Lecture Notes 14:
Global Financial Corporation Case

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CS 661: Simulation

Road Map

What did we learn so far?

- Introduction to Simulation Modeling using ARENA
- Process-oriented simulation.

What next?

- Application of Simulation Modeling in Business Process Re-engineering.
  - GFC Case: Introduction
  - Analysis using Simulation
  - Simulation-Supported Recommendations.

Objective: Using Simulation to re-design a process.

The Global Financial Corp.

Setting: Global Financial Corporation is a subsidiary of GEC that handles financing of the GEC customers.

Problem:

- The loan approval process at the Bakersfield, CA, office is taking too long (unlike the office in the Northeast).
- The chief competitor promises to respond in "10 business days" or less.
- Nancy Rodriguez, manager of the Bakersfield Office, is under pressure to reduce the loan approval times.

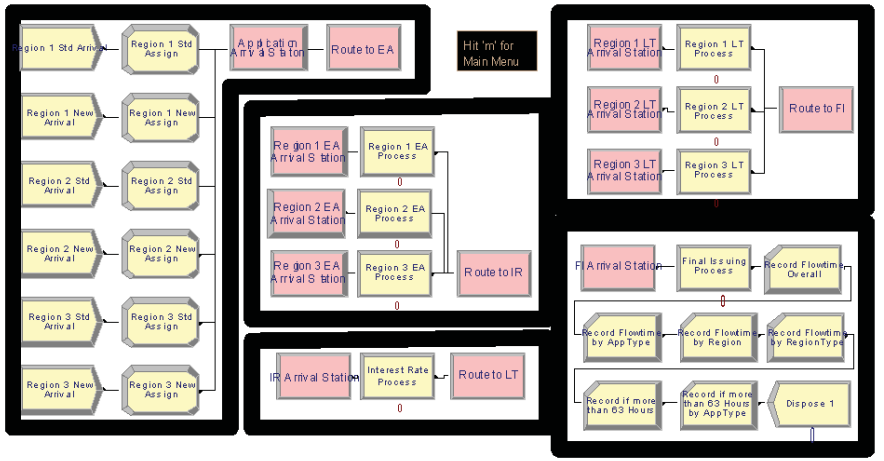
Solution

- Develop a simulation model for the loan-approval process.
  - Goals of the Model and key Outcomes
  - Key Inputs
  - Simulation Model using ARENA
- Use the simulation model to identify the bottlenecks and causes for excessive delays.
- Provide recommendations.
- Evaluate the recommendations using simulation.
- Compare the recommendations.
- Make final recommendation and evaluate capability of final recommendation to meet projected increase in demand.

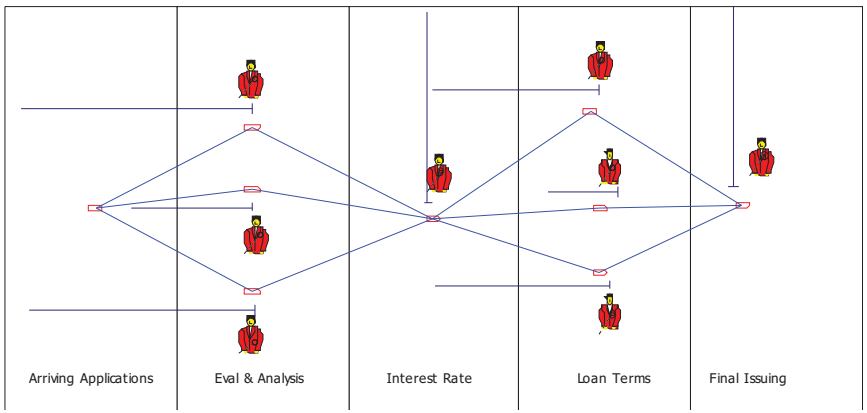
Three Important Questions

- *What are the goals of this study? What are the key outcomes needed to achieve these goals?*
- *How is the process organized?*
- *What are the key uncertainties and how can you model them?*

Arena Model for Original GFC Problem



Animation for Original GFC Model



Simulation Model

- Application Interarrival Times:
  - Distribution depends on region and type
  - How do we determine distributions?
- Completion Times for other tasks
  - Depend on type of application and specific task
    - Evaluation & Analysis
    - Interest Rate Determination
    - Loan Terms
    - Final Issuing
  - How to choose distributions?

