Logo, company name

Description automatically generated

COURSE TITLE: **ADDITIVE MANUFACTURING AND PRODUCTION SYSTEMS**

GUIDED BY – Prof. ALBERTO BOSCHETTO

**EXERCISE 3**

**PART\_B FLEXIBLE ASSEMBLY SYSTEMS**

**GROUP NUMBER: 10**

|  |  |
| --- | --- |
| VARUN YASHWANT RASALKAR | **1921452** |
|  |  |
|  |  |

A picture containing projector

Description automatically generated

Diagram

Description automatically generated

|  |  |  |
| --- | --- | --- |
| **Data Given** | **Values** | **units** |
| **Da**: Annual Demand | **155000** | parts/year |
| **W**: working weeks in a year | **45** | weeks/year |
| **S**: number of shifts in one week | **10** | shifts/week |
| **H**: number of hours in one shift | **8** | hours/shift |
| **Tr**: repositioning time | **12** | sec |
|  | **0.2** | min |
| **η**: Availability | **0.95** |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Formulae** | **Rp**: Production Rate = | **Da/(W\*S\*H)** | parts/hours |
| **Tc**: Cycle Time = | **60\*η/Rp** | min |
| **Ts**: Station time = | **Tc - Tr** | min |
| **w\***: Number of workers = | **roundup(Twc/Tc)** | workers |
| **Application** | **Rp** | **43** | parts/hours |
| **Tc** | **1.33** | min |
| **Ts** | **1.13** | min |
| ***w\**** | **4** | workers |

Chart, waterfall chart

Description automatically generated

Figure: exploded view of the gearbox to be assembled with components numbered.

