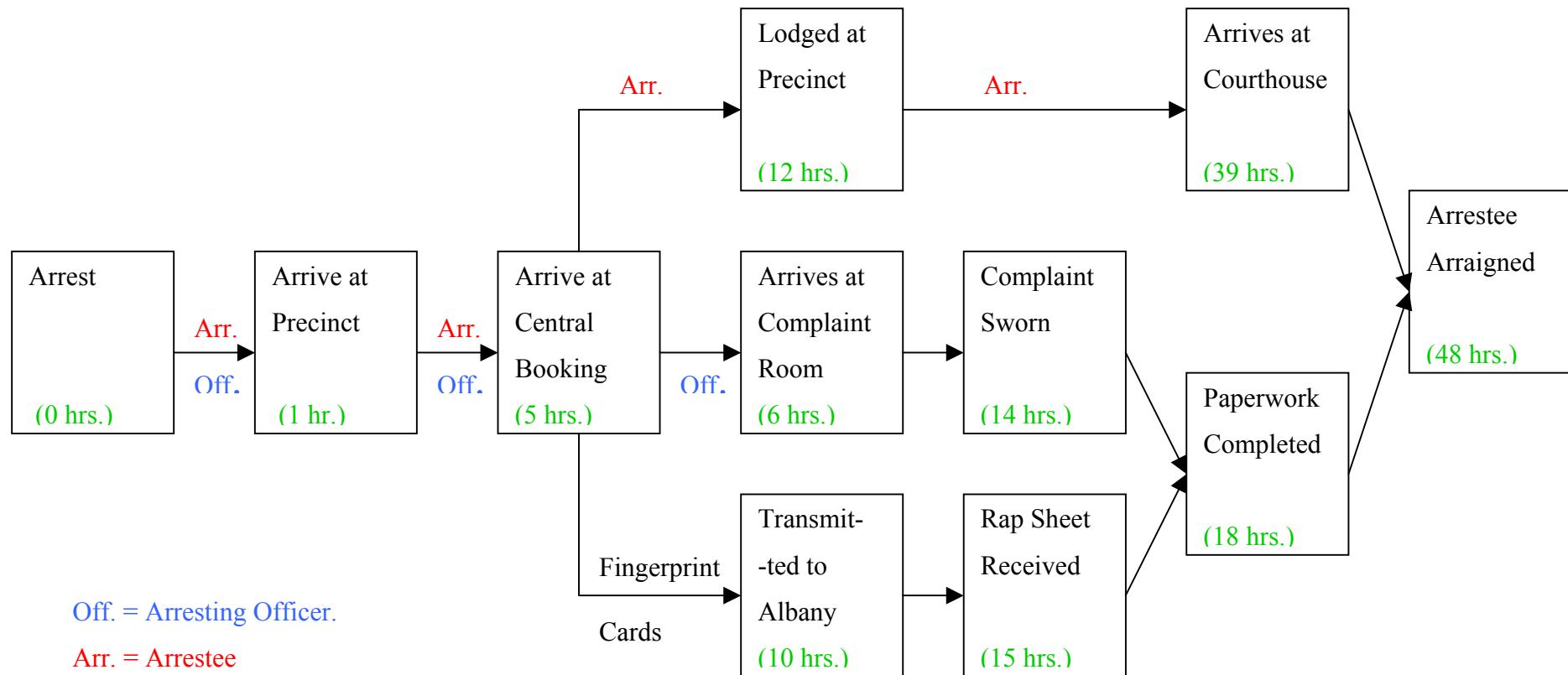
Dynamic Stochastic PERT

Activities, **Resources**, Random durations

Multiple projects



Arrest - to – Arraignment (Larson, ...)

