IE 469 Manufacturing Systems

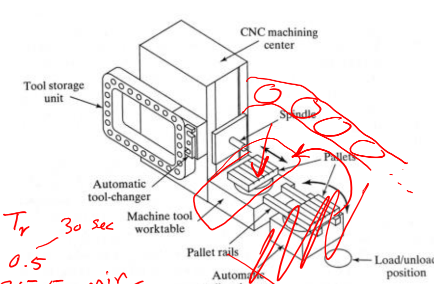
Chapter 14 Tutorial

Parts Storage and Multitasking Machines

14.1 **(A)** A CNC machining center has a programmed cycle time of 25.0 min for a certain part. The time to unload the finished part and load a starting work unit = 5.0 min. (a) If loading and unloading are done directly onto the machine tool table and no automatic storage capacity exists at the machine, what are the cycle time and hourly production rate? (b) If the machine tool has an automatic pallet changer so that unloading and loading can be accomplished while the machine is cutting another part, and the repositioning time = 30 sec, what are the total cycle time and hourly production rate? (c) If the machine tool has an automatic pallet changer that interfaces with a parts storage unit whose capacity is 12 parts, and the repositioning time = 30 sec, what are the total cycle time and hourly production rate? Also, how long does it take to perform the loading and unloading of the 12 parts by the human worker, and what is the time the machine can operate unattended between parts changes?

(a) no pallet changer: $T_c = T_m + T_s$
$= 25 + 5$
$T_c = 30 \ \frac{min}{pc}$

$R_c = \frac{1}{T_c} = \frac{1}{30} \times 60 = \frac{60}{30} = 2 \ \frac{pc}{hr}$



(b) pallet changer: $T_c = Max(T_m, T_s) + T_r$ 30 sec
$= Max(25, 5) + 0.5$
$= 25 + 0.5 = 25.5 \ \frac{min}{pc}$

$R_c = \frac{1}{25.5} \times 60 = 2.35 \ pc/hr$

(c) $T_c = Max(25, 5) + 0.5$

$= 25.5 \ min/pc$

$R_c = \frac{1}{25.5} \times 60 = 2.35 \ pc/hr$

Time to load/unload = 12(5) = 60 min

$UT = n_p T_c - 60 = 12(25.5) - 60$

$= 306 - 60 = 246 \ min = 4.1 \ hr$

Determining Workstation Requirements

14.4 **(A)** A total of 9000 stampings must be produced in the press department during the next three days. Manually operated presses (one operator per press) will be used to complete the job and the cycle time is 24 sec. Each press must be set up with a punch-and-die set before production starts. Setup time is 2.0 hr, and availability is assumed to be 100%. How many presses and operators must be devoted to this production during the three days, if there are 7.5 hr of available time per machine per day?

$n = \frac{WL}{AT}$

$WL = \underbrace{9000\left(\frac{24}{60}\right)}_{\text{(production)}} + \underbrace{2(60)\,n}_{\text{setup}} = 3600 + 120\,n = 60 + 2n \ (hr)$

$AT = 3(7.5) = 22.5 \ hr$

$n = \frac{60 + 2n}{22.5}$

$22.5\,n = 60 + 2n$

$20.5\,n = 60$

$n = \frac{60}{20.5} = 2.93 \rightarrow$ round up to 3 presses & operators

14.8 A plastic extrusion plant will be built to produce 30 million meters of plastic extrusions per year. The plant will run three 8-hr shifts per day, 360 days/yr. For planning purposes, the average run length = 7500 meters of extruded plastic. The average changeover time between runs = 3.5 hr and average extrusion speed = 15 m/min. Assume scrap rate = 1%, and average uptime proportion per extrusion machine = 95% during run time and 100% during changeover. If each extrusion machine requires a floor area of 2 m by 25 m, and there is an allowance of 40% for aisles and office space, what is the total area of the extrusion plant?

