

LEM

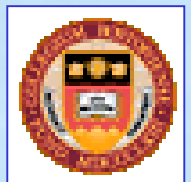
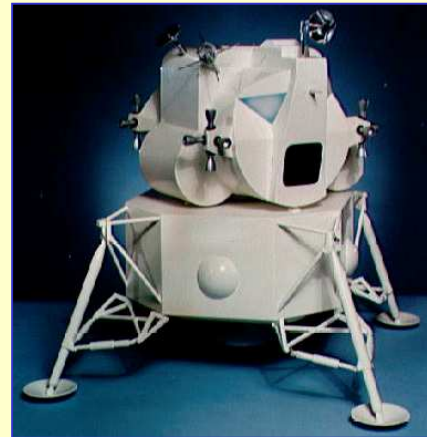
Logistics Education Module

OVERVIEW

A.G. Bruzzone

R. Signorile

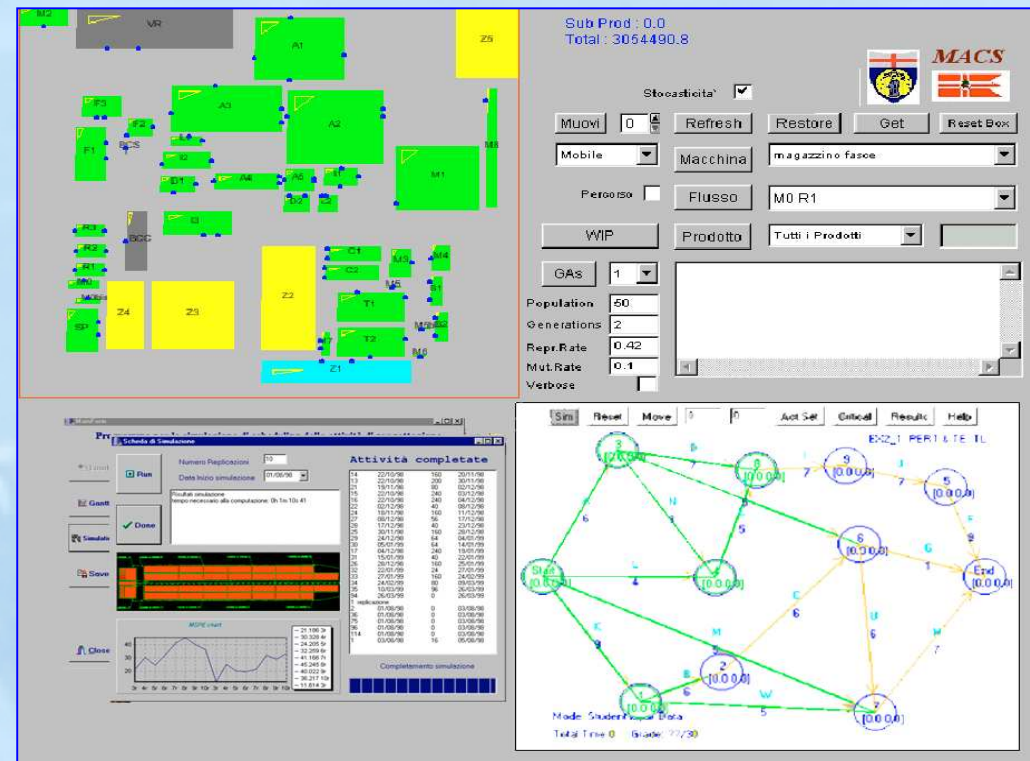
E.J. Williams



LEM

Logistics Educational Module

The LEM Project is a joint venture between various entities to provide logistics experts in the professional and academic worlds with logistics training. LEM's main goal is to create teams skilled in logistics subjects.