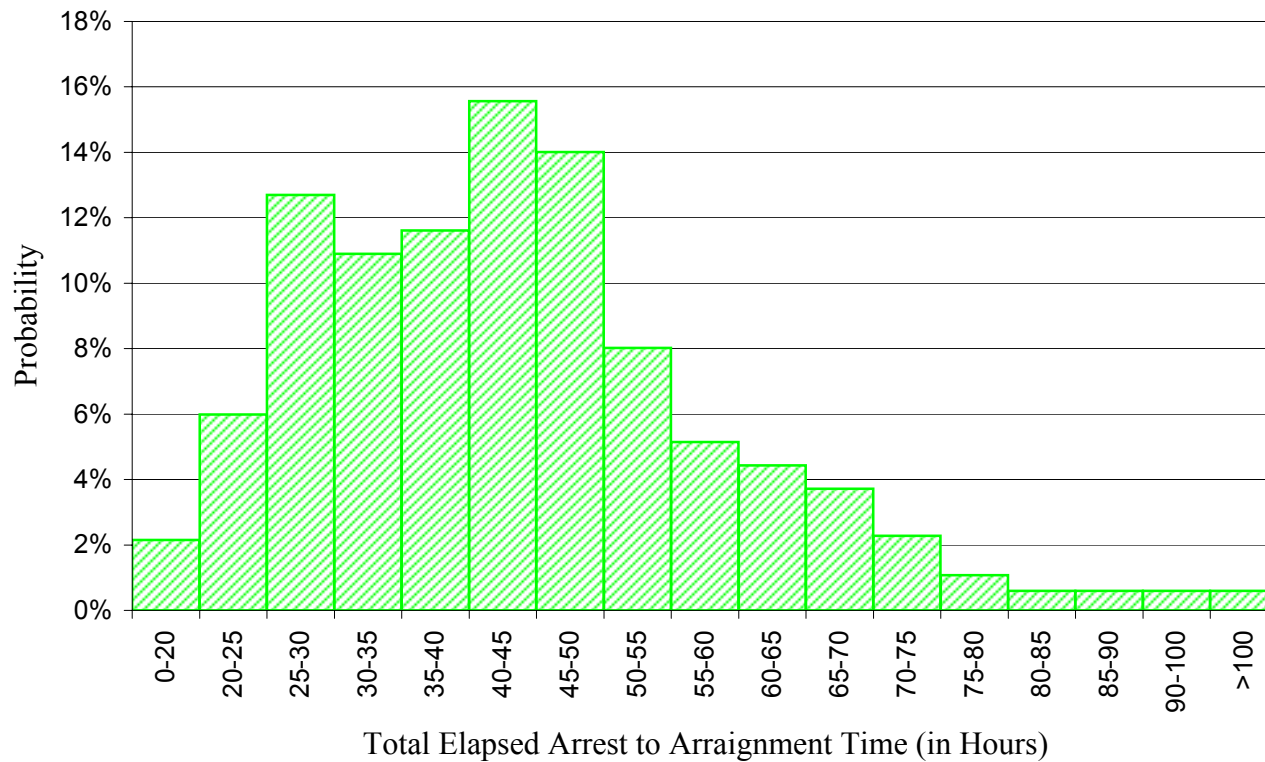


Source:

Improving the N.Y.C A-to-A system
Larson, R. Cahn, M. Shell, M.
Interfaces 23, 1993

Arrest to Arraignment Time

Stochastic dynamic model:



