

## Application Solutions Case Study

### Clean Room Robot

Featured Product – Whistle 15/60

Integrated solution for rapid and precise motion



**Elmo**  
Motion Control  
[www.elmomc.com](http://www.elmomc.com)

*The challenge:  
high power  
drives in a small  
space*

## The Requirement: Small Size, High Power

Elmo's Whistle drives are intelligent, high power and compact drives. This case study shows how one of our customers, a large automation and robotics company, used them for a clean room robot application. This paper will interest you if you would like to:

- Get up to 3.3 kW peak power using a matchbox sized servo drive.
- Place your drive almost anywhere on your machine.
- Minimize your development time, resulting in short time-to-market.

## Clean Room Robot – Four Axes in a Limited Space

Our customer was requested to build a robot that transfers LCD panels in a clean room. The application presented several challenges:

- Smooth, fast movement – requires a drive that supplies enough power and has great motion control abilities.
- Small size – as described below, much of the available space is taken by other parts of the system.
- Good connectivity – the smart drive enabled quick and easy customization.
- High reliability – clean rooms are expensive, so downtime is not tolerated.

## Machine Description

The product in which Elmo's **Whistle** drives have been integrated is an advanced robot that moves items very rapidly and places them with great precision. The robot is integrated into the workflow of automated machinery where LCD (Liquid Crystal Display) flat panels are manufactured in a clean room environment. The small LCD screens are used in a wide variety of products, such as smart mobile phones, PDAs (personal digital assistant) and Game Boys, etc.

The advanced robot is produced by a large semiconductor company that specializes in automatic production machinery for clean rooms.

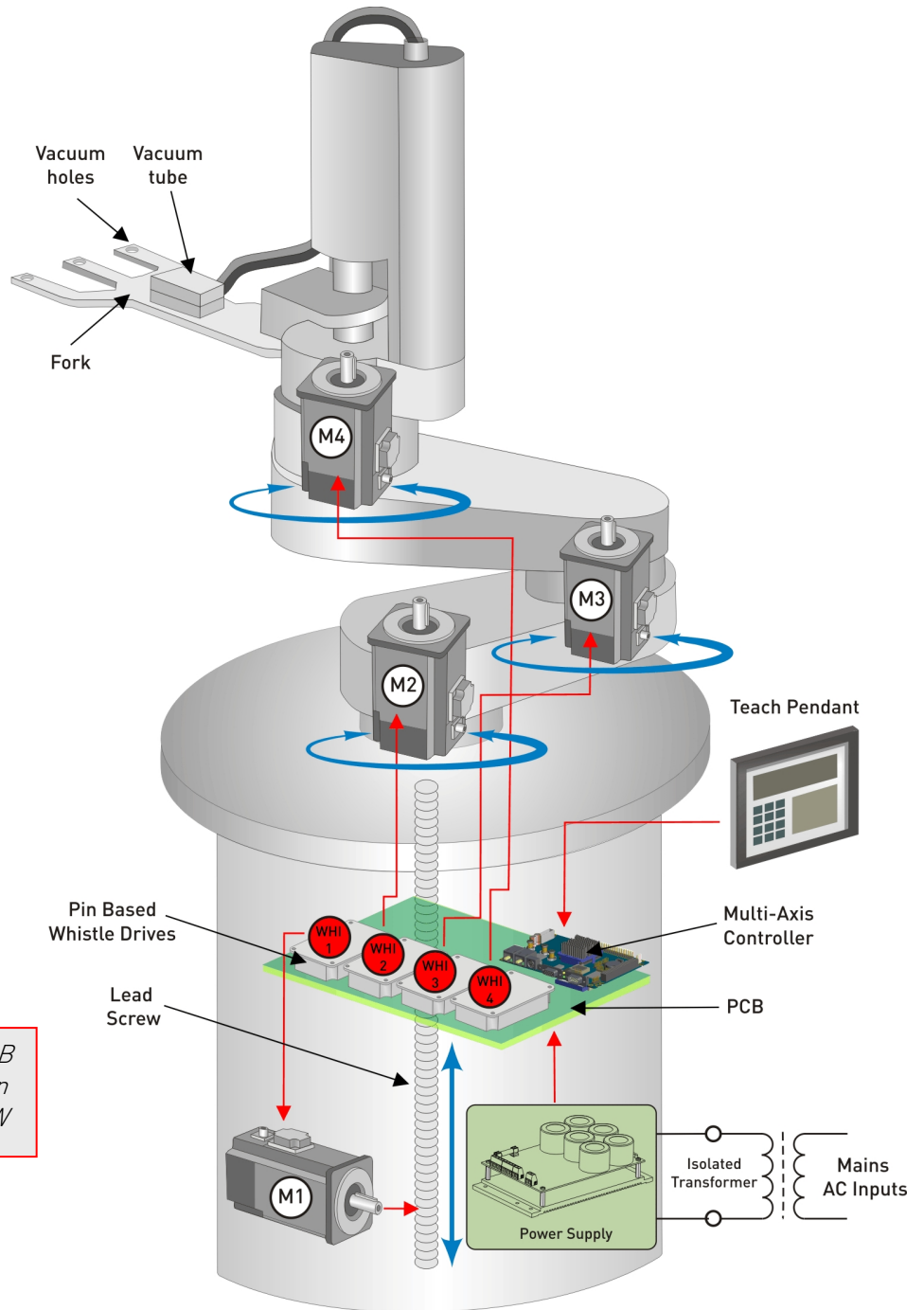
During production, the LCD flat panels go through several processes that are carried out by different parts of the automatic clean room machinery. The robot transfers the LCD screens and "feeds" them into the machine.