LEM Problem Framework

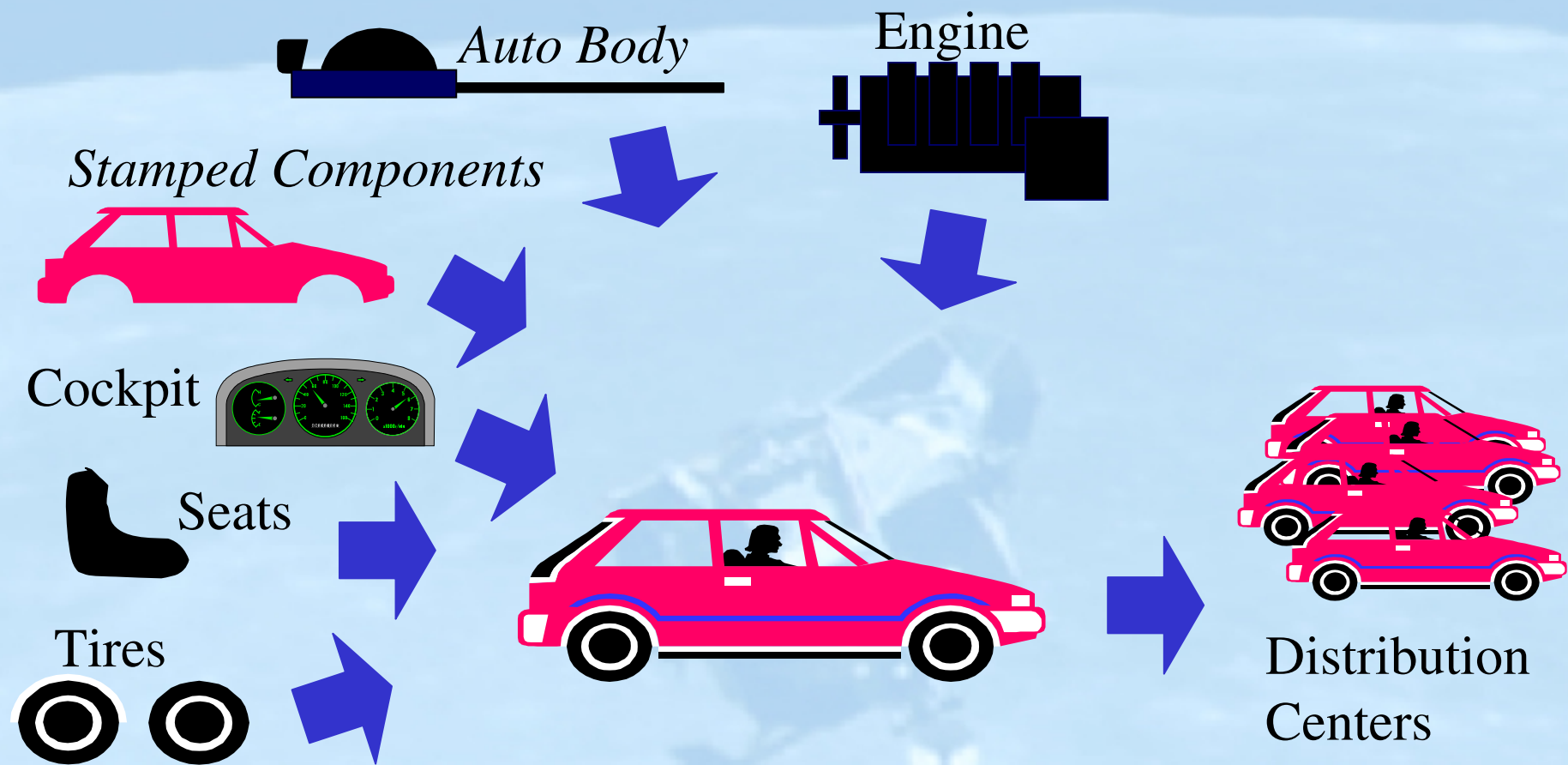


- Pittsburgh
- Clinton
- Pocahontas
- Florissant

This is a likely but neither real nor detailed scenario



Simplified supply chain



LEM Mission Goals



- To improve internal and external logistics in the current scenario
- To introduce 2 new products and consequently re-manage the relative logistics.



LEM Team Organization



- LEM is a logistics game where teams operate competitively.
- Each team must complete the mission independently.
- Teams will be provided with computational tools for making evaluations.
- All detailed data will be supplied at the beginning.



Evaluation Criteria



- Evaluation criteria are based on 2 evaluations: one relative between teams and the other absolute based on the results achieved by each team.
- Results are obtained from model outputs operating on a specific scenario, introducing the decisions made by each team.



Work team delivery procedure



- Teams will deliver a report with the values of the decision parameters for which they are enabled to operate (i.e. selection of suppliers for each product).

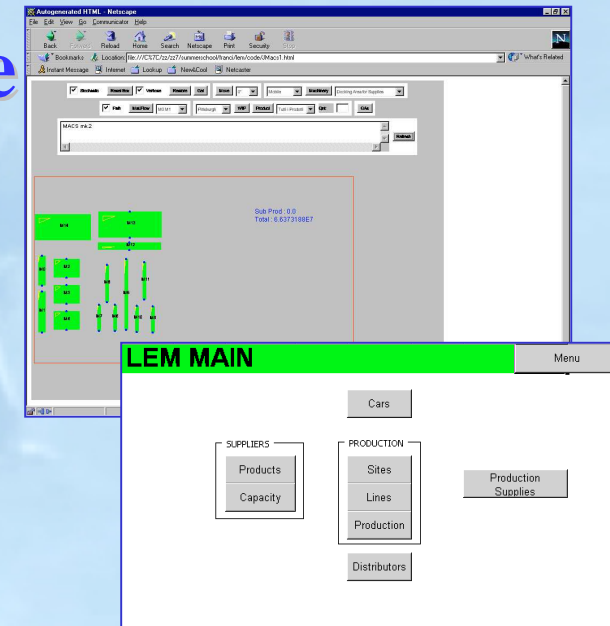


LEM Modules



In LEM there are 2 main modules:

- Scenario Definition Module
- Simulation Module



LEM Excel Modules



LEM MAIN

Menu

Cars

SUPPLIERS

Products

Capacity

PRODUCTION

Sites

Lines

Production

Production
Supplies

Distributors



What to do and what not to do



- Teams cannot change data in cells without a white background.

Production Lines						Menu
Line ID	Line DAE1	Line DAE2	Line B&S	Line A1	Line A2	
Car Type	Luxury	Compact	Luxury	Compact	Compact	
Site	PS	PS_01	PS_02	PS_03	PS_04	
Location	Pittsburgh	Pittsburgh	Clinton	Poconontas	Florissant	
Initial Max Capacity	500,000	400,000	500,000	750,000	750,000	cars/year
Productivity Increase						cars/year
Theoretical Productivity	500,000	400,000	500,000	750,000	750,000	
Current Production	400,000	250,000	200,000	650,000	400,000	cars/year
Productivity	80%	63%	40%	87%	53%	
Overall Efficiency	97%	97%	88%	94%	97%	
MTBF	18.0	16.0	19.0	31.0	31.0	weeks
MTTR	1.4	1.2	1.4	2.2	2.0	days
Cost for Improving Productivity	9.78	8.6	9.78	6.8	8.7	\$ for improving 1 car /year [management cost \$/year]
Cost for Enabling new Car Same type	150,000	100,000	160,000	140,000	140,000	\$ for each new model enabled [management cost \$/year]
Car already Enabled						
CA_01	Yes	Impossible	Yes	Impossible	Impossible	
CA_02	Yes	Impossible	Yes	Impossible	Impossible	
CA_03	Impossible	Impossible	Impossible	Yes	Impossible	
CA_04	Impossible	Yes	Impossible	Yes	Impossible	
CA_05	Yes	Impossible	Impossible	Yes	Impossible	
CA_06	Impossible	Impossible	Impossible	Yes	Impossible	
CA_07	Impossible	Impossible	Impossible	Impossible	Impossible	
CA_08	Impossible	Impossible	Impossible	Impossible	Impossible	

- Values of data in cells with a white background can be changed.

