PMMDA GUIDE TO ROBOTS

Guide to Robots

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Introduction

This document has been compiled by the PMMDA to provide general information on Robot types and applications. People unfamiliar or with varying degrees of Robot experience will find this guide a useful aid in selecting the correct type of Robot for an application. Benefits, justifications and grippers are also covered.

Application of Robots

Robots are ideally suited to applications involving repetitive, cyclic operations. The Robot will ensure consistent cycle times and will always accurately follow the programmed paths. Inspection of parts can be carried out by vision, weight and check stations, which signal to the Robot production of good or bad parts. The Robot will continue it's normal path for good parts and can be programmed to follow a different path for rejects. Robots are equipped with counters, which are used to count parts packed/placed or rejected.

Ease of program and gripper changes allow even short production runs to be automated.

Typical Mould Shop Applications

Insert loading mould and post moulding.
Part orientation
Printing/labelling/decoration.
De-gate parts from sprues
Separate cavities e.g. left from right handed parts
Clean room operations
Adhesive applications
Palletising/packing.
Welding/heat staking.
Unmanageable parts due to weight/heat/environment
Inspection
Assembly
Routing

Benefits in Automating a Moulding Machine

To ensure consistent cycle times when compared to a machine running in semi-auto or using an operator.
Added value via secondary operations.
Minimise mould open time
Prevent damage and contamination to mouldings when ejected whilst running a fully automatic cycle.
Increased productivity
Predictability in production timings.
Labour deployment
New Business
Produce parts to higher specification
Operator safety e.g. repetitive strain injury.
Reduce mould wear and damage
Reduced labour costs.
Improved quality, reject reduction
Company Image
Faster cycle times.
15-20% increase in good parts

Financial Justification

The U.K. investment in automation lags behind many of it's European neighbours, who are reaping the benefits of a reduction in labour costs, increase in quality and quantity. Many indirect cost savings are sometimes overlooked: such as losing supplier status due to defect parts, the time and effort wasted when full deliveries are returned due to one defective moulding and the gaining of a new customer who is aware that automation ensures he gets the best price and quality.

Even when some labour is used the indirect benefits mentioned, are of extremely high value. In the majority of cases the pay back time for a robot can be less than one year.

Robot Types (Mechanical Structure)

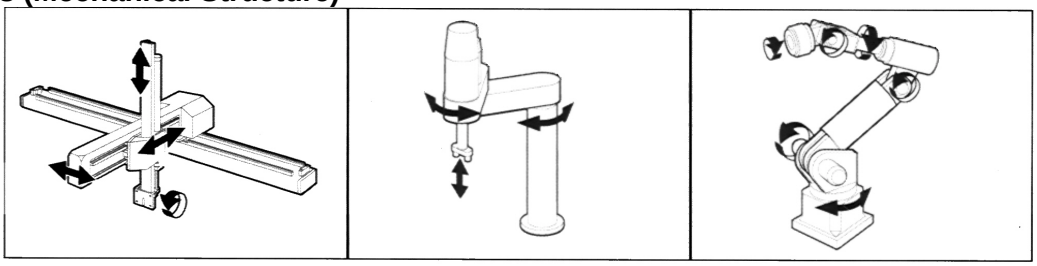

Fig.1 CARTESIAN ***Fig.2 SCARA*** ***Fig.3 ARTICULATED***

1. **Cartesian Robot** - also known as beam or gantry. Always with linear axes, horizontal, vertical and de-mould. Usually specified with 1 or more rotational axis. Mounting of the Robot is normally platen or floor fixing.
   Access to the mould is normally top or side entry. Mouldings are generally deposited at the rear/front or end of the moulding machines. Fig.1, NB. Cartesian Robots can be equipped with a second vertical arm for sprue removal from 3 plate tools.
   Sprue Pickers - used for part/sprue separation
2. **Scara Robots** - Robots whose arms have two parallel rotary joints to provide compliance in a plane (can have from three to five axis). Fig. 2.
3. **Articulated Robots** - Generally used in automation cells e.g. glueing, spraying, welding and assembly.
   Occasional use on moulding machines. Fig. 3

Press/Robot Interface - Euromap 12

To simplify and standardise the interface between moulding machine and the Robot, a standard interface has been developed, this interface is called Euromap 12.

To enable a handling device (Robot) to run efficiently and moreover safely, it is necessary that a EUROMAP 12 interface is fitted to the moulding machine. Certain signals must be exchanged between the moulding machine and the Robot during the moulding cycle. E.g. mould open confirmation, or core and ejector function.

The Robot Interface cable terminates in a standard 32pin Harting Plug (16pin+16 pushes) which simply connects to the mating socket on the moulding machine when fitted with Euromap 12.

Most moulding machine suppliers offer this Robot Interface.

The scope of Euromap 12 interface goes beyond the exchange of signals and also specifies the electrical connections of the Robot. The only note of caution is that the interface specifies 400VAC Three Phase Cekon socket mounted to the machine. Some more simple manipulators and sprue pickers require only a single-phase supply.

Other Interfaces

An interface similar to the foregoing description is always necessary, there is however another type of interface that is available. This interface has the name of EUROMAP 17, which enables the microprocessor control of the moulding machine to communicate with the microprocessor of other peripheral equipment, including robots.

