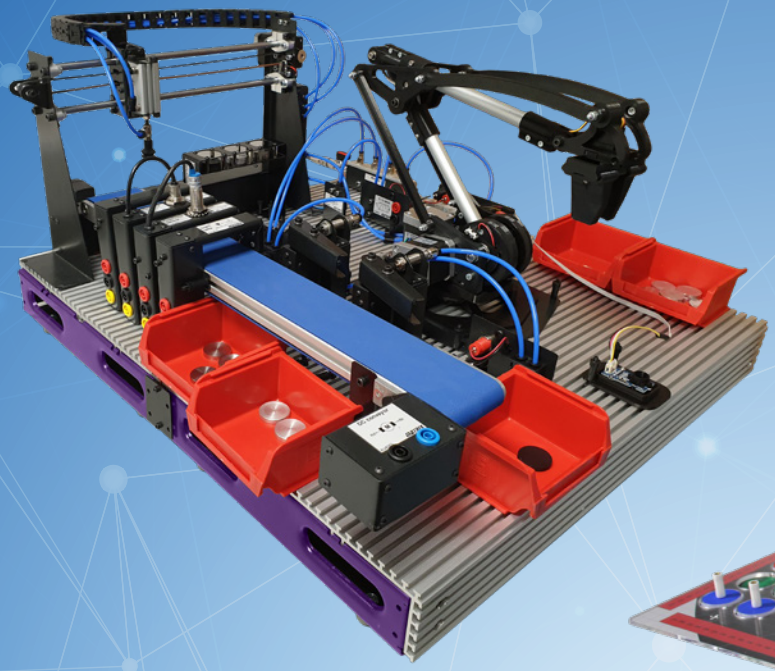
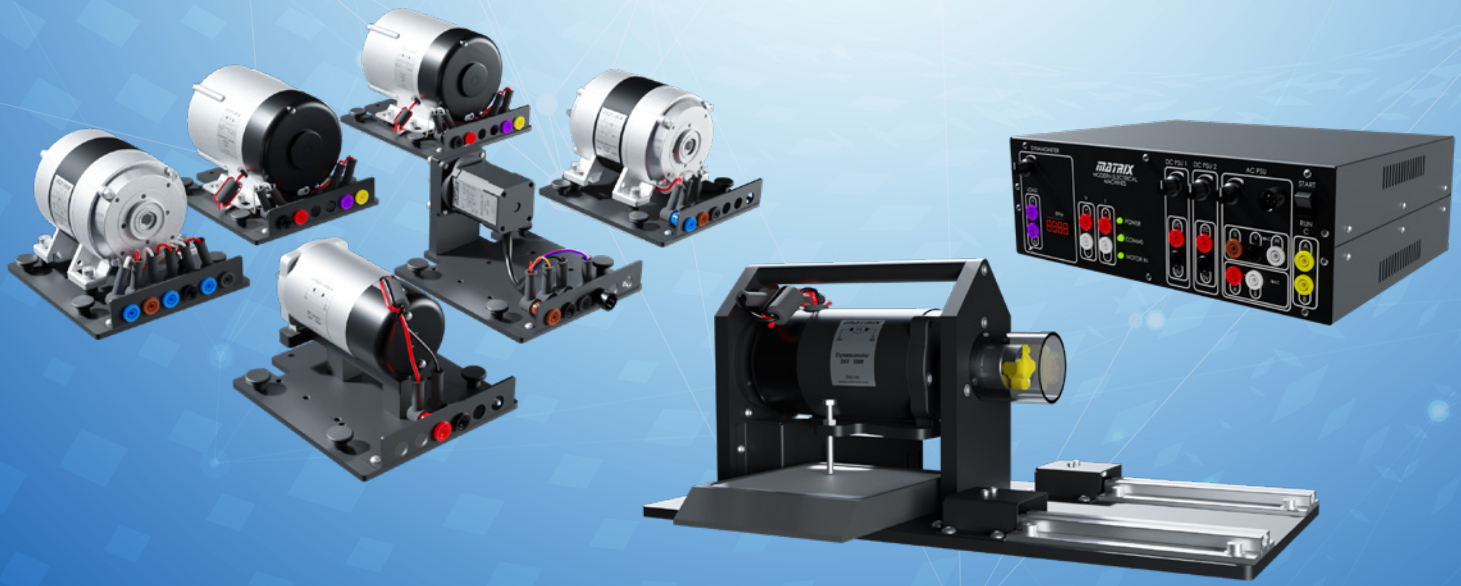
A&P INSTRUMENT®
科 藝 儀 器