$A = n\,(2\times 25)(1+0.4)$

$n = \dfrac{WL}{AT}$

WL : production : $WL = \dfrac{30{,}000{,}000}{15(60)\,(1-0.01)} = 33\,670\ \dfrac{hr}{yr}$

$AT = 3(8)(360)(0.95) = 8208\ hr/yr$

changeover : no. of changeovers $= \dfrac{30{,}000{,}000}{7500} = 4000$ runs

$WL = 4000(3.5) = 14{,}000\ \dfrac{hr}{yr}$

$AT = 3(8)(360) = 8640\ \dfrac{hr}{yr}$

$n = \dfrac{33\,670}{8208} + \dfrac{14000}{8640} = 4.1 + 1.62$

$= 5.72 \rightarrow$ ru to 6 machines

$A = 6\,(2\times 25)(1+0.40)$

$= 420\ m^2$

Machine Clusters

14.13 **(A)** The CNC grinding section has a large number of machines devoted to grinding shafts for the automotive industry. The grinding cycle takes 3.6 min and produces one part. At the end of each cycle an operator must be present to unload and load parts, which takes 40 sec. (a) Determine how many grinding machines the worker can service if it takes 20 sec to walk between the machines and no machine idle time is allowed. (b) How many seconds during the work cycle is the worker idle? (c) What is the hourly production rate of this machine cluster?

(a) $n = \dfrac{T_m + T_s}{T_s + T_r} = \dfrac{3.6(60) + 40}{40 + 20} = \dfrac{256}{60} = 4.27 = 4$

(b) $IT_w = 256 - 4(40 + 20) = 256 - 240 = 16 \text{ sec}$

(c) $T_c = 256 \text{ sec} = 4.267 \text{ min}$

$R_c = \left(\dfrac{1}{4.267}\right)(60)(4) = 56.25 \text{ pc/hr}$

14.14 A worker is currently responsible for tending two machines in a machine cluster. The service time per machine is 0.35 min and the time to walk between machines is 0.15 min. The machine automatic cycle time is 1.90 min. If the worker's hourly rate = \$12/hr and the hourly rate for each machine = \$18/hr, determine (a) the current hourly rate for the cluster, and (b) the current cost per unit of product, given that two units are produced by each machine during each machine cycle. (c) What is the percent idle time of the worker? (d) What is the optimum number of machines that should be used in the machine cluster, if minimum cost per unit of product is the decision criterion?

(a) $C_o = 12 + 2(18) = \$48/\text{hr}$

(b) $T_c = T_m + T_s = 1.9 + 0.35 = 2.25 \text{ min/cycle}$

$R_c = \left(\dfrac{1}{2.25}\right) \times 60 \times 2 \times 2 = 106.67 \text{ pc/hr}$

$c_{pc} = \dfrac{48}{106.67} = \$0.45/\text{pc}$

(c) $T_w = 2(0.35 + 0.15) = 1 \text{ min}$

$IT_w = T_c - T_w = 2.25 - 1 = 1.25$

$\% IT_w = \dfrac{1.25}{2.25} = 0.555 = 55.5\%$

(d) $n = \frac{T_m + T_s}{T_s + T_r} = \frac{1.9 + 0.35}{0.35 + 0.15} = \frac{2.25}{5} = 4.5$ machine

$n_1 = 4 \qquad C_{pc} = ?$

$n_2 = 5 \qquad C_{pc} = ?$

→ $n_1 = 4 \qquad C_{pc}(n_1) = \left(\left(\frac{C_L}{n_1} + C_m\right)(T_m + T_s)\right) / 2$

we divided by 2 because two units are produced by each machine in a cycle

$C_{pc}(4) = \$0.394/pc$ ✓

$n_2 = 5 \qquad C_{pc}(n_2) = \left((C_L + C_m n_2) T_s + T_r\right) / 2$

$= \$0.425/pc$

$\therefore \quad n = n_1 = 4$