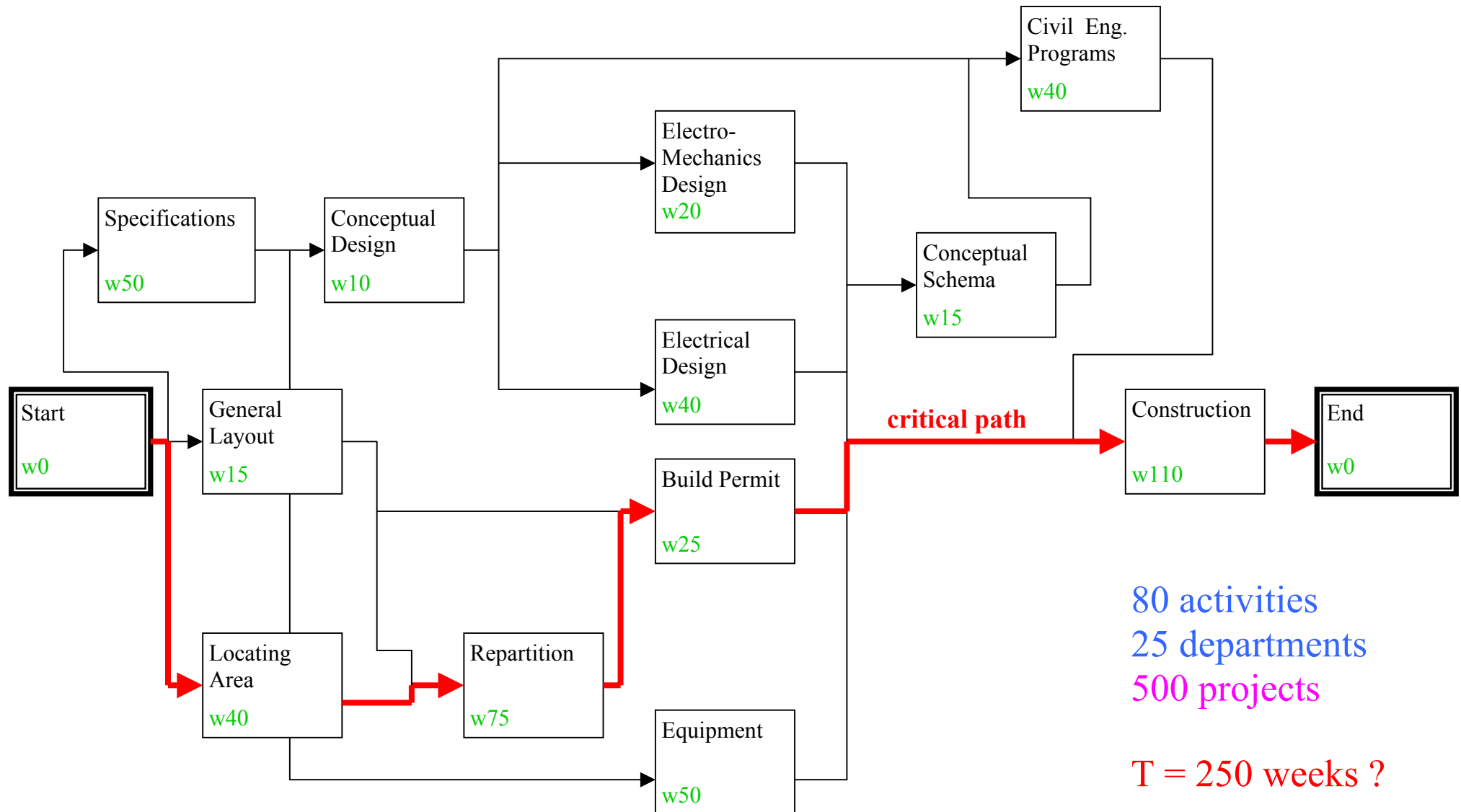
Avg. 44.0 hours

Std. 16.2