Solutions for Industry 4.0



MATRIX

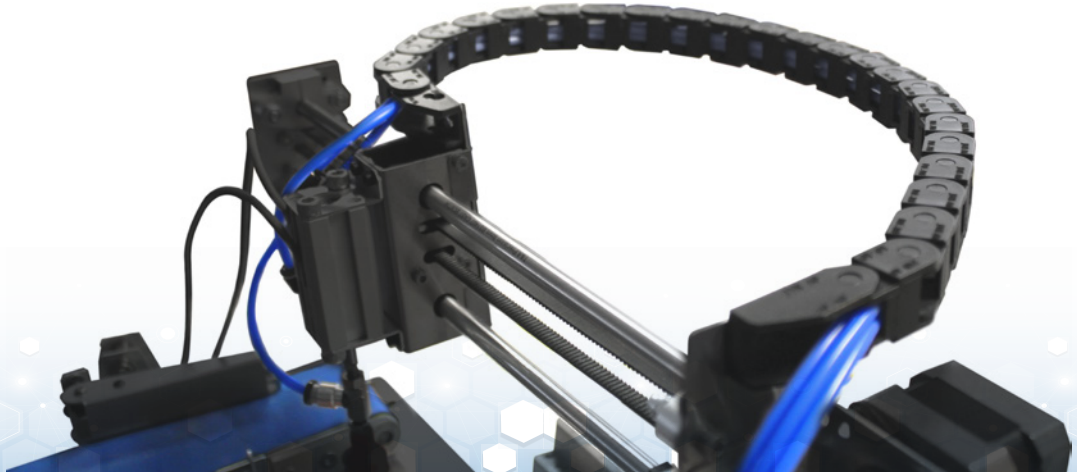
www.matrixtsl.com

A&P INSTRUMENT CO., LTD.
科 藝 儀 器 有 限 公 司
地址：香港九龍灣啟祥道 9 號信和工商中心 1 樓 68 室
Room 68, 1/F Sino Industrial Plaza,
9 Kai Cheung Road, Kowloon Bay, Kowloon
Tel: (852) 2755 6578 E-mail: info@anp.com.hk
Fax: (852) 2755 4549 http://www.anp.com.hk/

Summary

Industry 4.0 is the term that has been adopted to describe the 'fourth' industrial revolution currently underway in the manufacturing and commercial sectors of our society. It is a revolution based on the integration of physical systems with the Internet of Things and services. This integration has been enabled by the development of advanced manufacturing technologies.

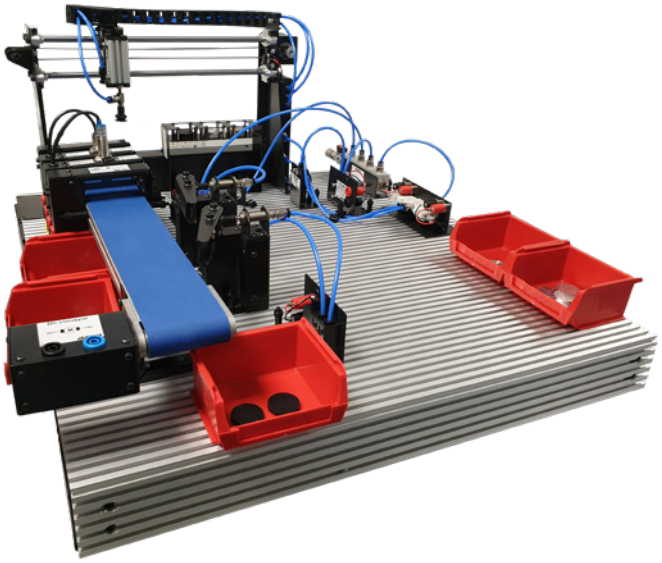
Industry 4.0 is changing the way the world's most successful companies produce the products that their global customers demand. Through this brochure, we provide equipment and curriculum that gives students an understanding of why and how smart factories are changing the face of manufacturing. Students learn about the latest technologies that make smart factories work, including communications, programming, PLCs, sensors and robotics.



Contents

Smart Factory

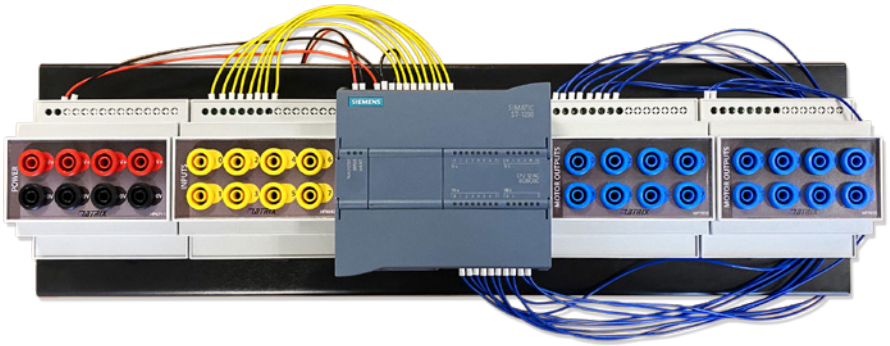
The Automatics Smart Factory allows students to get experience of a number of processes and technologies that are commonly used in manufacturing and modern-day Industry 4.0 principles. This includes conveyor systems, sensing systems, pneumatic pick and place technology, DC motor drives, and stepper motor drives. The factory includes a number of coloured discs made from plastic and other materials. A conveyor belt moves these pieces into the factory, where user programmed sensors sort the discs into multiple rejection bins. Some are picked off the conveyor by a suction device and a stepper motor-controlled gantry sorts the discs into appropriately coloured containers. The smart factory is completely self-contained and can be stored away in one of our standard trays. The smart factory can be used with Siemens (or other brand) 12V or 24V) PLC and is also compatible with our dsPIC MIAC .

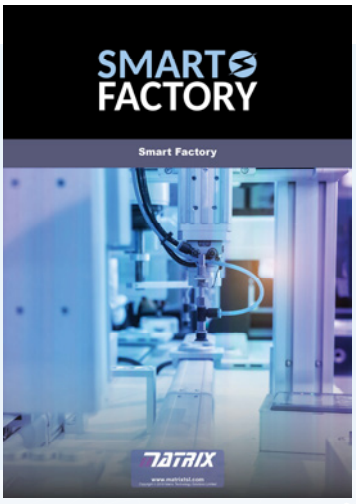


Smart Software

The Smart Factory is controlled in one of two ways. Users can either opt to control using two of our dsPIC driven MIAC controllers, which are educational PLC's and perfect for younger students to understand the capabilities and possibilities of industrial smart factories. Alternatively our Siemens add-on for the smart Factory, gives students the ability to program the system using an industrial grade S7-1200 PLC. This is provided on a DIN rail bracket with adaptor modules. As a Siemens education partner, we can also provide you with software to control these upon request.

