ENGG*3070 – Assignment No. 3 (Due Nov 10, 2021, 11:59 Dropbox)

Multiple Stations

1. A six-station dial indexing machine is designed to perform four assembly operations at stations 2 through 5 after a base part has been manually loaded at station 1. Station 6 is the unload station. Each assembly operation involves the attachment of a component to the existing base. At each of the four assembly stations, a hopper-feeder is used to deliver components to a selector device that separates components that are improperly oriented and drops them back into the hopper. The system was designed with the operating parameters for stations 2 through 5 as given in the table below. It takes 2 sec to index the dial from one station position to the next. When a component jam occurs, it takes an average of 2 min to release the jam and restart the system. Line stops due to mechanical and electrical failures of the assembly machine are not significant and can be neglected. The foreman says the system was designed to produce at a certain hourly rate, which takes into account the jams resulting from defective components. However, the actual delivery of finished assemblies is far below that designed production rate. Analyze the problem and determine the following: (a) The designed average production rate that the foreman alluded to. (b) What is the proportion of assemblies coming off the system that contain one or more defective components? (c) What seems to be the problem that limits the assembly system from achieving the expected production rate? (d) What is the production rate that the system is actually achieving? State any assumptions that you make in determining your answer.

Station	Assembly time	Feed rate f	Selector θ	q	m
2	4 sec	32/min	0.25	0.01	1.0
3	7 sec	20/min	0.50	0.005	0.6
4	5 sec	20/min	0.20	0.02	1.0
5	3 sec	15/min	1.0	0.01	0.7

Single Station

2. A single-station assembly cell uses an industrial robot to perform a series of assembly operations. The base part and parts 2 and 3 are delivered by vibratory bowl feeders that use selectors to insure that only properly oriented parts are delivered to the robot for assembly. The robot cell performs the elements in the table below (also given are feeder rates, selector proportion θ, element times, fraction defect rate q, and probability of jam m, and, for the last element, the frequency of downtime incidents p). In addition to the times given in the table, the time required to unload the completed subassembly is 4 sec. When a line stop occurs, it takes an average of 1.8 min to make repairs and restart the cell.

Determine (a) yield of good product, (b) average hourly production rate of good product, and (c) uptime efficiency for the cell? Assume the feeders continue to operate and deliver parts into the feed track even when a jam occurs during assembly and the low-level quantity n_{f1} is sufficient to eliminate possibility of a stockout. (d) Solve the problem again assuming the feeder stops when jam occurs.

Element	Feed rate f	Selector θ	Element	Time T_e	q	m	p
1	15 pc/min	0.30	Load base part	4 sec	0.01	0.6	
2	12 pc/min	0.25	Add part 2	3 sec	0.02	0.3	
3	25 pc/min	0.10	Add part 3	4 sec	0.03	0.8	
4			Fasten	3 sec			0.02

Partial Automation

3. A partially-automated production line has three mechanized and three manual workstations, a total of six stations. The ideal cycle time is 57 sec, which includes a transfer time of 3 sec. Data on the six stations are listed in the table below. Cost of the transfer mechanism is \$0.10/min, cost to run each automated station is \$0.12/min, and labor cost to operate each manual station is \$0.17/min. It has been proposed to substitute an automated station in place of station 5. The cost of this new station is estimated at \$0.25/min and its breakdown rate = 0.02 per cycle, but its process time would be only 30 sec, thus reducing the overall cycle time of the line from 57 sec to 36 sec. Average downtime per breakdown of the current line, as well as for the proposed configuration, is 3.0 min. Determine the following for the current line and the proposed line: (a) hourly production rate, (b) proportion uptime, and (c) cost per unit. Assume that when an automated station stops, the whole line stops, including the manual stations. Also, in computing costs, neglect material and tooling costs.

Station	Type	Process time	p_i
1	Manual	36 sec	0
2	Automatic	15 sec	0.01
3	Automatic	20 sec	0.02
4	Automatic	25 sec	0.01
5	Manual	54 sec	0
6	Manual	33 sec	0

4. Reconsider Problem 4 except that both the current line and the proposed line will have storage buffers before and after the manual stations. The storage buffers will be of sufficient capacity to allow these manual stations to operate independently of the automated portions of the line. Determine (a) production rate, (b) proportion uptime, and (c) cost per unit for the current line and the proposed line.

Group Technology

5. he following table lists the weekly quantities and routings of ten parts that are being considered for cellular manufacturing in a machine shop. Parts are identified by letters and machines are identified numerically. For the data given, (a) develop the part-machine incidence matrix, (b) apply the rank order clustering technique to the part-machine incidence matrix to identify logical part families and machine groups, and (c) for each machine group identified, apply the Hollier method to determine the most logical sequence of machines for this data.

Part	Weekly quantity	Machine routing
A	50	$3 \rightarrow 2 \rightarrow 7$
B	20	$6 \rightarrow 1$
C	75	$6 \rightarrow 5$
D	10	$6 \rightarrow 5 \rightarrow 1$
E	12	$3 \rightarrow 2 \rightarrow 7 \rightarrow 4$
F	60	$5 \rightarrow 1$
G	5	$3 \rightarrow 2 \rightarrow 4$
H	100	$3 \rightarrow 2 \rightarrow 4 \rightarrow 7$
I	40	$2 \rightarrow 4 \rightarrow 7$
J	15	$5 \rightarrow 6 \rightarrow 1$