The robot has four degrees of freedom (DOF) with a multi-jointed arm; three of the joints enable the robot to move to the desired position in the plane and the fourth – a central shaft – extends its movements to three dimensions.

*Clean room robot must perform smooth, high velocity motion, with no faults.*

Precision, accuracy and speed are essential features that are required in this application.

The following diagram describes the structure of the robot which consists of three joints and arms, one up/down lead screw joint that is used to transfer rotary movement into linear movement, the robot's "hand" and "fingers", and an outer casing in which the drives, multi-axis controller, power supplies and all the electronics are located.



*Matchbox sized, PCB mountable drive can provide up to 3.3 KW*

Figure 1: Schematic of the robot

## Challenges

The robotics team had a number of design challenges, some of which are inherent in the requirements and some that arose during implementation.

- Limited space: The size of the robot's casing is fixed and cannot be altered, since it is part of a large clean room machine. Therefore, compact drives with a small footprint are essential in the application's solution.
- Accuracy and fast movement define the final throughput of the machine.
- Reliable drives with a minimal failure rate and high MTBF(Mean time between failures)
- The robot works as part of a machine that runs continuously for 24 hours a day, seven days per week. Any downtime in the process is very costly for the customer.
- Integration of the drives as part of a multi-axis motion control system must be easy and simple. This significantly reduces the time and cost of R&D.
- The robot requires three digital outputs: (1) Alarm, (2) Servo On/Off and (3) Brake.

## Elmo's Solution: PCB-mounted Drives

The robot has a flat "hand" that is attached to the end point of the last joint of the arm. It consists of three broad, flat "fingers" and each "finger" has a small vacuum hole that enables it to hold a single LCD flat screen and transfer it safely into the station. The robot's function is to slide the hand underneath three LCD screens that are ready to undergo the next stage in the production process, and transfer them from a rack into the next station in a fast, smooth and accurate manner.

Four pin-based **Whistle** drives are integrated into a single PCB (Printed Circuit Board) designed by the customer. A centralized, multi-axis controller is integrated on the same PCB and it sends Pulse and Direction commands to the drives. A teach pendant is used to communicate with the multi-axis controller via an RS-232 communication channel. At the beginning, the user "teaches" the robot how to move to the desired end points in space by programming and sending commands from the teach pendant to the multi-axis controller. The multi-axis controller calculates separately the motion trajectories required for each axis. When these trajectories are synchronized and coordinated, they enable the robot to automatically move to any position in the space.

*Our experienced engineers will help you get it right the first time.*

The **Whistle** digital drive was chosen for this application, due to its compact size. It is PCB-mounted and as such has the ability to integrate into the joints of the robotic arm.



**Whistle Intelligent Digital Servo Drive**

The **Whistle** is very compact, measuring just 55 x 15 x 46.5 mm.

Four WHI-15/60s were chosen to be installed in the robot.

The **Whistle** drives are designed to perform with high reliability and to meet the demands of the most rigorous industrial applications. The production of the LCD panels and the operation of the clean room environment make any downtime very costly. Elmo's high MTBF (Mean time between failures) drives significantly contribute to this requirement.

A peak current of 30 A can be delivered to enable high acceleration of the robotic arm during its initial movement. The drives are able to deliver the LCD screens in a very precise and smooth movement due to Elmo's advanced motion control algorithms that are implemented in the drives. Elmo's proprietary Composer software is used to program the **Whistle** and enable the robot to perform the precise tasks that require smooth movement.

There is very limited space in the casing of the robot for the PCB (drives and multi-axis controller), z-axis lead screw and gear box, power supplies, transformer and cables, etc. Elmo's compact and high power drives were essential in the implementation in order to keep the space needed to a minimum.

Simple and fast integration of Elmo's pin-based **Whistle** drive on the PCB were essential for keeping the engineering development time to a minimum.

The unbalanced vertical axis was controlled and tuned by Elmo's up/down **Whistle** drive using special output for controlling an external Brake.

A special version of firmware was developed for this application in order to use the auxiliary encoder pins as an extra digital output.

Elmo's team of support and implementation engineers is able to work with the customer at all stages of design and implementation in order to identify engineering solutions to issues that arise.

## Why Elmo

- Compact, pin-based, PCB-mounted products that have a small footprint.
- High power density and intelligence within a small package.
- Dedication of support engineers to the successful implementation of solutions.
- Fast, precise and smooth motion control.
- High reliability in demanding industrial environments.
- Ease of integration into industrial robotics.
- Standard communication protocols.

For more information on Elmo:

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