Note: Modifications to other data will not create any problems during the evaluation phase since output will be calculated from the models of the team of evaluators.



Production lines



Production Lines						Menu	
Line ID	Line DAE1	Line DAE2	Line B&S	Line A1	Line A2		
Car Type	Luxury	Compact	Luxury	Compact	Compact		
Site	PS_01	PS_01	PS_02	PS_03	PS_04		
Location	Pittsburgh	Pittsburgh	Clinton	Pocahontas	Florissant		
Initial Max Capacity	500,000	400,000	500,000	750,000	750,000	cars/year	
Productivity Increase	-	-	-	-	-	cars/year	
Theoretical Productivity	500,000	400,000	500,000	750,000	750,000		
Current Production	400,000	250,000	200,000	650,000	400,000	cars/year	
Productivity	80%	63%	40%	87%	53%		
Overall Efficiency	97%	97%	98%	94%	97%		
MTBF	19.0	16.0	19.0	31.0	31.0	weeks	
MTTR	1.4	1.2	1.4	2.2	2.0	days	
Cost for Improving Productivity	9.78	8.6	9.78	8.8	8.7	\$ for improving 1 car /year [management cost \$/year]	
Cost for Enabling new Cars same type	150,000	100,000	160,000	140,000	140,000	\$ for each new model enabled [management cost \$/year]	
Car already Enabled	Line DAE1	Line DAE2	Line B&S	Line A1	Line A2		
CA_01	Yes	Impossible	Yes	Impossible	Impossible		
CA_02	Yes	Impossible	Yes	Impossible	Impossible		
CA_03	Impossible		Impossible		Yes		
CA_04	Impossible	Yes	Impossible	Yes			
CA_05	Yes	Impossible		Impossible	Impossible		
CA_06	Impossible		Impossible	Yes			
CA_07	Impossible	Impossible		Impossible	Impossible		
CA_08	Impossible		Impossible				



Effective production



Effective Production					
					Menu
Productable Cars	PS_01 Pittsburgh	PS_02 Clinton	PS_03 Pocahontas	PS_04 Florissant	(excluded set not feasible)
CA_01 Car Frenchie	200000	100000	0	0	On line 1
CA_02 Car Mago	100000	100000	0	0	On line 1
CA_03 Car Panettone	0	0	0	400000	
CA_04 Car Edsil	250000	0	300000	0	On line 2
CA_05 Car Wolf	100000	0	0	0	On line 2
CA_06 Car Bertoz	0	0	350000	0	
CA_07 New Car Gabry	0	0	0	0	
CA_08 New Car Strega	0	0	0	0	
Effective Productivity	PS_01 Pittsburgh Line DAE1	PS_01 Pittsburgh Line DAE2	PS_02 Clinton Line B&S	PS_03 Pocahontas Line A1	PS_04 Florissant Line A2
	443263	250000	453895	654969	600565
CA_01 Car Frenchie	200,000		100,000	-	-
CA_02 Car Mago	100,000		100,000	-	-
CA_03 Car Panettone		-	-	-	400,000
CA_04 Car Edsil		250,000	-	300,000	-
CA_05 Car Wolf	100,000		-	-	-
CA_06 Car Bertoz		-	-	153,895	-
CA_07 New Car Gabry	-		-	-	-
CA_08 New Car Strega		-	-	-	-
Total	400,000	250,000	200,000	453,895	400,000
Use Coeff.	89%	70%	44%	69%	59%



Production mix



Production of cars

Menu

	PS_01 Pittsburgh	PS_02 Clinton	PS_03 Pocahontas	PS_04 Florissant	Production	
					Set	Required
CA_01 Car Frenchie	200,000	100,000			300,000	500,000
CA_02 Car Mago	100,000	100,000			200,000	200,000
CA_03 Car Panettone				400,000	400,000	400,000
CA_04 Car Edsil	250,000		300,000		550,000	550,000
CA_05 Car Wolf	100,000				100,000	100,000
CA_06 Car Bertoz			350,000		350,000	350,000
CA_07 New Car Gabry					-	200,000
CA_08 New Car Strega					-	150,000
	650,000	200,000	650,000	400,000	1,900,000	

Components of cars

CA_01 Car Frenchie	Components	Quantity	Components	Quantity
Type <i>Luxury</i>	Chassis_A	1		
	Tires_A	5		
	Engine_A	1		
	Console_A	1		
	Seats_A	4		
	Auto body		Steel_A	25 [yd]

Masterization	Dim	Masterization	a' totale
Quantity/Box		Box/Container	
1	3	40	40
10	2	35	350
1	1	56	56
2	1	38	76
2	1	80	160
540	3	3	1620