Processing Times

	Estimated Processing Times (in hours)			
	Standard		New	
	Mean	Std. Dev.	Mean	Std. Dev.
Evaluation & Analysis	2.8	1.2	6.1	3.0
Interest Rate Determination	0.6	0.2	0.6	0.2
Loan Terms	3.8	1.4	5.6	2.6
Final Issuing	3.5	1.2	3.5	1.2
Total	10.7	5.1	15.8	2.9

Std. Dev. is the Standard Deviation of processing times. About two-thirds of the observed processing times are between the mean and plus or minus one Std. Dev.

Interesting Modeling Concepts: Attributes

Processing times at each station depend on the characteristics (attributes) of the entities.

- Open *Assign* module
- In new window that appears, click on Add.
- In new *Assignments* window, choose *Attribute* as *Type*
- In *Attribute* box, enter name of Attribute:
  - E.g., EA Time
- In *New Value* box, enter value for attribute
  - E.g., Standard EA Time, which we defined as an *Expression* on the Advanced Process template.

Interesting Modeling Concepts: Sequence

Applications from different regions follow different paths

- Use *Sequence* module (Advanced Transfer template) and Assign module to define the sequence of stations for region-1, region-2 and region-3 customers.
  - In *Sequence* module, use spreadsheet to define Name (e.g., Region 1 Plan) and order of stations to visit by clicking on *Steps* to enter rows.
  - In *Steps* window, for each step, enter *Station Name* (e.g., Region 1 EA Station) and *Step Name* (e.g., region 1 step 1).
- In Assign module, click Add button. In new window,
  - Specify *Type* to be *Attribute*
  - Specify *Attribute Name* to be *Entity.Sequence*
  - Specify *New Value* to be name of sequence defined in Sequence module (e.g., Region 1 Plan)

Interesting Modeling Concepts: Tally Set

Tally Set: collection of *tallies* indexed by *Set Index*.

- *Tally Set* is the Arena-analogue of an array.
- Use *Set* module from *Basic Process* template.
  - In spreadsheet, enter *Name* (e.g., Tally Flowtime by Type)
  - Specify *Type* as *Tally*, and click on *Members* button to enter Tally Names (e.g., Std Flowtimes).
- Use *Record* module from *Basic Process* template.
  - Specify *Name* (e.g., Record Flowtime by Type) and *Type* (e.g., Time Interval).
  - If *Type* is *Time Interval*, specify *Attribute Name* (e.g., Arrive Time).
  - Click on *Record into Set* box. Specify *Tally Set Name* (e.g., Tally Flowtime by Type) and *Set Index* (e.g., AppType).
  - *Set Index* is attribute used to index into the set.

Interesting Modeling Concepts: Tally Expression

Want to determine fraction of applications taking more than 10 days (63 hours).

- Use *Record* module and specify *Type* as *Expression*
- Specify (TNOW – Arrive Time > 63) as *Value*, where
  - TNOW is Arena variable for current simulation time
  - Arrive Time is a user-defined *Attribute* defined in *Assign* module.

