Northeastern University

School Of Engineering

MECHANICAL & INDUSTRIAL ENGINEERING DEPARTMENT

IE7200 Supply Chain Engineering

Partial Exam Project

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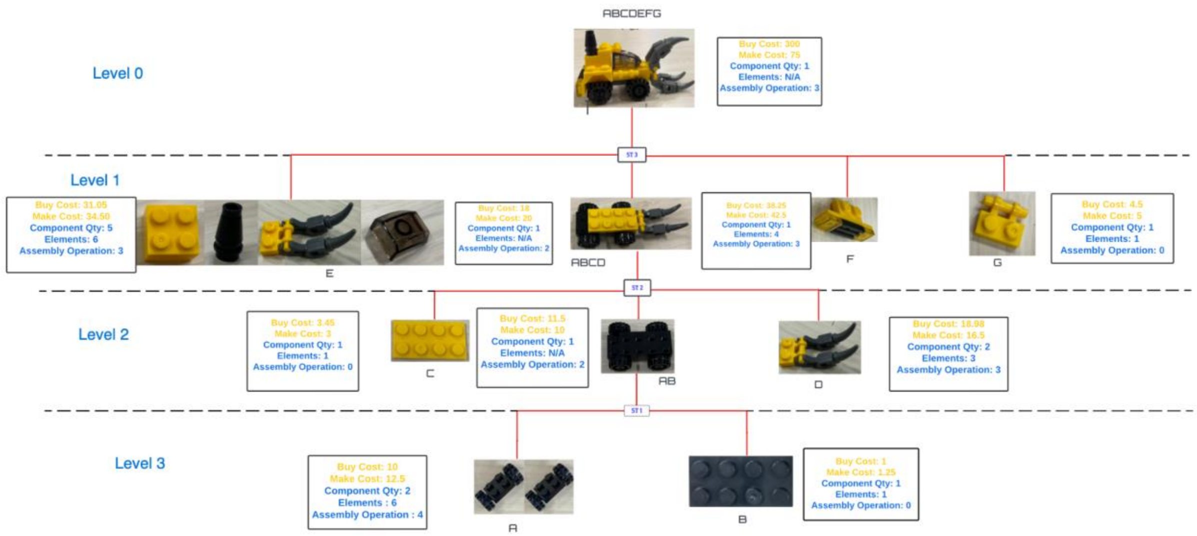
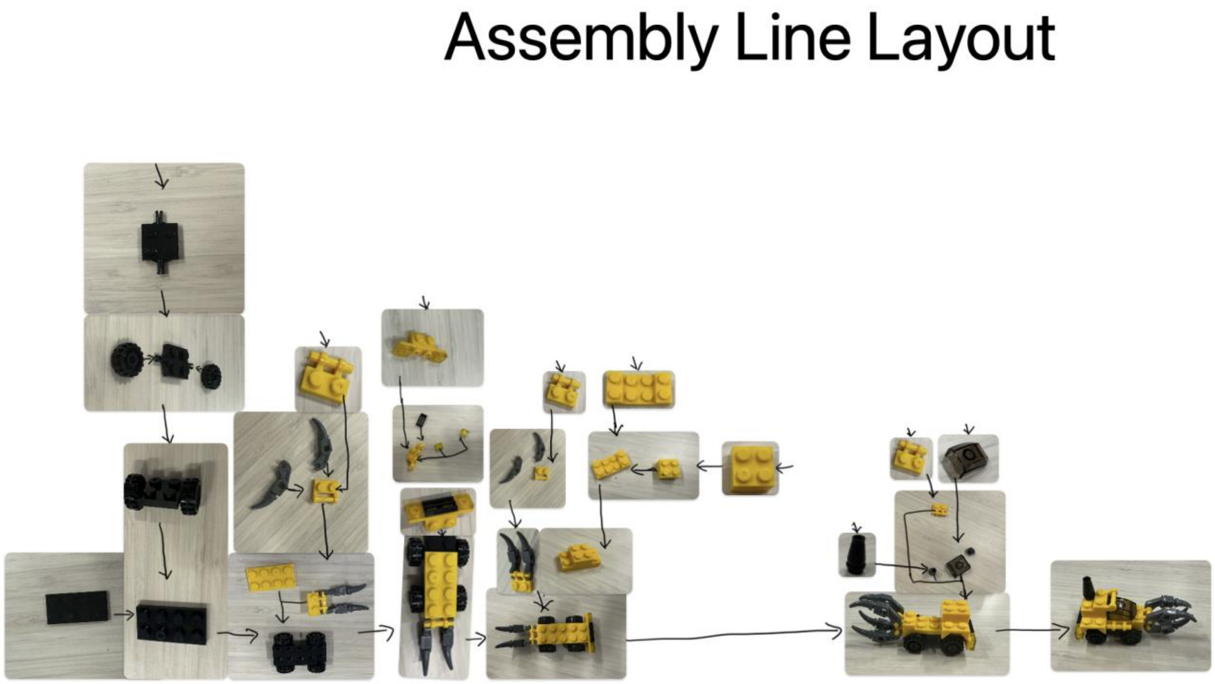
March 2024