Suppliers and their production capacity



Suppliers					Menu						
Code	Site	Products			Capacity	Prices					
SUP_01	Batesville	Tires_A	Tires_B		3,500,000	Tires_A	20.00	Tires_B	25.00		
SUP_02	Carlinville	Steel_B			12,000,000	Steel_B	10.00				
SUP_03	Emporia	Console_A	Console_B	Console_C	2,000,000	Console_A	60.00	Console_B	64.00	Console_C	80.00
SUP_04	Emporia	Seats_B			8,000,000	Seats_B	42.00				
SUP_05	Jefferson City	Engine_A	Mix_A		1,500,000	Engine_A	120.00	Mix_A	85.00		
SUP_06	Jefferson City	Engine_A	Engine_B		1,800,000	Engine_A	115.00	Engine_B	100.00		
SUP_07	Jonesboro	Seats_A			4,000,000	Seats_A	45.00				
SUP_08	Joplin	Tires_A	Tires_B		3,500,000	Tires_A	22.00	Tires_B	24.00		
SUP_09	Muskogee	Engine_A			500,000	Engine_A	125.00				
SUP_10	Springfield	Seats_A			8,000,000	Seats_A	47.00				
SUP_11	Springfield	Steel_A	Steel_B		42,000,000	Steel_A	9.00	Steel_B	9.60		
SUP_12	St. Louis	Console_C			1,000,000	Console_C	75.00				
SUP_13	St. Louis	Mix_A			800,000	Mix_A	75.00				
SUP_14	Topeka	Tires_B			4,500,000	Tires_B	27.00				
SUP_15	Tulsa	Engine_B			500,000	Engine_B	105.00				
SUP_16	Carlinville	Chassis_A			600,000	Chassis_A	400.00				
SUP_17	St. Louis	Chassis_B			800,000	Chassis_B	550.00				
SUP_18	Springfield	Chassis_A	Chassis_B		1,200,000	Chassis_A	380.00	Chassis_B	500.00		



Supplier selection



Production Supply Chain
Menu

Production Site

PS_01 Pittsburgh ▼

Car Model

CA_02 Car Mago ▼

	Chassis	Tires	Engine	Console	Seats	Auto body	
	UpDate		(Mix)			Steel	
	Supplier	SUP_18 Sp ▼	SUP_14 To ▼	SUP_06 Je ▼	SUP_12 St ▼	SUP_04 En ▼	SUP_02 Ce ▼
Production 100000	Frequency	1.0	1.0	1.0	1.0	1.0	1.0
	Quantity	274	1,370	274	274	1,096	6,849
	Warehousing						
Calculate	Distance	233	22	146	99	99	263
	Transport No.	12	9	86	9	18	11

days
Items
Items
miles
Trucks



Supplier use

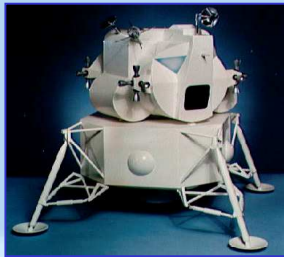


Supplier Capacity

Code	Site	Request	Value [\$]	Use Coef.		Delays Prob.
SUP 01	Batesville	3,269,474	191,168,421	93%	Tires	9%
SUP 02	Carlinville	8,750,000	17,500,000	73%	Steel	11%
SUP 03	Emporia	1,603,895	137,311,579	80%	Consoles	13%
SUP 04	Emporia	1,303,895	54,763,579	16%	Seats	8%
SUP 05	Jefferson City	600,000	57,500,000	40%	Engines	7%
SUP 06	Jefferson City	903,895	103,947,895	50%	Engines	4%
SUP 07	Jonesboro	400,000	12,800,000	10%	Seats	4%
SUP 08	Joplin	2,750,000	300,000,000	79%	Tires	6%
SUP 09	Muskogee	200,000	30,800,000	40%	Engines	4%
SUP 10	Springfield	-	-	0%	Seats	8%
SUP 11	Springfield	33,947,368	66,217,789	81%	Steel	11%
SUP 12	St. Louis	100,000	7,500,000	10%	Consoles	3%
SUP 13	St. Louis	-	-	0%	Engines	5%
SUP 14	Topeka	2,500,000	142,500,000	56%	Tires	6%
SUP 15	Tulsa	-	-	0%	Engines	6%
SUP 16	Carlinville	500,000	440,000,000	83%	Chassis	7%
SUP 17	St. Louis	350,000	420,000,000	44%	Chassis	8%
SUP 18	Springfield	853,895	981,978,947	71%	Chassis	4%