Simulation Results for Base Case

- 10 Replications
  - 10,000 hours each
  - Warm-Up Period of 1,000 hours
- Simulation estimates with 95% C.I.H.W.
  - Average Flow Time (hrs) of all applications

    60.4 ± 8.7
  - Proportion of all applications taking > 10 days:

    0.33 ± 0.06

Simulation Results for Base Case

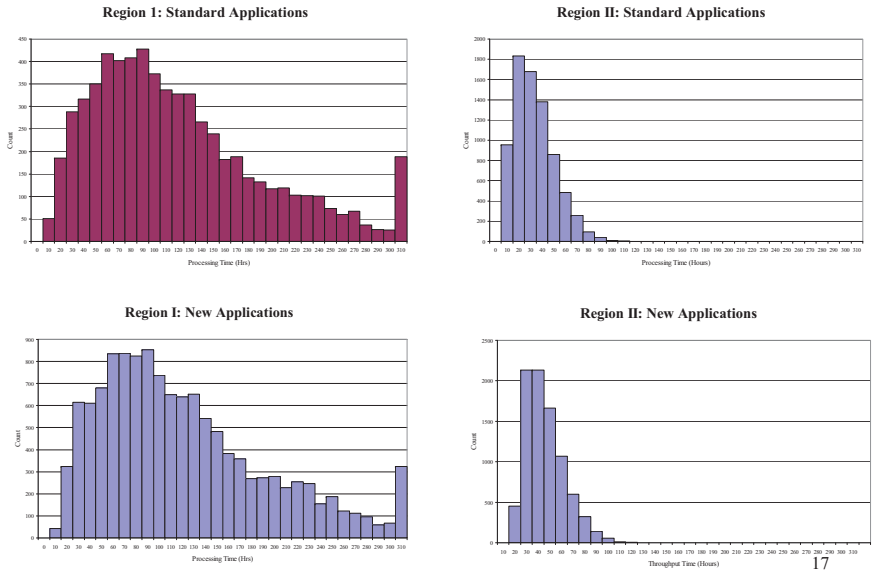
- Utilizations (95% C.I.H.W.)

	Evaluation & Analysis	*Interest Rate*	*Loan and Terms*	*Final Issuing*
Region 1	0.94 (0.01)		0.94 (0.01)	
Region 2	0.72 (0.01)		0.75 (0.01)	
Region 3	0.84 (0.03)		0.86 (0.02)	
All		0.31 (0.00)		0.92 (0.01)

Simulation Results - 1 Rep, 10^5 Hours

	Region 1		Region 2		Region 3		Overall		
Throughput Times (hrs)	Standard	New	Standard	New	Standard	New	Standard	New	Total
0-20	120	153	1761	1279	855	717	2736	2149	4885
20-40	484	953	3531	4376	2677	3684	6692	9013	15705
40-60	569	1148	1367	1843	1908	2608	3844	5599	9443
60-80	632	1223	534	649	1168	1672	2334	3544	5878
80-100	688	1366	179	230	509	774	1376	2370	3746
100-120	688	1372	43	65	292	373	1023	1810	2833
120-140	713	1388	2	7	99	179	814	1574	2388
140-160	570	1109			42	74	612	1183	1795
160-180	568	1192			30	39	598	1231	1829
180-200	512	1021			33	34	545	1055	1600
200-220	381	841			40	51	421	892	1313
220-240	261	513			37	48	298	561	859
240-260	143	255			17	33	160	288	448
260-280	77	172			6	17	83	189	272
> 280	42	84			0	0	42	84	126
Totals	6448	12790	7417	8449	7713	10303	21578	31542	53120
% > 60 Hours	82%	82%	10%	11%	29%	32%	38%	47%	43%
Means	125.039	126.446	33.93	36.78	51.67	54.11	67.5	78.7995	74.20811
Means by Region	125.9744		35.4476		53.0654				