SIEMENS



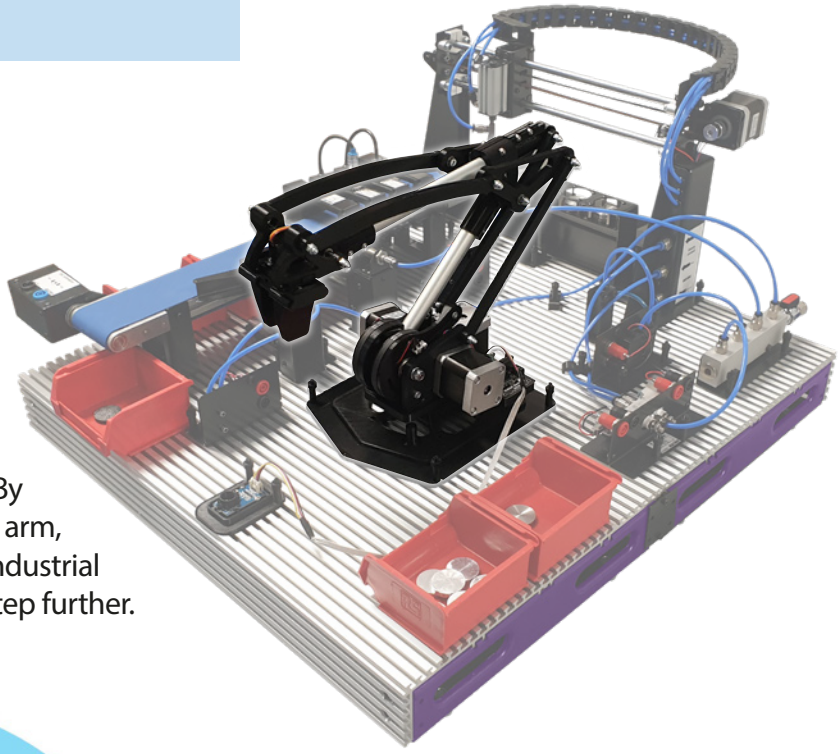


Learning Objectives

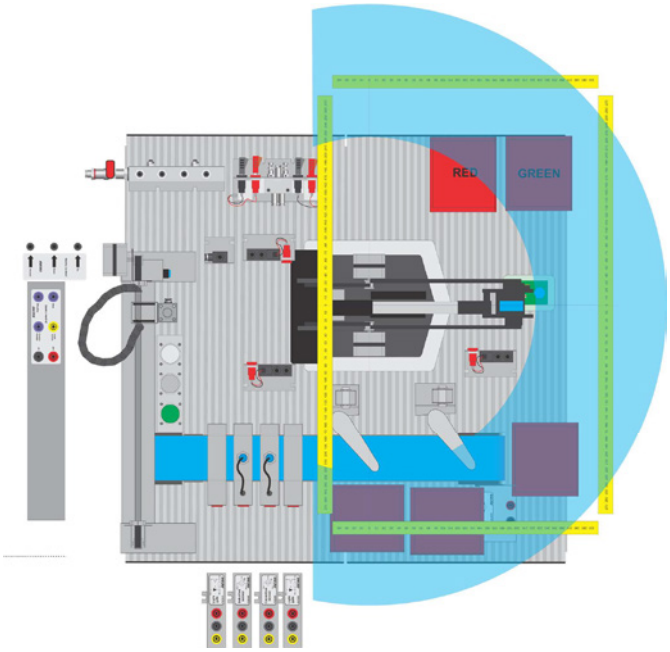
- Factory control and automation systems
- Software design for automation
- DC motor and stepper drives
- Conveyor and gantry systems
- Vacuum pick and place systems
- Component sensing and sorting
- System design with more than one controller (some systems)

FREE CURRICULUM
www.matrixtsl.com/learning

Robot Arm Integration



The Smart Factory is compatible with the AllCode robot arm production cell. This can be added to provide a powerful Industry 4.0 learning solution. By introducing a programmable robot arm, that acts in the same way as an industrial robot, users can take their learning a step further.



Students create a counter sorting program in which the Robot Arm will collect plastic counters and using the colour sensor, they are sorted into appropriate collection bins. The system can be operated manually or using internet communications, students can implement a handshaking system to automate the process.

Ordering information	
Smart Factory	AU4956
Smart Factory Siemens Control add-on	AU3686
Smart Factory MIAC Control add-on	AU4417
AllCode Robot Arm Production Cell	RB1387
Corresponding curriculum	CP7329
Instruments Required	
Compressor	AU1050