1) **BOM Tree**



The image provides a detailed visual representation of a Bill of Materials (BOM) for a complex product, structured across several hierarchical levels. It illustrates the breakdown from the final product (Level 0) into its primary assemblies or sub-components at Level 1, further dissected into smaller components at Level 2, and down to the basic elements or individual parts at Level 3. Each component is listed with associated costs for buying and making, the quantity needed, and the number of assembly operations required. This structured approach highlights the interdependencies of components and provides insights into the cost optimization, assembly complexity, and inventory management needed to assemble the final product efficiently.

2) Assembly Line Layout



This image presents an assembly line layout for constructing a complex product, depicting the progression from individual components to the completed assembly. It illustrates a step-by-step process, showcasing how parts are methodically combined into subassemblies and ultimately integrated into the final product. The visual layout highlights the efficiency and organization of the assembly process, emphasizing the importance of a logical sequence in minimizing production time and ensuring quality. This modular approach not only aids in understanding the construction process but also enhances scalability and flexibility in manufacturing.

3) Lingo Code

Lingo Model – Lingo1.lng*

```
MODEL:
        SETS:
                TYPES/ ABCDEFG/: M,B,MP,BP,NEED;
                MATERIALS/ E,ABCD,F,G/: MM,MB,MMP,MBP;
                SUBMATS/ C,AB,D/: SMM,SMB,SMP,SBP;
                SUBSUBMATS/ A,B/: SSMM,SSMB,SSMP,SSBP;
                REQ(TYPES,MATERIALS):MATREQ;
                MREQ(MATERIALS,SUBMATS): SMATREQ;
                SREQ(SUBMATS, SUBSUBMATS):SSMATREQ;
        ENDSETS

        DATA:
                NEED = 1;
                MP = 291;
                BP = 300;
                MMP = 34.50 20 42.50 5;
                MBP = 31.05 18 38.25 4.5;
                SMP = 3 10 16.5;
                SBP = 3.45 11.5 18.98;
                SSMP = 12.5 1.25;
                SSBP = 10 1;
                MATREQ = 1 1 1 1;
                SMATREQ = 0 0 0
                          1 1 2
                          0 0 0
                          0 0 0;
                SSMATREQ = 0 0
                           2 1
                           0 0;
        ENDDATA

MIN = @SUM(TYPES : 1*MP + 0*BP) + @SUM(MATERIALS: MM * MMP + MB * MBP) + @SUM(SUBMATS: SMM * SMP + SMB * SBP) + @SUM(SUBSUBMATS: SSMM * SSMP + SSMB * SSBP); @FOR(TYPES: M + B = NEED);
@FOR(MATERIALS(I): MM(I) + MB(I)= @SUM(TYPES(J) : M(J) * MATREQ(J, I)));
@FOR(SUBMATS(I) : SMM(I) + SMB(I) = @SUM(MATERIALS(J): MM(J) * SMATREQ(J, I)));
@FOR(SUBSUBMATS(I):SSMM(I) + SSMB(I) = @SUM(SUBMATS(J): SMM(J) * SSMATREQ(J,I)));
END
```

Variable	Value	Reduced Cost
M(ABCDEFG)	0.000000	0.000000
B(ABCDEFG)	1.000000	0.000000
MP(ABCDEFG)	291.0000	0.000000
BP(ABCDEFG)	300.0000	0.000000
NEED(ABCDEFG)	1.000000	0.000000
MMP(E)	34.50000	0.000000
MMP(ABCD)	20.00000	0.000000
MMP(F)	42.50000	0.000000
MMP(G)	5.000000	0.000000
MBP(E)	31.05000	0.000000
MBP(ABCD)	18.00000	0.000000
MBP(F)	38.25000	0.000000
MBP(G)	4.500000	0.000000
SMP(C)	3.000000	0.000000
SMP(AB)	10.00000	0.000000
SMP(D)	16.50000	0.000000
SBP(C)	3.450000	0.000000
SBP(AB)	11.50000	0.000000
SBP(D)	18.98000	0.000000
SSMP(A)	12.50000	0.000000
SSMP(B)	1.250000	0.000000
SSBP(A)	10.00000	0.000000
SSBP(B)	1.000000	0.000000
MATREQ(ABCDEFG, E)	1.000000	0.000000
MATREQ(ABCDEFG, ABCD)	1.000000	0.000000
MATREQ(ABCDEFG, F)	1.000000	0.000000
MATREQ(ABCDEFG, G)	1.000000	0.000000
SMATREQ(ABCD, C)	1.000000	0.000000
SMATREQ(ABCD, AB)	1.000000	0.000000
SMATREQ(ABCD, D)	2.000000	0.000000
SSMATREQ(AB, A)	2.000000	0.000000
SSMATREQ(AB, B)	1.000000	0.000000