Throughput Times from 1 Replication



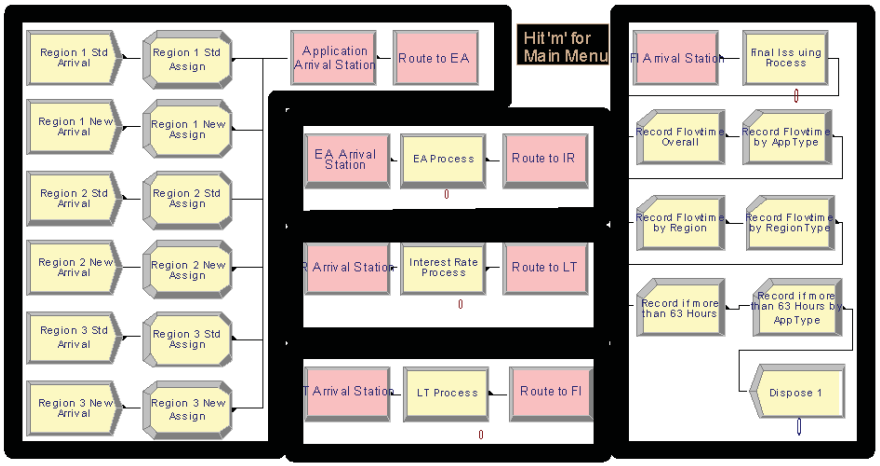
Resource Pooling

Observation: Under the base configuration,

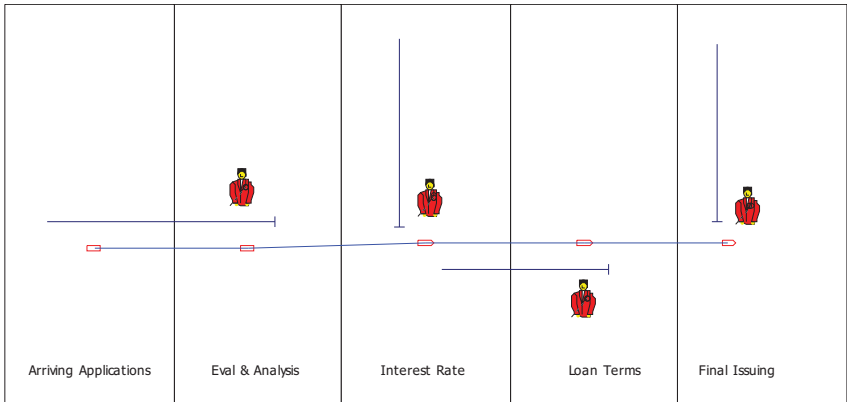
- resources in region 1 are overutilized
- resources in regions 2 and 3 are sometimes idle.

Recommendation: Pool the E&A teams together and the LT individuals together to achieve a better resource utilization.

Arena Model: Pooling & No Priority



Arena Model: Pooling & No Priority



Simulation Results for Pooled Process, No Priority

- 10 Replications
  - 10,000 hours each
  - Warm-Up Period of 1,000 hours
- Proportion of all applications taking > 10 days:
  0.021 ± 0.02 (95% C.I.H.W.)
- Utilizations (95% C.I.H.W.)

Utilization Rate			
Evaluation & Analysis	***Interest Rate***	***Loan and Terms***	***Final Issuing***
0.84 (0.01)	0.31 (0.00)	0.85 (0.01)	0.92 (0.01)

Utilization

- No Pooling (from before)

	Evaluation & Analysis	***Interest Rate***	***Loan and Terms***	***Final Issuing***
Region 1	0.94 (0.01)		0.94 (0.01)	
Region 2	0.72 (0.01)		0.75 (0.01)	
Region 3	0.84 (0.03)		0.86 (0.02)	
All		0.31 (0.00)		0.92 (0.01)

- Pooling

Utilization Rate			
Evaluation & Analysis	***Interest Rate***	***Loan and Terms***	***Final Issuing***
0.84 (0.01)	0.31 (0.00)	0.85 (0.01)	0.92 (0.01)

Simulation Results – Pooling (1 Rep)