INDUSTRY 4.0

Featuring Internet Control

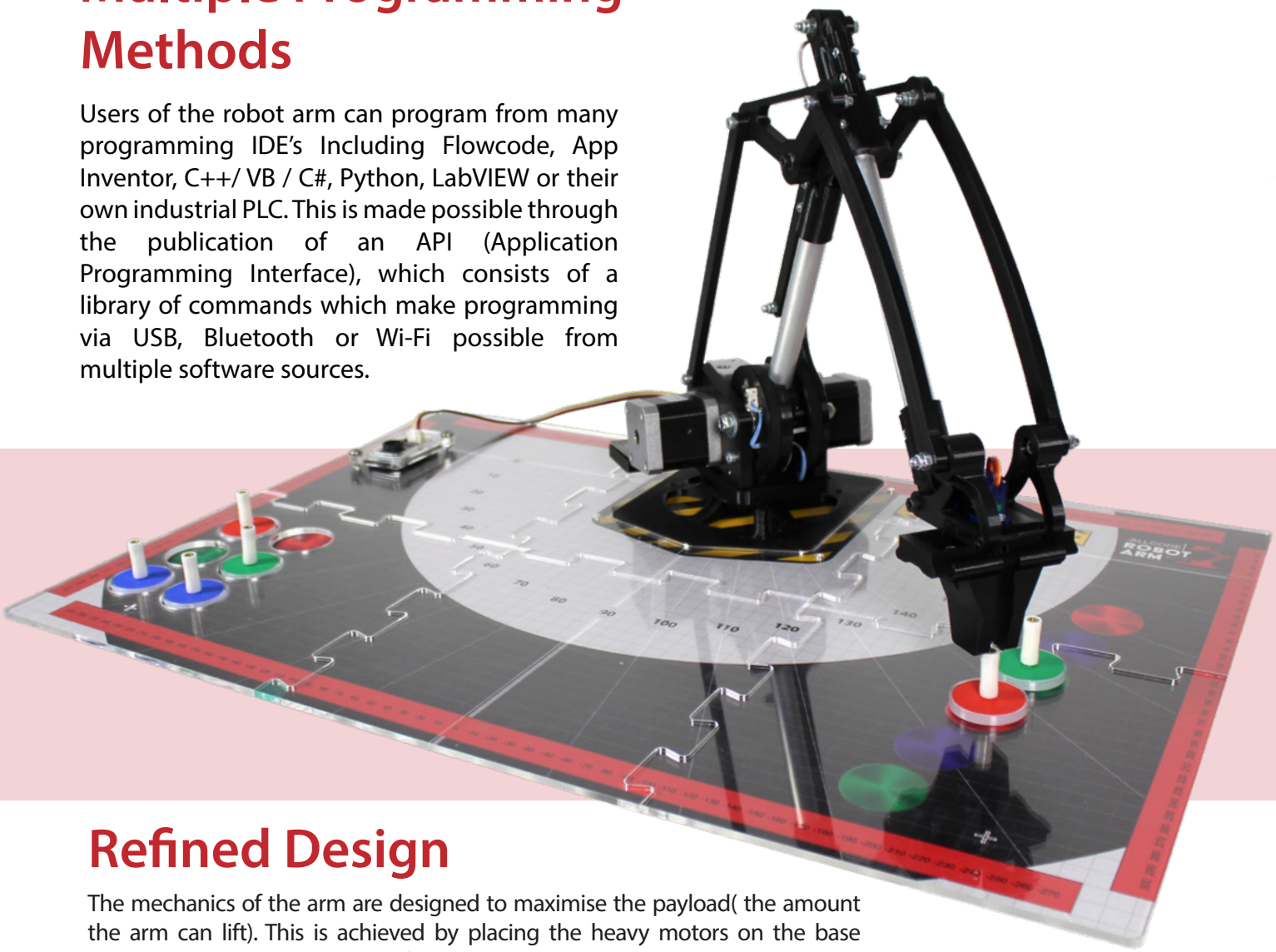
Using API (Application Programming Interface) functionality, which is provided pre-programmed on the Robot Arm Production Cell, users can control the system using any software application, including Flowcode, MATLAB, LabVIEW and many other IDE's. This gives users a powerful remote, automated environment through which to control an industrial system.

Robot Arm Production Cell

The robot arm production cell consists of a rugged stepper motor controlled 3 degrees of freedom arm bolted to a base plate and supplied with activity mat that provides a range of exercises to replicate an industrial robot arm. The free instructional guide includes worksheets in pendant, G code, API and microcontroller programming, sensors and actuators, kinematics and more. The user can connect the robot arm production cell to their hardware platform – Windows PC, Android mobile, Raspberry Pi/Linux device using USB, Bluetooth or Wi-Fi technology.

Multiple Programming Methods

Users of the robot arm can program from many programming IDE's Including Flowcode, App Inventor, C++/ VB / C#, Python, LabVIEW or their own industrial PLC. This is made possible through the publication of an API (Application Programming Interface), which consists of a library of commands which make programming via USB, Bluetooth or Wi-Fi possible from multiple software sources.