The screenshots from a LINGO optimization analysis reveal that manufacturing a product in-house is more cost-effective than purchasing it. The LINGO output highlights key variables indicating the costs associated with both manufacturing and buying the product, with manufacturing emerging as the cheaper option. The detailed model script outlines the optimization problem, aiming to minimize the total cost of production. This analysis supports a strategic decision towards in-house production to reduce expenses and enhance profit margins, demonstrating the value of optimization tools in evaluating production strategies and making informed business decisions.

4) Excel - Make or Buy Decision Sheet

		Buy		Make					
Component	Qty.	Cost	Total	Cost	Total	Minimum	Decision		
A	2	10.00	20.00	12.50	25.00	20.00	Buy A	21.00	==> AB
B	1	1.00	1.00	1.25	1.25	1.00	BuyB		
		Buy		Make					
Component		Cost	Total	Cost	Total	Minimum	Decision		
AB	1	11.50	11.50	10.00	10.00	10.00	Make AB	29.50	==> ABCD
C	1	3.45	3.45	3.00	3.00	3.00	Buy C		
D	1	18.98	18.98	16.50	16.50	16.50	Make D		
		Buy		Make					
Component		Cost	Total	Cost	Total	Minimum	Decision		
ABCD	1	18.00	18.00	20.00	49.50	18.00	Make ABCD	216.50	==> ABCDEFG
E	5	31.05	155.25	34.50	172.50	155.25	Buy E		
F	1	38.25	38.25	42.50	42.50	38.25	Buy F		
G	1	4.50		5.00	5.00	5.00	Make G		
		Buy		Make					
Component		Cost	Total	Cost	Total	Minimum	Decision		
ABCDEFG	1	300.00	300.00	75.00	291.50	291.50	Buy ABCDEFG		

Component	Qty.	# Elements	# Assy Operations	Raw Material Cost	Total	Assy Operation Cost	Total	Make Cost Total	Make Cost Total/Component
A	2	6	4	1.25	15	2.5	10	25	12.5
B	1	1	0	1.25	1.25	2.5	0	1.25	1.25
Component		# Elements	# Assy Operations	Raw Material Cost	Total	Assy Operation Cost	Total	Make Cost Total	Make Cost Total/Component
AB	1	NA	2	NA		5	10	10	10
C	1	1	0	3	3	5	0	3	3
D	2	3	3	3	18	5	15	33	16.5
Component		# Elements	# Assy Operations	Raw Material Cost	Total	Assy Operation Cost	Total	Make Cost Total	Make Cost Total/Component
ABCD	1	NA	2	NA		10	20	20	20
E	5	6	3	5	150	7.5	22.5	172.5	34.5
F	1	4	3	5	20	7.5	22.5	42.5	42.5
G	1	1	0	5	5	7.5	0	5	5
Component		# Elements	# Assy Operations	Raw Material Cost	Total	Assy Operation Cost	Total	Make Cost Total	Make Cost Total/Component
ABCDEFG	1	NA	3	NA		25	75	75	75

The provided cost analysis tables offer a detailed comparison between the costs of buying and making various components for assembling a final product. Each table breaks down the costs for individual components, combined components (assemblies), and the entire product, including the cost to buy, cost to make, and the total cost associated with each option. Decisions based on the minimum cost between buying and making indicate the most cost-effective approach for each component and assembly. The analysis concludes that manufacturing the product in-house is more economical than purchasing it pre-assembled, demonstrating the significance of a thorough cost evaluation in optimizing production costs and efficiency.

5) **Conclusion**

Based on the analysis presented across these images, it is evident that manufacturing the product in-house is cheaper than purchasing it pre-assembled or buying its components off-the-shelf. The detailed breakdown and optimization model highlight how strategic decisions on whether to buy or make components can lead to significant cost savings. This, in turn, can enhance profit margins by reducing the overall cost of production. The decision-making process is underpinned by a thorough analysis of each component's cost implications, assembly operations required, and the efficiency of the production workflow. This analysis exemplifies the importance of meticulous cost evaluation and production planning in manufacturing. By choosing to manufacture components in-house when it is cost-effective, and only purchasing those that are cheaper to buy, a company can optimize its production process. This strategy not only reduces expenses but also allows for greater control over the production timeline, quality of the components, and ultimately, the final product's market readiness and profitability.