	Region 1		**Region 2**		**Region 3**		**Overall**		
Throughput Times (hrs)	**Standard**	**New**	**Standard**	**New**	**Standard**	**New**	**Standard**	**New**	**Total**
0-20	2096	2255	2282	1696	2425	1881	6803	5832	12635
20-40	2890	7096	3504	4784	3729	5701	10123	17581	27704
40-60	802	2233	1008	1468	1074	1847	2884	5548	8432
60-80	327	823	385	587	376	660	1088	2070	3158
80-100	53	151	65	112	53	147	171	410	581
100-120	36	75	44	58	41	45	121	178	299
120-140	8	43	16	24	17	25	41	92	133
140-160		1						1	1
160-180									
180-200									
200-220									
220-240									
240-260									
260-280									
> 280									
Totals	6212	12677	7304	8729	7715	10306	21231	31712	52943
% > 60 Hours	7%	9%	7%	9%	6%	9%	7%	9%	8%
Means	29.52	34.01	30.00	33.86	29.89	33.81	29.82	33.90	32.27
Means by Region	32.53338		32.10154		32.1318				

Priority to Standard Applications

- Management is more concerned about *Standard* applications.
- Work on *Standard* applications before *New* apps.
- To accomplish this in ARENA,
  - Click on *Queue* module in Basic Process
  - In spreadsheet, go to *Type* column, and change from First In First Out to Lowest Attribute Value.
  - In *Attribute Name* column, enter AppType.
  - Recall that we defined the *Attribute* AppType with
    - AppType=1 for Standard
    - AppType=2 for New

Priority to Standard Applications (No pooling)

	Region 1		Region 2		Region 3		Overall		
Throughput Times (hrs)	Standard	New	Standard	New	Standard	New	Standard	New	Total
0-20	3324	173	4793	1068	4374	619	12491	1860	14351
20-40	3025	979	2726	3391	3501	2587	9252	6957	16209
40-60	2	1035		2138	5	2237	7	5410	5417
60-80		911		1086		1724		3721	3721
80-100		887		449		1249		2585	2585
100-120		897		266		829		1992	1992
120-140		1000		119		509		1628	1628
140-160		1011		52		274		1337	1337
160-180		852		14		175		1041	1041
180-200		735				77		812	812
200-220		688				75		763	763
220-240		601				31		632	632
240-260		431				5		436	436
260-280		353						353	353
> 280		2100						2100	2100
Totals	6351	12653	7519	8583	7880	10391	21750	31627	53377
% > 60 Hours	0%	83%	0%	23%	0%	48%	0%	55%	33%
Means	20.02	169.82	18.36	45.59	19.47	66.94	19.25	102.31	68.46
Means by Region	119.7566		32.87466		46.46692				

Priority & Pooling

	Region 1		Region 2		Region 3		Overall		
Throughput Times (hrs)	Standard	New	Standard	New	Standard	New	Standard	New	Total
0-20	5917	1754	7084	1261	7381	1467	20382	4482	24864
20-40	474	5379	540	3708	600	4382	1614	13469	15083
40-60		3095		2086		2483		7664	7664
60-80		1464		984		1134		3582	3582
80-100		528		385		465		1378	1378
100-120		240		168		169		577	577
120-140		160		79		95		334	334
140-160		53		24		41		118	118
160-180		5		3		4		12	12
180-200									
200-220									
220-240									
240-260									
260-280									
> 280									
Totals	6391	12678	7624	8698	7981	10240	21996	31616	53612
% > 60 Hours	0%	19%	0%	19%	0%	19%	0%	19%	11%
Means	14.81	42.49	14.85	41.94	14.91	41.94	14.86	42.16	30.96
Means by Region	33.21		29.29		30.1				

Priority & Pooling

- Proportion of all applications taking > 10 days:
  0.07 ± 0.02 (95% C.I.H.W.)
- Utilizations

Utilization Rate			
Evaluation & Analysis	***Interest Rate***	***Loan and Terms***	***Final Issuing***
0.84 (0.01)	0.31 (0.00)	0.85 (0.01)	0.92 (0.01)

- Is this an acceptable proposal?
- What will happen if demand goes up 10% as expected?