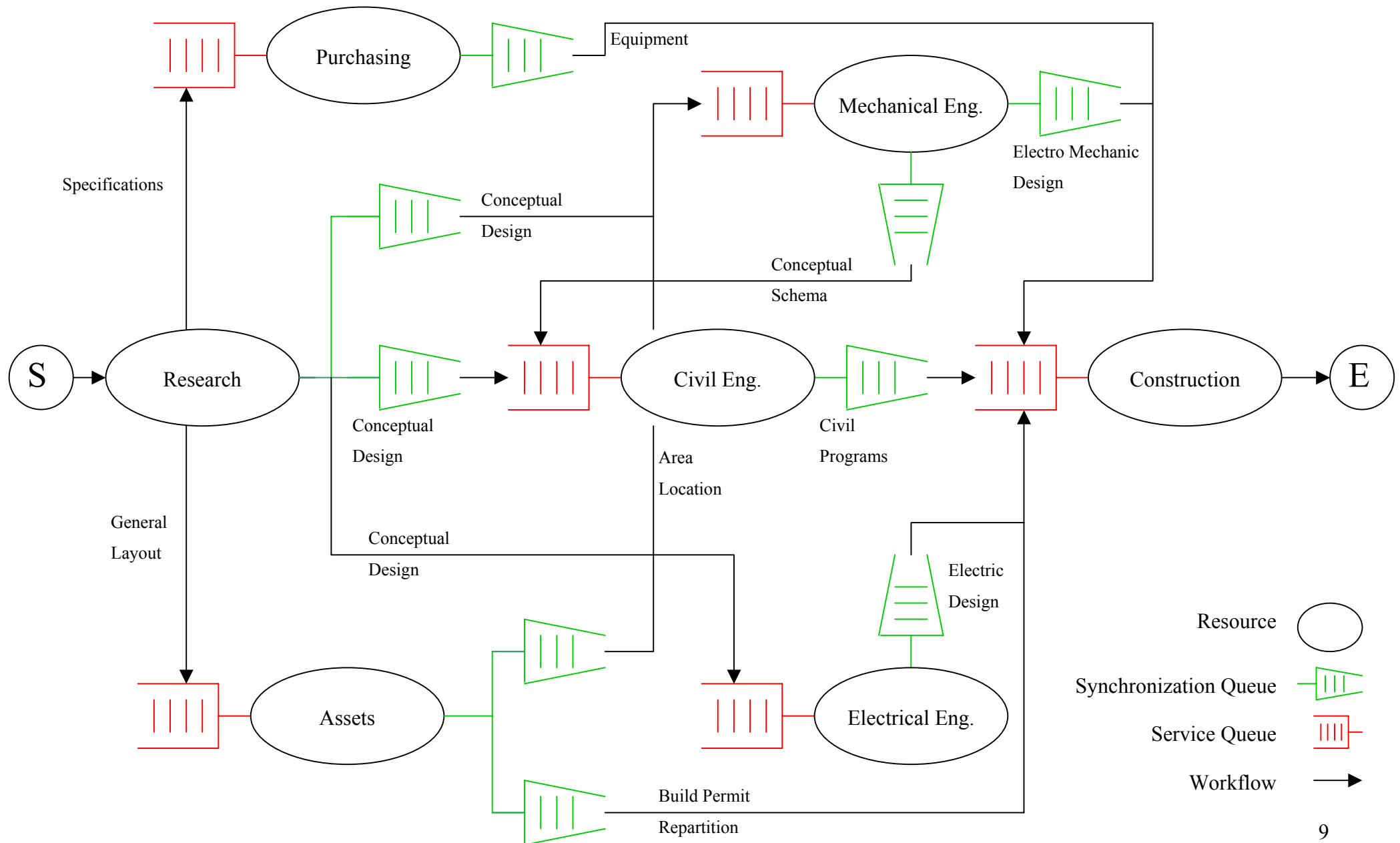
Should be less than
24 hours.