DISTANCE MAP



		Pittsburgh	Clinton	Pocahontas	Florissant	Batesville	Carlinsville	Emporia	Emporia	Jefferson City	Jefferson City	Jonesboro	Joplin	Muskogee	Springfield	Springfield	St. Louis	St. Louis	Topeka	Tulsa	Carlinsville	St. Louis	Springfield	St. Louis	Springfield	Batesville	Tulsa	Emporia	Kansas City
		PS_01	PS_02	PS_03	PS_04	SUP_01	SUP_02	SUP_03	SUP_04	SUP_05	SUP_06	SUP_07	SUP_08	SUP_09	SUP_10	SUP_11	SUP_12	SUP_13	SUP_14	SUP_15	SUP_16	SUP_17	SUP_18	DS_1	DS_2	DS_3	DS_4	DS_5	DS_6
Pittsburgh	PS_01	0	85	215	249	88	287	106	106	161	157	249	23	118	79	81	255	260	130	110	283	258	79	259	79	86	113	110	121
Clinton	PS_02	87	0	205	180	212	213	127	129	87	86	241	95	201	86	87	189	193	111	189	212	194	89	195	87	212	194	129	63
Pocahontas	PS_03	220	208	0	171	63	215	319	313	177	172	31	202	248	144	143	171	165	326	271	212	169	146	163	145	63	267	316	267
Florissant	PS_04	254	186	177	0	212	40	311	314	104	103	198	252	347	195	188	16	16	281	353	39	16	193	16	187	216	363	316	232
Batesville	SUP_01	89	211	63	215	0	251	298	309	192	192	56	181	208	134	134	211	210	317	238	258	207	136	210	133	0	244	297	279
Carlinsville	SUP_02	285	219	216	39	254	0	340	348	125	128	234	300	381	234	234	48	48	313	401	0	48	235	48	230	255	403	345	243
Emporia	SUP_03	107	127	313	304	299	336	0	0	216	214	357	128	184	172	174	313	317	55	151	344	324	172	326	178	305	152	0	104
Emporia	SUP_04	106	125	325	316	304	346	0	0	216	215	353	125	181	175	172	326	325	55	151	336	324	175	323	172	300	155	0	103
Jefferson City	SUP_05	163	86	175	102	195	128	215	217	0	0	204	156	265	109	113	104	105	194	270	126	102	110	104	113	193	274	220	134
Jefferson City	SUP_06	156	87	177	105	187	127	217	212	0	0	210	157	262	109	112	102	103	191	267	127	102	110	105	113	194	271	215	135
Jonesboro	SUP_07	251	237	32	203	56	243	351	356	204	203	0	226	249	169	166	192	193	347	301	235	187	167	189	165	54	293	351	304
Joplin	SUP_08	24	94	196	251	187	299	128	127	161	156	223	0	102	73	72	252	252	141	106	293	255	71	257	71	184	105	127	133
Muskogee	SUP_09	119	195	251	354	205	389	182	187	267	264	259	103	0	151	151	337	340	218	38	382	348	155	341	151	203	40	183	227
Springfield	SUP_10	78	89	141	190	135	231	177	175	109	109	171	71	150	0	0	191	192	186	170	228	187	0	188	0	133	166	176	151
Springfield	SUP_11	79	87	144	187	135	227	171	173	109	110	170	70	153	0	0	187	192	181	165	226	193	0	193	0	133	166	176	153
St. Louis	SUP_12	251	187	166	16	208	47	315	320	105	102	189	250	348	191	187	0	0	298	356	48	0	192	0	191	211	357	326	231
St. Louis	SUP_13	258	188	164	16	204	48	320	316	105	103	190	251	343	195	194	0	0	292	352	48	0	191	0	187	207	356	314	229
Topeka	SUP_14	129	109	318	288	317	304	56	57	190	192	357	142	223	181	179	292	294	0	203	309	302	181	301	186	311	196	55	55
Tulsa	SUP_15	109	191	274	352	238	396	154	150	273	269	291	104	39	164	166	364	364	197	0	395	367	170	361	165	234	0	151	215
Carlinsville	SUP_16	284	219	219	39	260	0	337	349	129	126	244	302	380	234	226	49	48	304	396	0	48	226	47	227	256	406	347	242
St. Louis	SUP_17	259	194	170	16	207	47	313	325	104	101	187	255	345	191	195	0	0	295	353	47	0	188	0	188	212	356	316	228
Springfield	SUP_18	80	85	145	190	137	232	174	176	110	110	168	72	150	0	0	190	190	184	170	232	193	0	192	0	136	164	178	153
St. Louis	DS_1	258	191	170	16	205	48	322	323	105	102	192	259	342	189	193	0	0	292	354	47	0	189	0	187	205	365	313	227
Springfield	DS_2	78	89	143	195	133	233	173	171	110	109	165	72	151	0	0	190	191	183	164	234	195	0	189	0	138	169	176	154
Batesville	DS_3	85	212	64	220	0	257	309	302	187	192	55	186	207	137	134	206	209	307	245	250	208	136	204	136	0	235	301	284
Tulsa	DS_4	113	188	272	365	239	392	153	151	265	267	293	105	39	167	170	360	353	200	0	397	359	170	357	167	237	0	148	219
Emporia	DS_5	109	128	325	304	309	346	0	0	219	220	356	126	187	178	176	320	324	55	154	345	319	174	325	177	305	150	0	104
Kansas City	DS_6	116	63	276	235	278	252	103	103	136	138	308	137	230	154	155	232	231	57	212	250	226	151	233	149	283	210	102	0