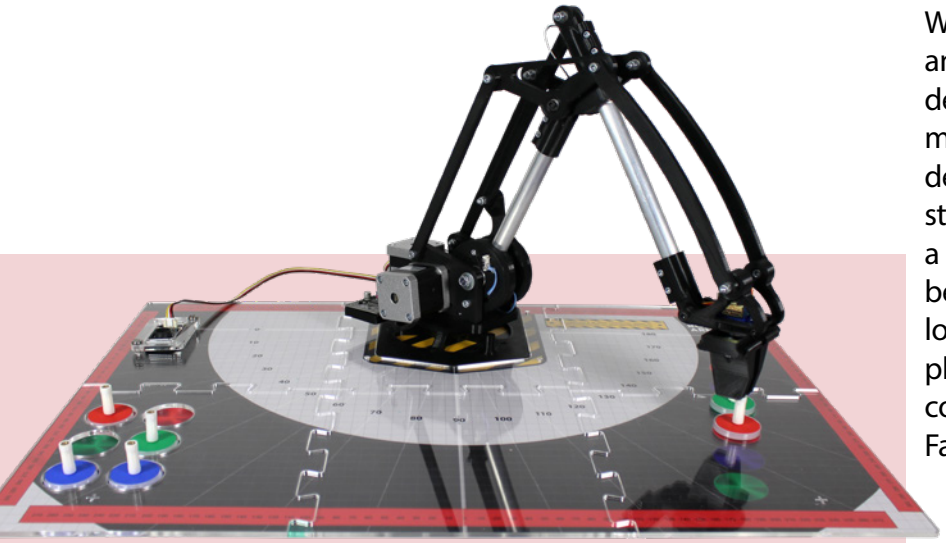


Refined Design

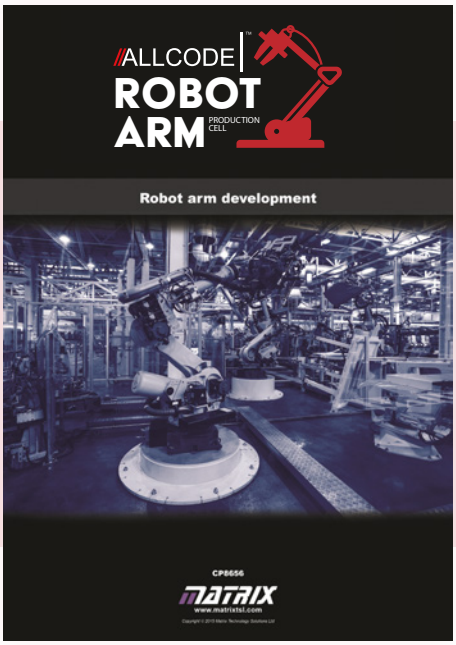
The mechanics of the arm are designed to maximise the payload(the amount the arm can lift). This is achieved by placing the heavy motors on the base platorm and by using a system of levers and cogs to allow the arm to move with great precision within its range of moton.

Ordering information	
AllCode robot arm production cell	RB1387
Corresponding curriculum	CP8656

Robot Arm Production Cell



With base, shoulder and elbow rotation and functional gripper, the arm itself delivers fast, accurate and repeatable movement. The stepper motor driven arm delivers an accuracy to 0.04 degrees per step, < 0.5mm XYZ. The kit is supplied with a number of coloured counters which can be moved by the arm into different locations in the work cell to study pick and place and sorting technology. It is also compatible with the Industry 4.0 Smart Factory (see pages 4 & 5).



Learning Objectives

- 4 levels of user supported
- Arm movement and construction
- Pendant programming
- G code programming
- API programming
- Microcontroller programming
- Sensors & Actuators in Robotics
- Kinematics
- 3D movement in robotic systems

FREE CURRICULUM
www.matrixtsl.com/learning

INDUSTRY 4.0

Featuring Internet Control

The AllCode Robot Arm includes Wireless communication capabilities, enabling remote operation as well as automated functionality. Users are therefore able to control the arm remotely using the API provided and the software application of their choosing.

Arduino Communications Courses

Arduino GSM Training Course

This training solution provides a complete course in developing communication systems. In completing the 20 hour course, students will learn about communications systems, the AT command protocol, communications strategies and many aspects of project development and management. The solution includes a fully working mobile phone based on E-blocks. A 50 page teacher's manual contains a range of exercises and is available to download from our website.

Learning objectives / experiments:

- General programming of systems including LCD, Keypad etc
- RS232 protocol and programming
- String construction and deconstruction in communications
- The use of state machines in controlling electronic systems
- RS232 communications and handshaking protocols
- ASCII representation of characters in messages
- AT command structure and command protocols used in telecommunications
- Sending and receiving text messages in mobile phone systems
- Modem control and messaging

GHOST™

Ghost & Flowcode provide:

- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

Ordering information	
Arduino GSM training course	BL0521
Requires Flowcode, which must be ordered separately	

Arduino Bluetooth Training Course

This 20 hour training solution allows students to carry out investigations into the Bluetooth standard using high level macros written in Flowcode. Students use the hardware, software (available separately) and curriculum (available to download from our website) to investigate various Bluetooth protocols and functions including the serial protocol (SPP). An 80 page teacher's manual covers system set-up, Bluetooth theory and a range of exercises for students to work through.

Learning objectives / experiments:

- Data communication between microcontroller and Bluetooth modules
- Bluetooth visibility
- Device discovery, pass keys and addresses
- Responses - sequence flow and error checking
- Connecting and pairing
- Data communication
- Using Bluetooth for control applications

GHOST™

Ghost & Flowcode provide:

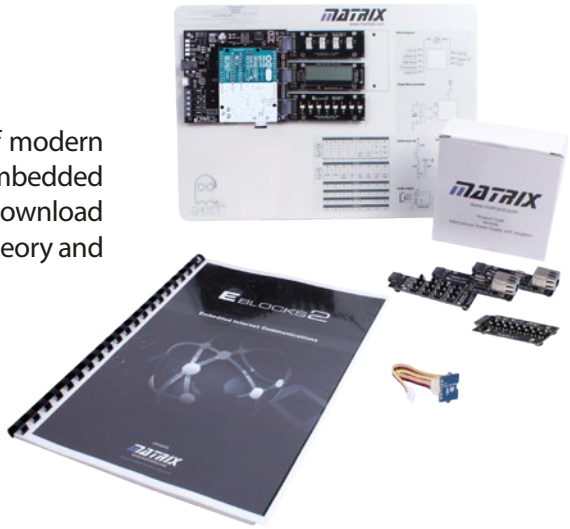
- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

Ordering information	
Arduino Bluetooth training course	BL0563
Requires Flowcode, which must be ordered separately	

Arduino Communications Courses

Arduino Embedded Internet Training Course

This 40 hour training solution gives students a full understanding of modern digital communications protocols and the development of embedded internet-based products. An 80 page teacher's manual is available to download from our website and covers system set-up, digital communications theory and contains a range of exercises for students to work through.