Traditional PERT/CPM Representation

Project View



Processing Network Representation

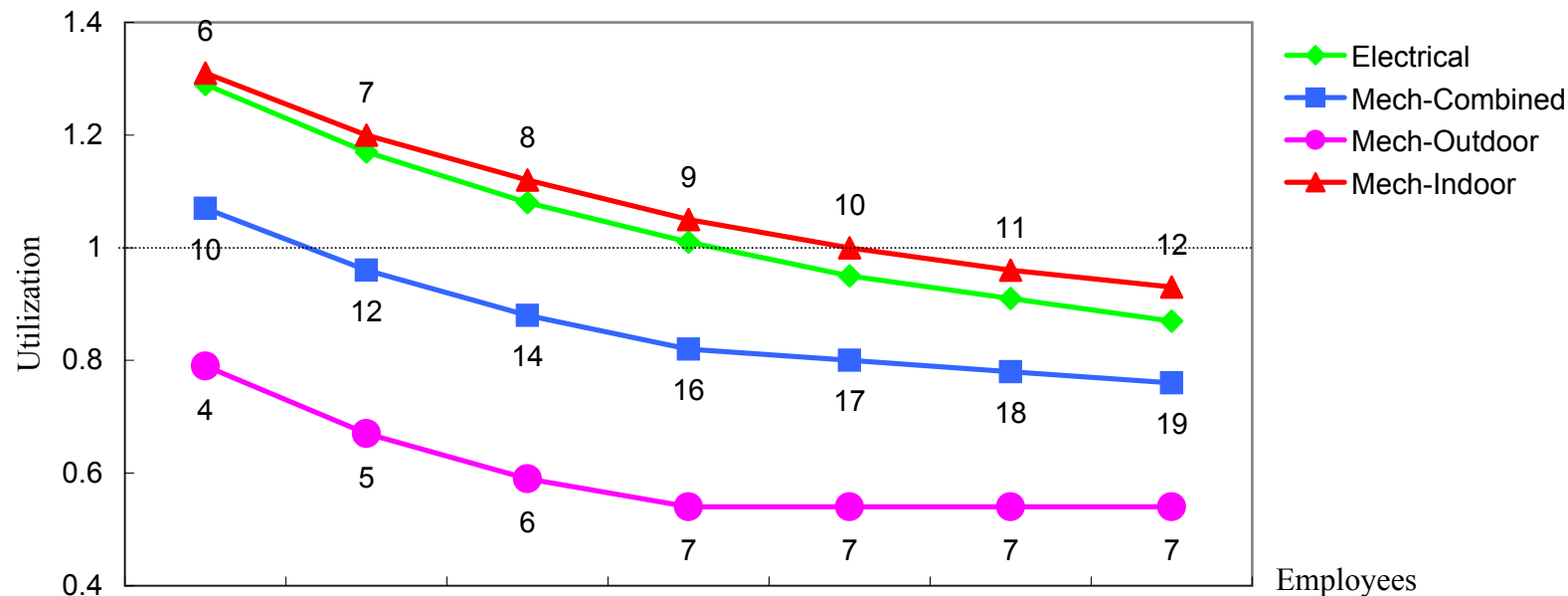


Can We Do It ?

Capacity Analysis - [= Fluid-view (first moments)]

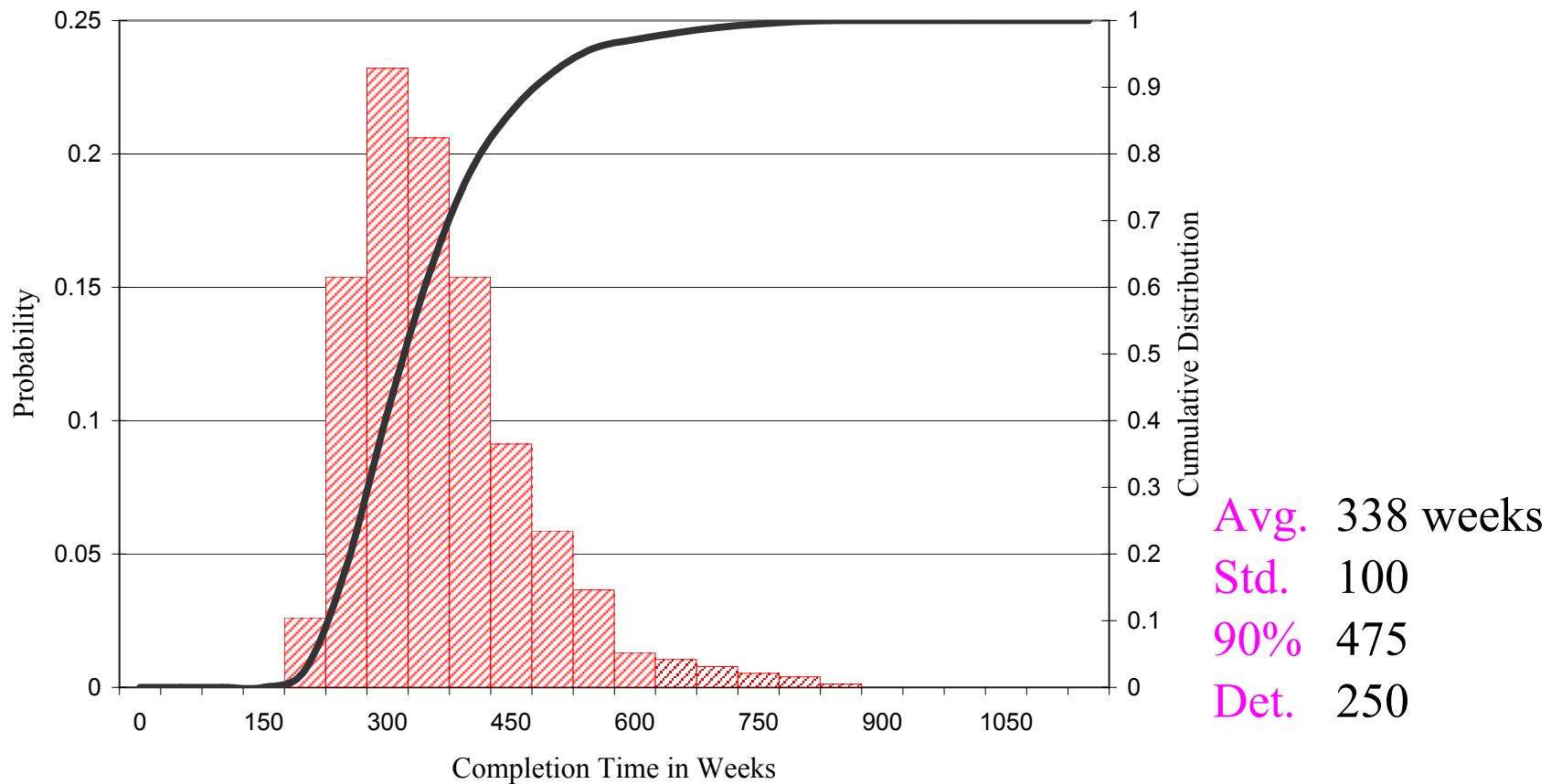
Utilization as a function
of the number of employees:

Electrical		Electro-Mechanic Combined		Electro-Mechanic Outdoor		Electro-Mechanic Indoor	
Employees	Utilization	Employees	Utilization	Employees	Utilization	Employees	Utilization
6	129%	10	107%	4	79%	6	131%
7	117%	12	96%	5	67%	7	120%
8	108%	14	88%	6	59%	8	112%
9	101%	16	82%	7	54%	9	105%
10	95%	17	80%	7	54%	10	100%
11	91%	18	78%	7	54%	11	96%
12	87%	19	76%	7	54%	12	93%



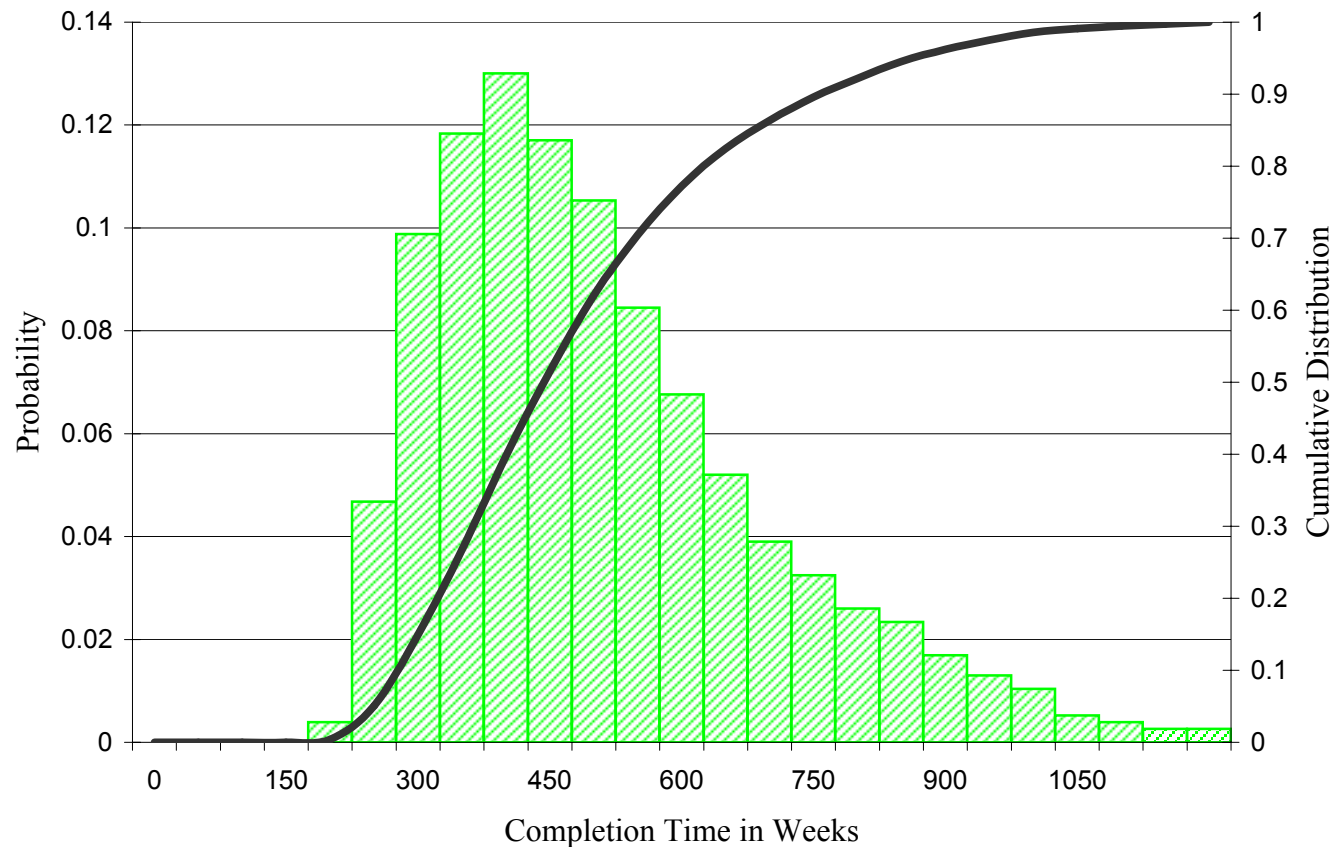
How long Will It Take ?