Distribution centers



Distributors

Menu

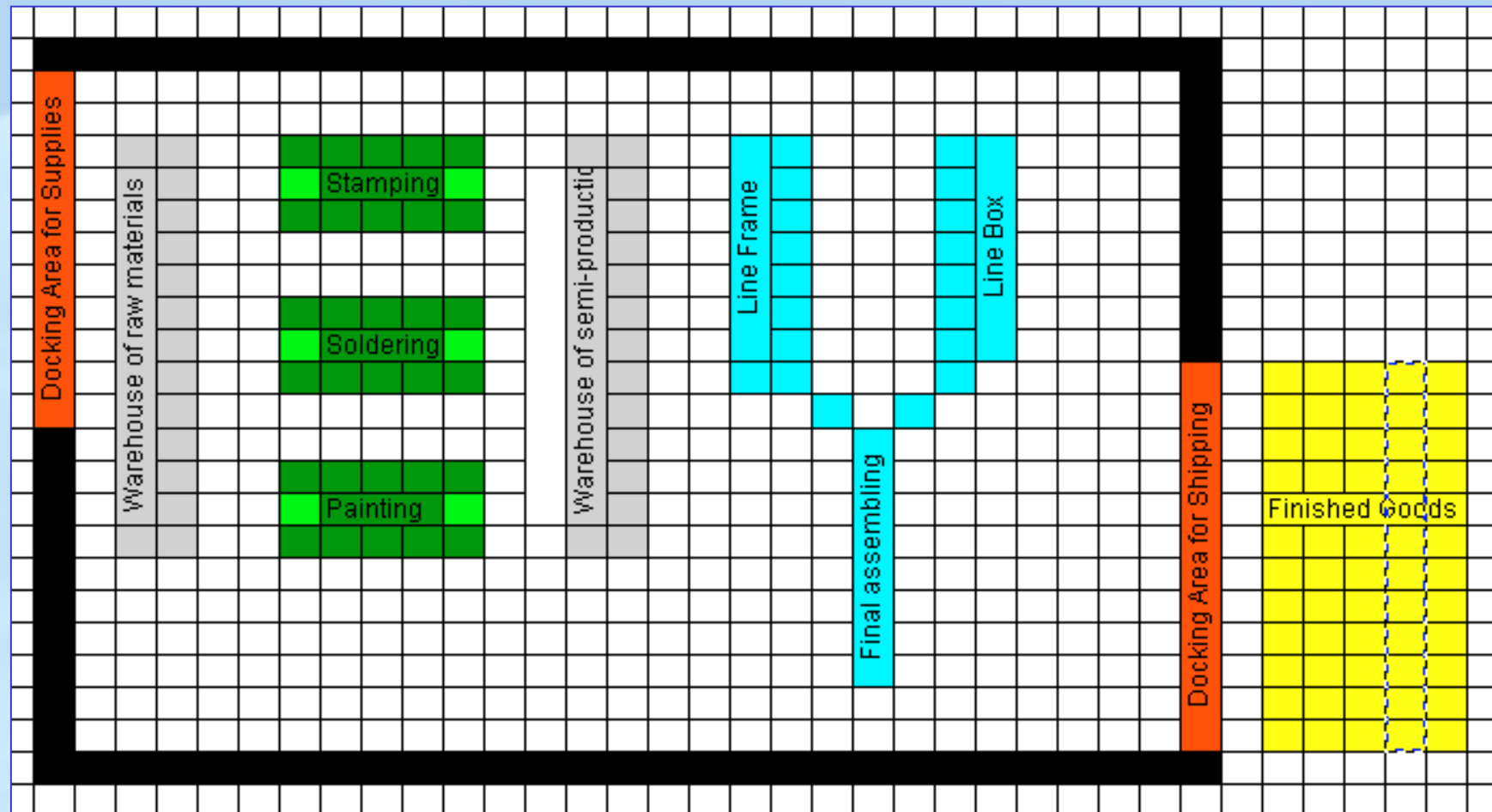
		CA_01	CA_02	CA_03	CA_04	CA_05	CA_06	CA_07	CA_08
		Car Frenchie	Car Mago	Car Panettone	Car Edsil	Car Wolf	Car Bertoz	New Car Gabry	New Car Strega
DS_1	St.Louis	150,000	100,000	70,000	140,000	50,000	100,000	100,000	55,000
DS_2	Springfield	20,000	10,000	60,000	80,000	5,000	40,000	20,000	20,000
DS_3	Batesville	10,000	10,000	90,000	60,000	2,500	30,000	5,000	10,000
DS_4	Tulsa	10,000	5,000	80,000	100,000	5,000	50,000	10,000	15,000
DS_5	Emporia	50,000	5,000	50,000	50,000	2,500	40,000	5,000	10,000
DS_6	Kansas City	60,000	70,000	50,000	120,000	35,000	100,000	60,000	40,000
		300,000	200,000	400,000	550,000	100,000	360,000	200,000	150,000

Demand Variability

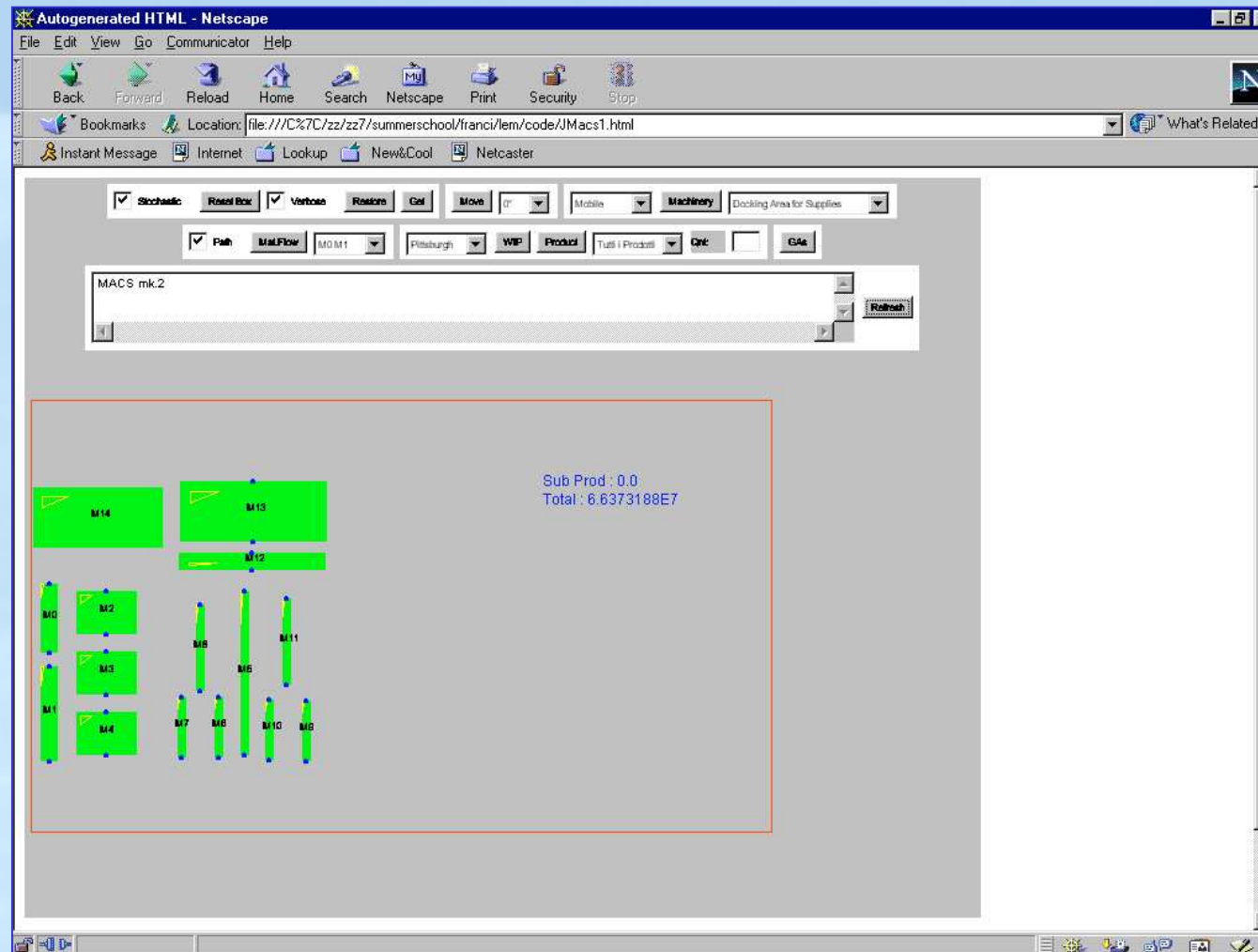
DS_1	St.Louis	10%
DS_2	Springfield	25%
DS_3	Batesville	25%
DS_4	Tulsa	15%
DS_5	Emporia	28%
DS_6	Kansas City	15%



