11.3 (a)
13.2

Cycle time = 33.0 + 5.0 = 38.0 sec

Tool change time = \( \frac{3.0}{30} \times 60 = 6.0 \) sec/piece

Average production time = 38.0 + 6.0 = 44.0 sec/piece

The hourly production rate with consideration of uptime efficiency is

\[
R_p = \frac{3600}{44} \times (1 - 0.03 - 0.02) = 77.7 \text{ pieces/hr}
\]

13.3

Cycle time = 5.5 + 33.0 + 4.8 + 1.7 = 45.0 sec

Tool change time = 6.0 sec/piece

Average production time = 45.0 + 6.0 = 51.0 sec/piece

The hourly production rate for two machine tools with consideration of the robot and machine tool uptime efficiency is

\[
R_p = \frac{3600}{51} \times 2 \times 0.97 \times 0.98
\]

\[= 134.2 \text{ pieces/hr}\]