Stochastic static model (single project):



How Long Will It Take ?

Stochastic dynamic model:



4 Types:

Type	Per year
New sub-station	3.27
New switching stations	0.6
Improvements	3.4
Additional capacity	1.9

Avg. 485 weeks

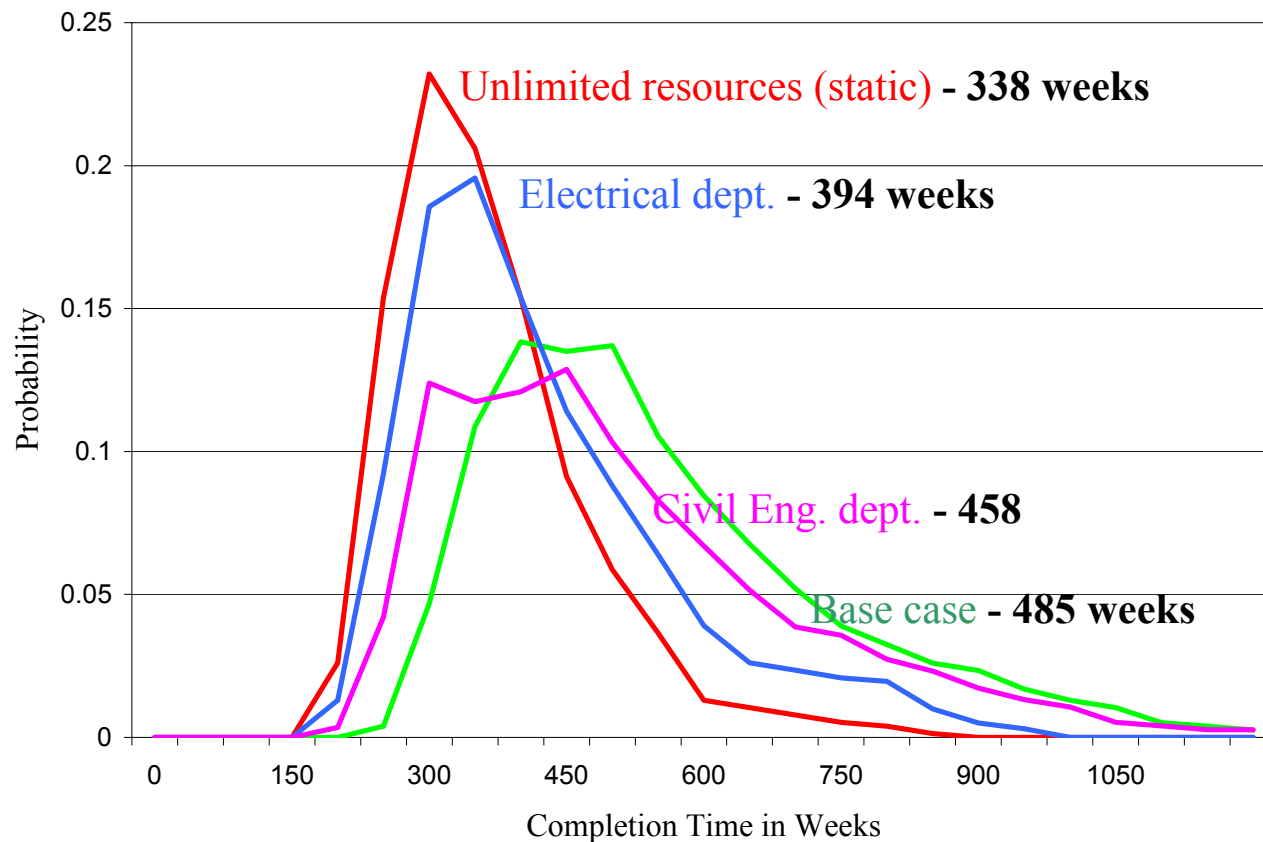
Std. 199

90% 770

Det. 250

Can We Do Better ?