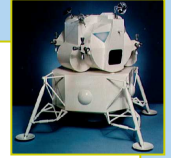
Production Cycle



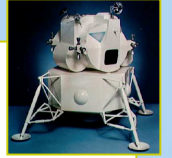
LEM Simulator



Process Cycle

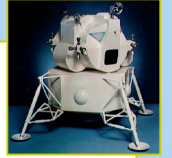


Production



- At each production site some lines are assigned to compact cars and some to luxury cars.
- The production capacity of each line could be increased.
- Enabling costs will automatically be included in the output if a new type of production is activated on non-enabled lines.

Suppliers



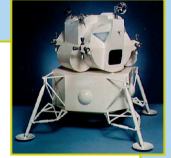
- Each production site can have only one supplier for a component for a type of car.
- Delivery delays are expressed as mean values considering negative exponential distributions.
- In the case of an overloaded supplier, components will be delivered but delivery delays will automatically be increased.

Distribution



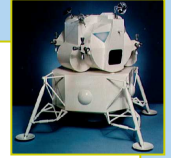
- Demand variability corresponds to the magnitude of a normal distribution expressed as a percentage with respect to the average value.
- If production is less than demand a non-revenue cost is assumed.
- In the case of a stockout with respect to demand, a 30% lost client rate is assumed.

Degrees of Freedom



Id	Var.Num.	Sheet	Description
1	5	<i>P_Lines</i>	Productivity Increase of each production line
2	32	2	Production of cars among the different production sites
3	24	<i>Dist. Sites</i>	Distribution of cars from production sites to distribution sites
4	48	<i>Dist. Sites</i>	Car storage in distribution sites
5	192	<i>PS</i>	Identification of the suppliers for each component of each site / car
6	192	<i>PS</i>	Component warehouse
7	1	<i>Summary</i>	Scenario
8	16	<i>Lay_{Site}</i>	Layout changes in each production site

Scenarios & LEM Awards

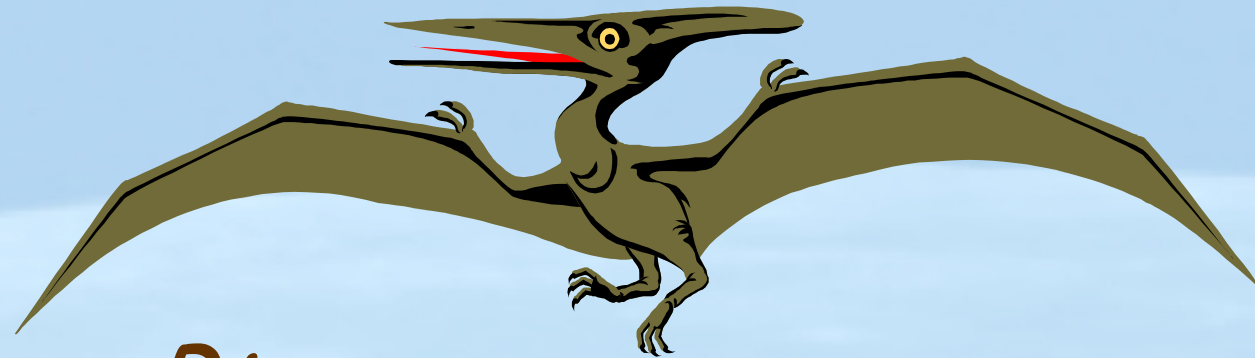


Each team must design the re-organization:

- **without considering the introduction of 2 new cars (Gabry and Strega)**
 - **considering the introduction of 2 new cars (Gabry 200,000 and Strega 150,000)**
-
- **To motivate the teams, winners will receive special awards.....**