Learning objectives / experiments:
- OSI model and layers
- Ethernet, DLC, MAC, ARP, TCP, IP, UDP, ICMP, HTTP and POP3 protocols
- MAC packet structure and message creation using microcontrollers
- Communication strategy and information flow
- Packet injectors and debuggers

Labs include:
- ARP scanning
- Ping
- Time and date messages using UDP
- Sending HTML using HTTP protocol
- Receiving HTML
- Sending an email using SMTP protocol

Advanced tasks include:
- Custom messaging using UDP
- A firewall application

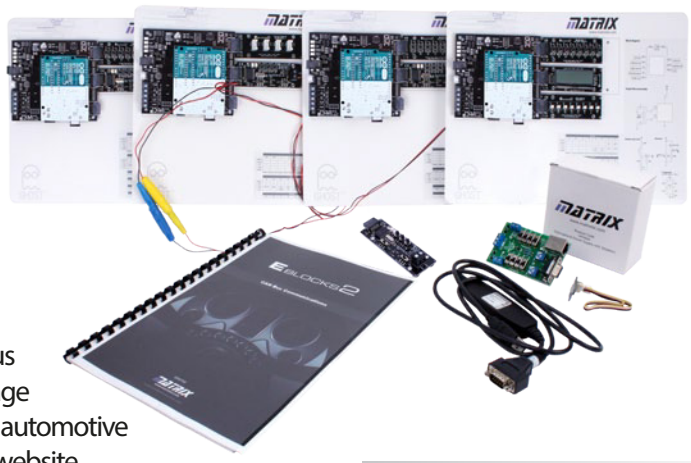
GHOST™

Ghost & Flowcode provide:
- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

Ordering information	
Arduino embedded internet training course	BL0535
Requires Flowcode, which must be ordered separately	

Arduino CAN bus Training Course

This 20 hour training solution is designed to facilitate the development and investigation of systems that use the CAN bus protocol. The solution is suitable for both automotive students and for electronics undergraduates. Four fully programmable CAN nodes are included in the solution, along with circuit boards which mimic the functions of indicator lamps, switches and sensors. A CAN bus analyser and message generator are also included. An 80 page teacher's manual contains a range of exercises for automotive technicians upwards and is available to download from our website.



Learning objectives / experiments:
- CAN technology, wiring, topology and networks
- CAN message structure and physical layer transmission
- Understanding CAN bus protocols
- Using buffers in CAN systems
- Using CAN transmit and receive messages
- Errors in CAN systems
- Programming techniques in CAN systems
- Masks and filters in CAN systems
- Higher level protocols
- Development of complete CAN systems based on microcontrollers

GHOST™

Ghost & Flowcode provide:
- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

Ordering information	
Arduino CAN bus training course	BL0587
Requires Flowcode, which must be ordered separately	

Arduino Communications Courses

Arduino ZigBee Training Course

This training solution provides a complete 20 hour course in developing wireless area networks based on the ZigBee standard. It gives students who are familiar with microcontrollers an understanding of the programming techniques involved in developing ZigBee wireless communications systems. A ZigBee packet analyser is included in the solution, along with four fully working ZigBee nodes based on E-blocks. A 50 page teacher's manual contains a range of exercises and is available to download from our website.

Learning objectives / experiments:

- Zigbee protocols, message transmission and reception, and networks
- Zigbee principles, topologies and components
- Development of microcontroller based systems using Zigbee technology
- Moulding the network
- Adding nodes
- Expanding the network
- Reducing power consumption
- Dynamic networks
- Message routing
- Data logging gateways
- A complete modular fire and burglar alarm
- Improving network security

GHOST™

Ghost & Flowcode provide:

- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

Ordering information	
Arduino ZigBee training course	BL0536
Requires Flowcode, which must be ordered separately	

Arduino RFID Training Course

This training solution provides a complete 20 hour course in developing RFID systems. It gives students who are familiar with microcontrollers an understanding of the programming involved in developing RFID systems. An E-blocks RFID board and four RFID tags embedded into credit cards are included. This hardware allows students to learn about reading and writing transponder data in both I-code and Mifare mode. A 50 page teacher's manual contains a range of exercises and is available to download from our website.

Learning objectives / experiments:

- RFID systems and applications
- Configuring RFID readers
- Commands and syntax used in reading and writing data to and from RFID cards
- Communication with both Mifare and I-code systems
- Development of microcontroller based systems using RFID technology

GHOST™

Ghost & Flowcode provide:

- In-Circuit-Test
- In-Circut-Debug
- Software oscilloscope
- Packet decoder
- Auto-ID

Ordering information	
Arduino RFID training course	BL0548
Requires Flowcode, which must be ordered separately	