It enables the programs of the peripheral equipment to be stored and recalled from the moulding machine controller. It also enables certain information from the peripherals to be transferred to the screen of the machine, such as error messages.

The interface gives a higher level of integration between the Robot and moulding machine.

EUROMAP 17 is not a substitute for EUROMAP 12, which is essential to enable the machine and robot to operate together.

The fixing holes for mechanically attaching the Robot to the press are defined by EUROMAP 18.

End of Arm Tooling (EOAT) - Points for Consideration

What to consider when selecting/designing End of Arm Tooling

1. Rigidity desires, weight and size of moulding
2. Is the component freely ejected etc. see 9 below.
3. Suitable materials of vacuum pads and gripping fingers to be non marking and heat resistant
4. Location of gripping areas on moulding i.e. stability and non marking of products.
5. Accuracy of repeatability of picking position
6. Method of retaining moulding i.e. vacuum pads, mechanical gripping etc.
7. Does the EOAT require additional facility for sub-gates and/or cutting of sprues on the end of arm tooling.
8. What type of component detection is required for moulding and/or runners.
9. Is the moulding to be transferred into a secondary operation /packaged. Is the moulding EOAT suitable for this
10. Is the component to be removed from the fixed or moving half of the tooling.
11. Are the required service obtainable from the robot i.e. number of vacuum circuits, number of gripping circuits input/output, electrical and pneumatic control, lifting capacity.
12. Are the components freely ejected. Do the components sit on ejectors/fall etc.
13. Ensure sufficient mould daylight available
14. Suitable ejection/core sequence
15. Keep weight of EOAT to a minimum
16. Consider time for EOAT operation.

Common Terms Associated with EOAT

Grippers & fingers
Vacuum Pads/cups
Spring mounted vacuum pads/cups.
Quick release
Universal end of arm tooling
Component detection - Vacuum controls - photo cell - limited switch
Sprue grip
Degating
Insert loading/over moulding
Label insertion
Dedicated end of arm tooling

Type of Drives and Controls

Typical characteristics of the popular Drives and Controls.
The table over provides some general guidance on the broad characteristics of the different types of drives and controls available on the market.

PLC - Programmable Logic Controller is capable of carrying out basic sequences. Positions are normally manually set by mechanical end stops and limit switches.

CNC - Computer Numerical Control is freely programmable and allows complex sequences to be carried out. CNC Robots are ideally suited to secondary operations. Feed back is normally by encoders giving position and speed information. Multi programme storage and recall is via 3½" disk.

	PNEUMATIC +PLC	INDUCTION +CNC	SERVO MOTOR +CNC
Speed	Average	Average/fast	Fast
Positioning	Damped end stops	+/- 0.1mm	+/- 0.1mm
Power Consumption	Low	Average	Average
Air Consumption	High	Low	Low
Operating Noise	High	Average	Average
Reliability	Good	Good	Good
Ease of Setting	Manual	Easy	Easy
Flexibility	Low	High	High
Price	Low Cost	Medium	Medium/High

Robot Guarding

This is best left to the Robot supplier, who will supply the mechanical guarding, lightbeams/pressure mats and interlocks to ensure safe operation of the Robot system, in accordance with The Supply of Machinery (Safety) Regulations 1992.

The mechanical guarding can be supplied in various forms and combinations, the most common being welded box frame in-filled with mesh or polycarbonate. Aluminum profile is often used for the frame work.

C E Marking

The CE mark does not guarantee equipment is safe, it merely confirms that the equipment complies with the relevant European Standards. When a Robot is used in conjunction with other machinery such as a moulding machine and can not be on it's own, a certification of incorporation is issued by the supplier.

It is the responsibility of the system user or customer to nominate the responsible person, who maybe one of the suppliers, the user themselves or a third party company qualified to undertake this type of conformity assessment.

Basic Considerations on Robot Selection

Before a robot or system can be specified, the robot supplier has to consider the following:

Moulding machine type and size.
Number of impressions.
Height restrictions/cranes etc.
Sprues to collect.
De-gate required.
Part size and weight.
Unloading position -front/rear.
Secondary operations
Cycle Time.

The following table shows Robot selection for varying applications.

Considerations on Robot Selection

TASK	Pneumatic PLC	Induction Motor + CNC	Servo Motor + CNC
Moulding machines:			
Up to 250t Clamp	YES	YES	YES
250-1000t Clamp	NO	YES	YES
1000-4000t Clamp	NO	YES	YES
Sprue Picker	YES	NO	NO
Low cost basic part removal to one defined position.	YES	NO	NO
Low cost basic part removal to two defined positions.	YES	NO	NO
Removal to several positions on each axis.	NO	YES	YES
High Speed minimum mould opening time.	NO	NO	YES
Dual action grippers for insert loading + part removal	NO	YES	YES
Simultaneous controlled axis movement.	NO	YES	YES
Robot moving with Moulding Machine platen.	NO	YES	YES
Weights up to 10 Kg	YES	YES	YES
Weights above 10Kg	NO	YES	YES
Extended axis travel	NO	YES	YES
Multi Tasking Systems with up and down stream equipment controlled by robot.	NO	YES	YES

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