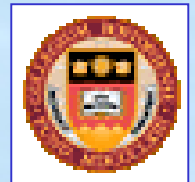


TEAM

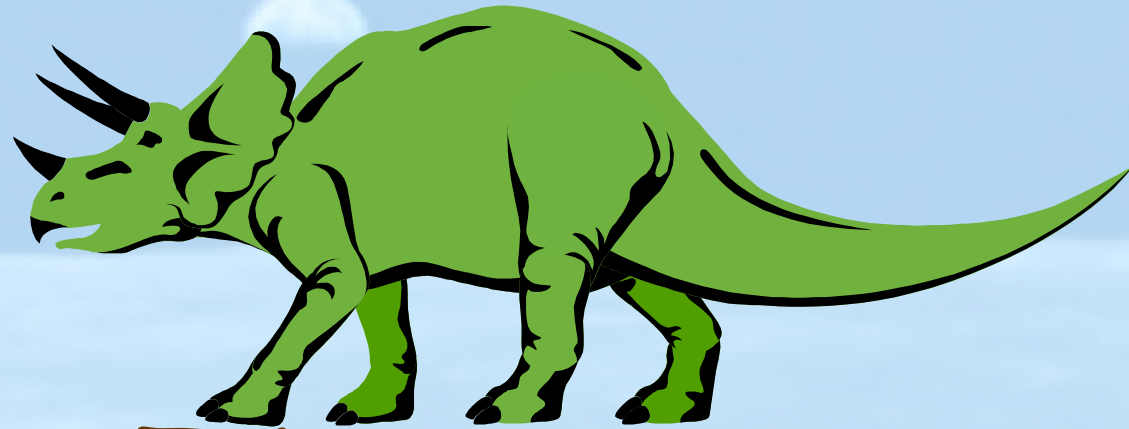


Pterosaurs

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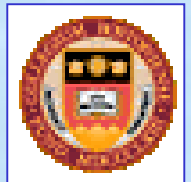


TEAM



Triceratops

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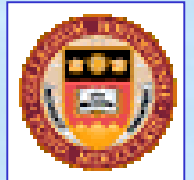


TEAM



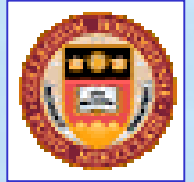
Tyrannosaurus rex

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Rabbits

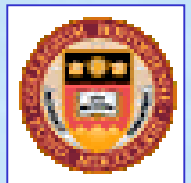
TEAM

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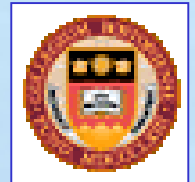
Hamsters

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Squirrels

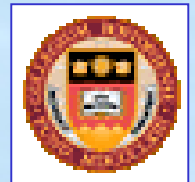
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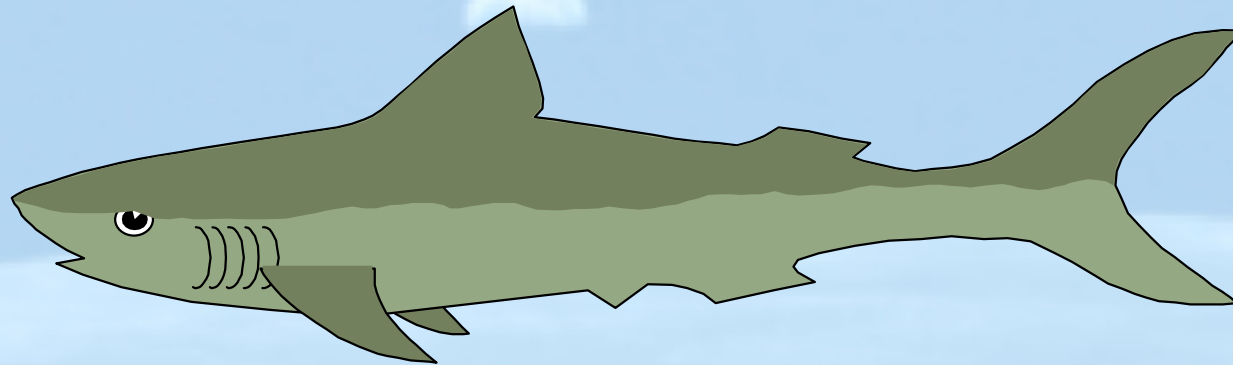


Seahorses

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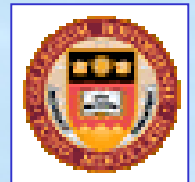


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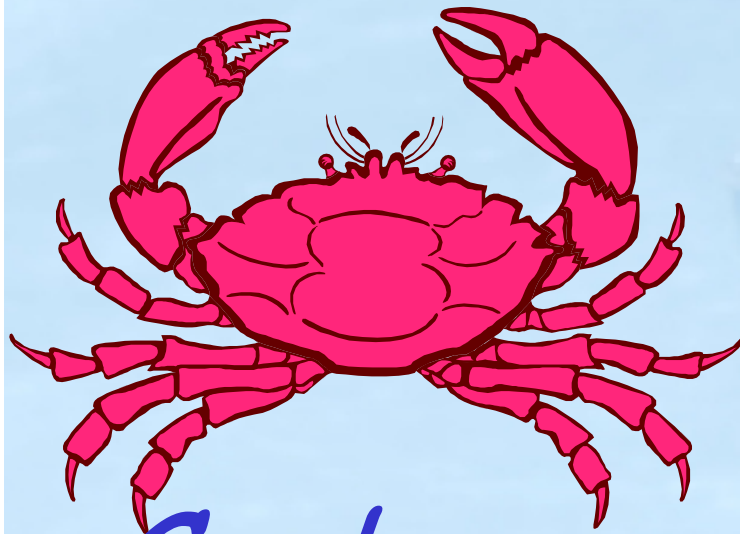
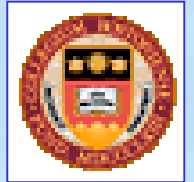
Sharks

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Crabs

TEAM

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