Pooling & Priority to News (1 Rep)

Standards		
Bin	*Frequency*	*Cumulative %*
20	49605	75.69%
40	9724	90.53%
60	3014	95.13%
80	1528	97.46%
100	907	98.84%
120	434	99.51%
140	202	99.81%
160	96	99.96%
180	23	100.00%
200	3	100.00%
More	0	100.00%

News		
Bin	*Frequency*	*Cumulative %*
20	37436	57.12%
40	20596	88.55%
60	6246	98.08%
80	1096	99.75%
100	158	99.99%
120	4	100.00%
140	0	100.00%
160	0	100.00%
180	0	100.00%
200	0	100.00%
More	0	100.00%

Complete Reorganization

A More Radical Solution:

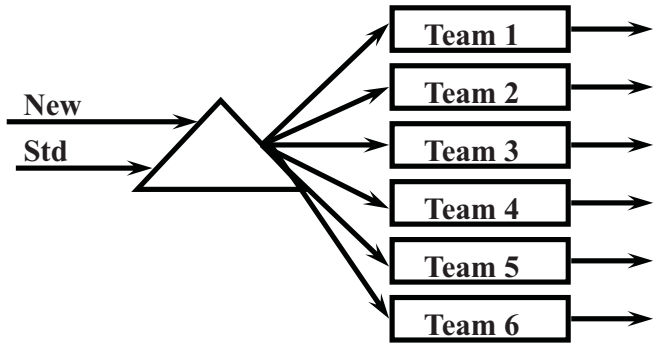
- Divide the work-force into six teams of two each.
- Each team will be cross-trained to handle all stages of the application process.

Problem:

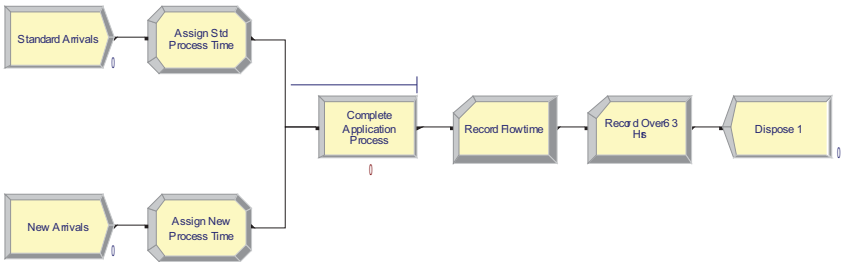
How will this affect the distribution of the processing times?

- Mean
- Standard Deviation
- Distribution

New Process Flow



Arena Model for Reorganized Process



Simulation Results - with 10% sales increase

	No Priority			Priority		
Throughput Times (hrs)	Standard	New	Total	Standard	New	Total
0-5	332	233	565	423	181	604
5-10	951	676	1627	1171	609	1780
10-15	544	964	1508	551	908	1459
15-20	218	670	888	38	713	751
20-25	105	334	439		368	368
25-30	31	142	173		193	193
30-35	28	69	97		87	87
35-40	3	22	25		35	35
40-45	2	7	9		29	29
45-50		4	4		23	23
50-55					3	3
55-60					2	2
60-65						
65-70						
> 70						
Totals	2214	3121	5335	2183	3151	5334
% > 60 Hours	0%	0%	0%	0%	0%	0%
Means	10.34	14.2	12.6	7.95	15.6	12.47

Complete Reorganization

Big Picture: Global competition forces managers to think of new ways to reduce cost.

- Improving performance of processes
- Make radical changes in *cross-functional* processes.

How?

- Radical changes rather than incremental changes.
- The analysis focuses on the whole process rather than a department or functional areas
- It attempts to achieve major improvement in performance
- Quantitative analysis is critical in enabling the change

Examples:

- FORD Accounts payable
- Mutual Benefit Life

Conclusions

Key Lesson: Using Simulation in reorganizing how a business operates

- Identify key performance measures.
- Understand and describe the process
- Develop the Simulation Model
- Redesign the process using the following guidelines:
  - Eliminate cross-functional boundaries if feasible.
  - Achieve smallest possible number of queueing points!
- Analyze and evaluate performance of modified system.
- Make a recommendation taking into account:
  - Is cross-training necessary?
  - Do we need new infrastructure?