Diagram, schematic

Description automatically generated

Figure: Priority Graph of gearbox assembly

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Operation** | **Description** | **Tek (s)** | **Tek (min)** | **RWPi (min)** |
|  |
|  |
| 1 | positioning of p.11 | 16 | 0.27 | 4.86 |  |
| 2 | insertion of p.12 in p.11 | 18 | 0.3 | 1 |  |
| 3 | insertion of peg p.13 in p.12 | 12 | 0.2 | 0.7 |  |
| 4 | insertion of shim p.14 on p.15 | 12 | 0.2 | 0.7 |  |
| 5 | insertion of p.15 in p.12 | 30 | 0.5 | 0.5 |  |
| 6 | positioning of p.10 | 11 | 0.18 | 1.6 |  |
| 7 | insertion of p.10 in p.11 | 12 | 0.2 | 1.42 |  |
| 8 | positioning of p.9 | 11 | 0.18 | 1.99 |  |
| 9 | insertion of p.9 in p.11 | 12 | 0.2 | 1.81 |  |
| 10 | insertion of p.8 on p.9 | 8 | 0.13 | 1.61 |  |
| 11 | insertion of p.7 on p.9 | 8 | 0.13 | 1.48 |  |
| 12 | insertion of p.6 on p.9 | 8 | 0.13 | 1.35 |  |
| 13 | positioning of p.5 | 10 | 0.17 | 1.22 |  |
| 14 | insertion of p.5 on group 1 | 15 | 0.25 | 1.05 |  |
| 15 | insertion of peg p.4 in p.5 | 8 | 0.13 | 0.8 |  |
| 16 | insertion of p.3 on p.5 | 10 | 0.17 | 0.67 |  |
| 17 | insertion of shim p.2 on p.1 | 12 | 0.2 | 0.7 |  |
| 18 | insertion of p.1 in p.5 | 30 | 0.5 | 0.5 |  |
|  | ***Sum Total (Twc)*** | ***243*** | ***4.04*** |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **LARGEST CANDIDATE RULE METHOD** | | | | |
|  |
| **s** | **i** | **Os** | **∑Tek** | **Ω** |  |
| 1 | 0 | {} | 0 | {1,4,17} |  |
| 1 | {1} | 0.27 | {2,4,17,6,8} |  |
|  | {1,2} | 0.57 | {4,17,3,6,8} |  |
|  | {1,2,4} | 0.77 | {17,3,6,8} |  |
|  | **{1,2,4,17}** | **0.97** | {3,6,8} |  |
| 2 | 0 | {} | 0 | {3,6,8} |  |
| 1 | {3} | 0.2 | {5,6,8} |  |
|  | {3,5} | 0.7 | {6,8} |  |
|  | {3,5,6} | 0.88 | {7,8} |  |
|  | **{3,5,6,7}** | **1.08** | {8} |  |
| 3 | 0 | {} | 0 | {8} |  |
| 1 | {8} | 0.18 | {9} |  |
|  | {8,9} | 0.38 | {10} |  |
|  | {8,9,10} | 0.51 | {11} |  |
|  | {8,9,10,11} | 0.64 | {12} |  |
|  | {8,9,10,11,12} | 0.77 | {13} |  |
|  | **{8,9,10,11,12,13}** | **0.94** | {14} |  |
| 4 | 0 | {} | 0 | {14} |  |
| 1 | {14} | 0.25 | {15} |  |
|  | {14,15} | 0.38 | {16} |  |
|  | {14,15,16} | 0.55 | {18} |  |
|  | **{14,15,16,18}** | **1.05** | {} |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **RANKED POSITIONAL WEIGHTS METHOD** | | | | |
|  |
| **s** | **i** | **Os** | **∑Tek** | **Ω** |  |
| 1 | 0 | {} | 0 | {1,4,17} |  |
| 1 | {1} | 0.27 | {8,6,2,4,17} |  |
|  | {1,8} | 0.45 | {9,6,2,4,17} |  |
|  | {1,8,9} | 0.65 | {10,6,2,4,17} |  |
|  | {1,8,9,10} | 0.78 | {6,11,2,4,17} |  |
|  | {1,8,9,10,6} | 0.96 | {11,7,2,4,17} |  |
|  | **{1,8,9,10,6,11}** | **1.09** | {7,12,2,4,17} |  |
| 2 | 0 | {} | 0 | {7,12,2,4,17} |  |
| 1 | {7} | 0.2 | {12,2,4,17} |  |
|  | {7,12} | 0.33 | {13,2,4,17} |  |
|  | {7,12,13} | 0.5 | {14,2,4,17} |  |
|  | {7,12,13,14} | 0.75 | {2,15,4,17} |  |
|  | **{7,12,13,14,2}** | **1.05** | {15,4,17,3} |  |
| 3 | 0 | {} | 0 | {15,4,17,3} |  |
| 1 | {15} | 0.13 | {4,17,3,16} |  |
|  | {15,4} | 0.33 | {17,3,16,5} |  |
|  | {15,4,17} | 0.53 | {3,16,5,18} |  |
|  | {15,4,17,3} | 0.73 | {16,5,18} |  |
|  | **{15,4,17,3,16}** | **0.9** | {5,18} |  |
| 4 | 0 | {} | 0 | {5,18} |  |
| 1 | {5} | 0.5 | {18} |  |
|  | **{5,18}** | **1** | {} |  |

|  |  |  |
| --- | --- | --- |
| **Ranked Positional Weights Rule** | | |
| **s** | **Os** | **∑Tek** |
| 1 | {1,8,9,10,6,11} | **1.09** |
| 2 | {7,12,13,14,2} | 1.05 |
| 3 | {15,4,17,3,16} | 0.9 |
| 4 | {5,18} | 1 |

|  |  |  |
| --- | --- | --- |
| **Largest Candidate Rule** | | |
| **s** | **Os** | **∑Tek** |
| 1 | {1,2,4,17} | 0.97 |
| 2 | {3,5,6,7} | **1.08** |
| 3 | {8,9,10,11,12,13} | 0.94 |
| 4 | {14,15,16,18} | 1.05 |

|  |  |
| --- | --- |
| Formula for Balancing Efficiency **Eb =** | **Twc/w\*Ts'** |

**Ts'**= Max of ∑Tek from largest candidate rule and ranked positional rule

|  |  |
| --- | --- |
| Eb for Largest Candidate Rule |  |
| **Eb** | **0.94** |
|  |  |
| Eb for Ranked Positional Rule |  |
| **Eb** | **0.93** |

While analyzing Line balancing, we select Ranked Positional Method and its station and process.

The two methods have given similar efficiencies. So, the selection of the assembly method is based on preference and the factory layout already in existence.