Flowcode

FLOWCODE

FEATURING

FLOWCODE APP DEVELOPER

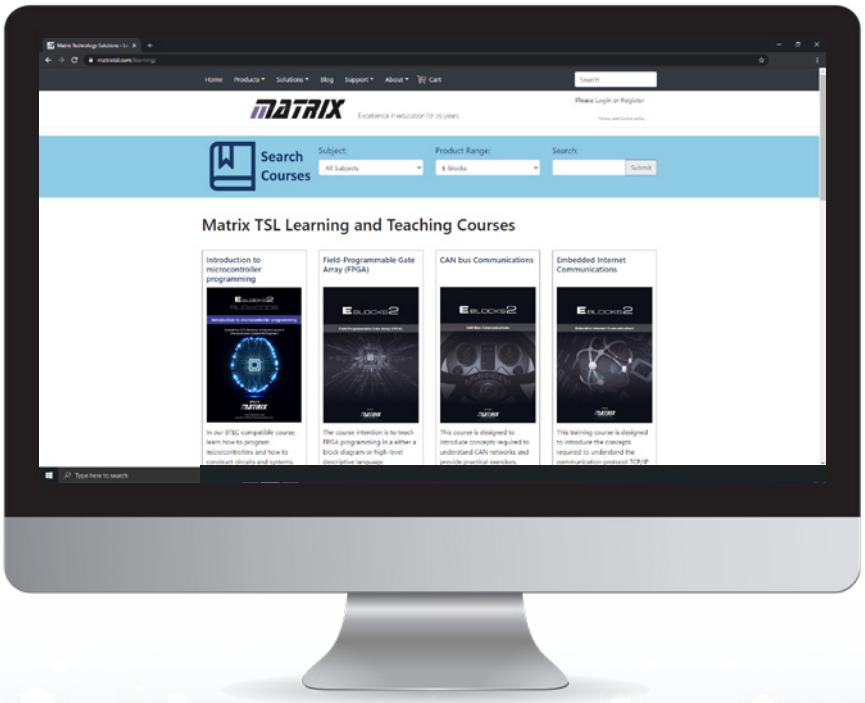
CREATE PROGRAMS

DISTRIBUTE GLOBALLY

ANALYSE DATA

TRY FOR FREE AT

www.flowcode.co.uk



Learning Centre

The Matrix Learning Centre is our easy to navigate library of product curriculum and training materials, containing workbooks, lesson plans and teachers notes to aid efficient study.

FREE CURRICULUM
www.matrixtsl.com/learning

Electrical Machines

Our modern electrical machines training system is a revolutionary way of safely studying the characteristics of different motor types in a learning environment. This solution includes eight different types of machine, integrated power supply and control box and PC-based applications for advanced controller of the different machine types. Further to this, we provide four separate curriculum manuals for teaching electrical machines principles using manual control with external meters, using PC control or using MATLAB.

Control box

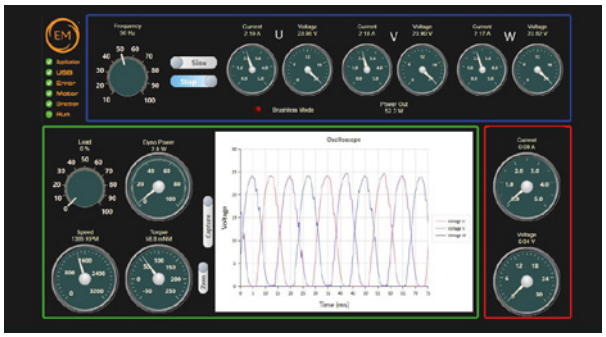
At the heart of both manual and PC control of the machines is our control box. The control box houses all of the electronics including motor drivers, to control the modern electrical machines training system.

Control box features

- Select DC, single-phase AC and 3-phase AC outputs
- Integrated voltage and current measurement
- Adjustable resistive loads for dynamometer and series winding resistor
- Switchable start and run capacitor
- 14 different instruments embedded within it
- A unique API, allowing connection to be made to the
- MATLAB environment
- A small size, around the size of a laptop, making it small enough to sit on a desk along with the rest of the kit and PC

PC Software

The system is designed to be used manually or via connection to a laptop or PC. When utilising the PC control option, the user should download the app from the Resources page on the website. Above are a range of screenshots showcasing the ways the proprietary software can be used to control each type of machine in the range. Through experimentation, users can review the results of altering the voltage, load etc of each machine and the subsequent effect this has on each machine's current, torque etc. over time.



Ordering information	
Modern electrical machines	EM6637-2
Corresponding curriculum	CP6490, CP4160, CP8385,
You will also need	
Fluke 115 True RMS Digital Multimeter	HP1324
Tektronix Digital Oscilloscope	HP8067
Also Available	
Transformer add-on	EM4425
Locked Rotor add-on	EM2551

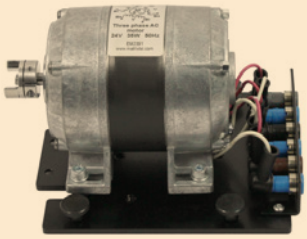
Electrical Machines

Motors

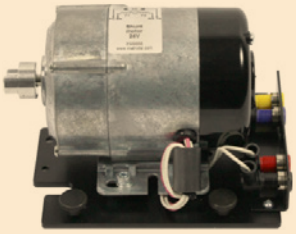
The aluminium cradle which houses our dynamometer features a rugged and safe sliding mechanism into which each of the other six motors in the range fix into position. The motor coupling meets the dynamometer in a protected housing and allows for safe study of each machine type at 24 volts. When using our system in manual mode, it is likely you will require two (per set) HP1324 Fluke 115 True RMS Digital Multimeter and one HP8067 Tektronix Digital oscilloscope.

