

IE 469 Industrial Robotics and Applications

Session 2: Comparisons between robots and fixed automation

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Case 1: Assembly of Liquid Level Monovial

Early manufacturing: (fig. 3.1)

- Orienting and placing the vials in bench fixtures
- Initiating the filling cycle
- Removing from the filling station and transferring to the ultrasonic welding station
- Orienting and loading of plastic cap and then initiating weld cycle
- Unloading of completed assemblies
- Loading into waiting containers

One operator → 15s → \$10,000 per year



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Case 1: Assembly of Liquid Level Monovial

Option 1:

Two robots, with orienting vibratory feeders for the two plastic parts, could be programmed such that

- one handled the filling operation
- the other took care of the welding station

→ **Capital investment costs \approx \$30,000**

→ **Production rate: one monovial every 6 seconds**



Case 1: Assembly of Liquid Level Monovial

Option 2: (figs. 3.2, 3.3 and 3.4)

Fixed automation was proposed to handle the assembly on a six-station, rotary index table machine

- a rate of 32 assemblies per minute
- or 1.87 seconds for each assembly

→ **Capital investment costs \approx \$50,000**



Case 1: Assembly of Liquid Level Monovial

Manual economic comparisons

To achieve a yearly total of two million assemblies

- ♣ six operators were used (labor cost \$60,000)
- ♣ material cost (\$0.015 per assembly)
- ♣ factory cost ($\$0.015 + \$0.03 = \$0.045$ per assembly)
- ♣ maintenance and capitalization of hand fixtures (\$0.005)
- ♣ giving a total factory cost of \$0.05 per assembly



Case 1: Assembly of Liquid Level Monovial

Option 1: Two robots

- ♣ 10 units per minute with two robots
- ♣ running for eight hours (usually seven hours for operator)
- ♣ turning out 2,400,000 assemblies on a two-shift basis (250 working days)
- ♣ assuming capitalization of the entire cost over five years
- ♣ cost per assembly \approx \$0.032 or saving \$43,200 per year



Case 1: Assembly of Liquid Level Monovial

Option 1: Fixed automation

- ♣ 32 assemblies per minute
- ♣ or 1,920 per hour
- ♣ on single-shift (five-day week), at 100-percent efficiency, this would produce about 3,840,000 assemblies
- ♣ capitalizing the equipment over its 10-year life would produce manufacturing costs of \$0.018 per assembly
- ♣ or a total saving of \$122,880 per year



Case 2: Tending Die-Casting Machines

Option 1: General-Purpose robot (fig. 3.5)

- ♣ one robot, centrally positioned between the two die-casting machines and the trim press
- ♣ the robot can be programmed to handle all three operations
- ♣ after each die-cast operation is completed, the robot would remove the casting from the machine and place it into the trim press for trimming
- ♣ the trimmed part is then removed from the trim press by the robot and deposited in the gondola container



Case 2: Tending Die-Casting Machines

- labors alone cost $6 \times \$11,000 = \$66,000$ (2-shift basis)
- payback $25,000 / (66,000 - 3,000) = 0.4$ year
- return on investment = Cash Flow / Investment
= (Yrly. Wages – Yrly. Depreciation) / Investment
- $(63,000 - 5,000) / 25,000 = 230\%$
- present value of future earnings = (earning)(present value factor)
= $\$63,000 \times 3.256$
= $\$205,000$



Case 2: Tending Die-Casting Machines

Option 2: Fixed automation

- ♣ the conventional press unloaders and handling devices for this application may need to redesign every year
- ♣ three machines would be required plus transfer conveyors and orienting devices
- ♣ this system costs around \$60,000
- ♣ yearly retooling for each new part is estimated to be \$12,000
- ♣ maintenance costs are comparable to the robot at \$3,000 per year



Case 2: Tending Die-Casting Machines

- payback = $60,000 / (66,000 - 3,000) = 0.95$ year
- return on investment
 - = $(66,000 - 3,000 - 12,000 - 12,000) / 60,000$
 - = 65%
- present value of future earnings
 - = $(66,000 - 3,000 - 12,000)(3.256)$
 - = \$166,000