Relieving bottlenecks:



Unlimited resources:
(= Stochastic static)

Avg. **6 years.**

10% over 9 years.

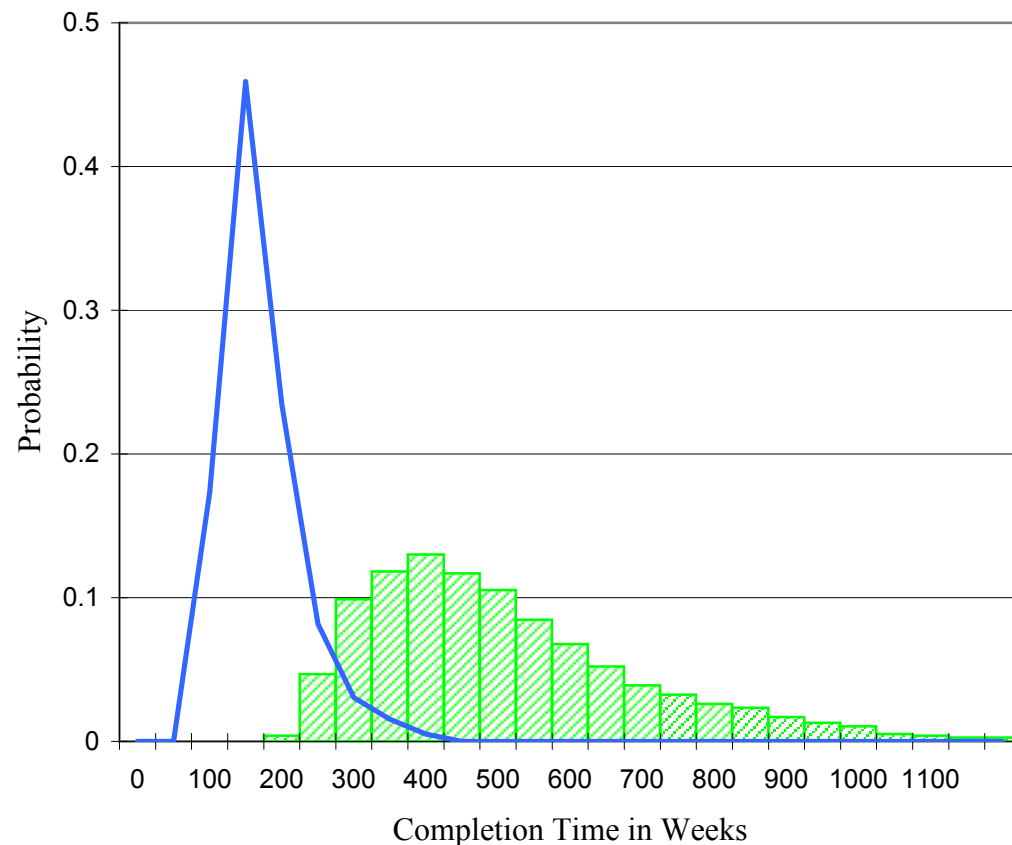
6 years avg. too long.

=> **Resources** NOT the
problem !

(**Infinite-server** models
are important).

Can We Do Better ?

New location management and standardization:



	Base	New
New location mgt:		
40 weeks,		8 weeks
0.5 prob. of repeat		0.8 prob.
Standardization:		
8000 hrs. planning,		2000
repeats,		none
long execution times		↓25%
Avg.	485 weeks	189
Std.	199	55
90%	770	294

Summary

	E	σ	90%
Deterministic	251 weeks	0	251
Stochastic Static Single-Project	338	100	475
Stochastic Dynamic Multi-Projects	485	200	770 (14 years)
Infinite Resources	338	...	...
Re-Engineering	189	55	294