DC Dynamometer / motor and cradle
Operating voltage – 24V AC
Max current - 2A
Speed – 1500rpm

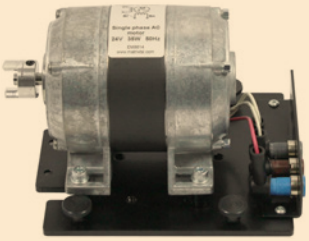
Three phase induction motor
Operating voltage – 24V AC
Frequency – 40-80Hz
Max current – 1.4A
Speed – 1400rpm



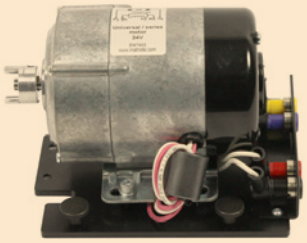
Shunt motor
Operating voltage – 24V AC
Max current – 12A
Speed – 1500rpm



Single phase induction motor
Operating voltage – 24V AC
Frequency – 40-80Hz
Max current – 1.4A
Speed – 1400rpm

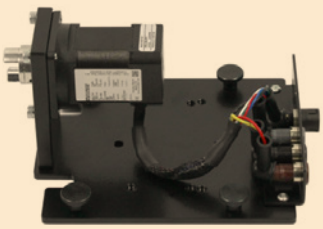


Universal / Series motor
Operating voltage – 24V AC
Frequency – 50Hz
Max current – 6A
Speed – 1500rpm



DC motor
Operating voltage – 24V AC
Frequency – 40-80Hz
Speed – 1500rpm

Brushless DC motor / 3 phase generator
Operating voltage – 24V AC
3 Phase
Max current – 2A
Speed – 1500rpm



INDUSTRY 4.0

Featuring Internet Control

The Matrix Electrical Machines feature built in internet based control allowing for remote operation through the proprietary software of each of the machines in the range.

Process Control

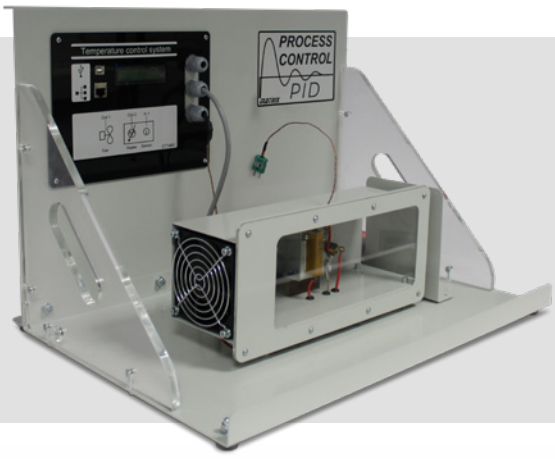
The Modern Process Control system from Matrix, allows students to investigate the principles of industrial process control, using independent Temperature, Pressure, Flow and Level based systems. With a common controller for all applications, the advanced 16 bit dsPIC processer with operating system, comes equipped with USB, WiFi Bluetooth and LAN communications. Once set up the system can run independently and does not require a PC connection. Data can be viewed on the internal graph or saved to a file for later analysis and comes ready to plug in for 110 – 240V operation. Full documentation is supplied with the units, including a manual for the equipment and a curriculum workbook, which guides students through the use of Process control systems and the Control function. Transfer functions can be studied using MATLAB or equivalent software. These sets of equipment are suitable for delivery of various qualifications at level 3 and above across many disciplines of engineering. In the UK, This includes the BTEC Higher National unit 45 Industrial Systems and other higher education courses.

FLOW

The Flow system consists of a water tank, variable speed pump, a turbine type flow sensor, an electrically operated proportional valve and a variable area flow meter (rotameter). This allows students to adjust the flow rate via the pump speed and the valve opening to develop a PID based control system.

Ordering information	UK
Process Control Flow	CT0673
Corresponding curriculum	CP5937

TEMPERATURE



The temperature process control system includes a heated plate within a duct. A thermocouple connects to the controller to allow students to check and calibrate the controller input. A fan at one end of the duct blows ambient air over the block, to change the control conditions and provide a disturbance to the system. The system allows students to adjust the heater power and the air flow rate to develop a PID based control system then adjust these parameters to achieve the required time/temperature change profile for the system in response to step changes in system requirements.

Ordering information	UK
Process Control Temperature	CT1491
Corresponding curriculum	CP5937

Process Control

PRESSURE

The Pressure system consists of a variable speed reciprocating air pump (compressor), the speed of which can be adjusted by students, a pressure vessel and an outflow system. The outflow system allows the air to escape via either a manually operated needle valve - providing an ongoing outflow, or via a solenoid valve and second needle valve - providing a step change in outflow. The vessel pressure is measured by a Bourdon type mechanical gauge along with a pressure sensor. The Bourdon gauge provides a visual indication of the pressure in the vessel and a means for students to check and calibrate the controller input from the pressure sensor.

Ordering information	UK
Process Control Pressure	CT1733
Corresponding curriculum	CP5937

LEVEL

The Level system consists of a reservoir water tank, a variable speed pump, a pressure-based level sensor, and clear process vessel with a scale. A proportional valve provides the process vessel drain. An overflow pipe in the process vessel prevents it being overfilled and the system allows students to adjust the pump speed and valve opening.

Ordering information	UK
Process Control Level	CT5971
Corresponding curriculum	CP5937

INDUSTRY 4.0

Featuring Internet Control

The Matrix Process Control equipment features inbuilt USB, Wifi, Bluetooth and LAN capabilities. This offers remote operation capabilities with data recording mirroring real world industrial control systems.

Solutions for Industry 4.0

A&P INSTRUMENT CO., LTD.
科 藝 儀 器 有 限 公 司

地址：香港九龍灣啟祥道 9 號信和工商中心 1 樓 68 室
Room 68, 1/F Sino Industrial Plaza,
9 Kai Cheung Road, Kowloon Bay, Kowloon
Tel: (852) 2755 6578 E-mail: info@anp.com.hk
Fax: (852) 2755 4549 http://www.anp.com.hk/

For more information, do not hesitate to contact us

Matrix Technology Solutions

The Factory, 33 Gibbet Street, Halifax, HX1 5BA, United Kingdom

t: +44 (0) 1422 252380 e: sales@matrixtsl.com

MATRIX

www.matrixtsl.com