A perspective on the characteristics of Advanced Industrial Robotic Systems

Ian Schofield ABB
Industrial Robotics
Agenda

- ABB Overview
- Brief History of robots
- Demographics
- Factors Driving Industry
- Case Studies
- Technology/Developments
- Summary
How ABB is organized
Five global divisions

- **ABB’s portfolio covers:**
  - Electricals, automation, controls and instrumentation for power generation and industrial processes
  - Power transmission
  - Distribution solutions
  - Low-voltage products
  - Robots and robot systems

2009 revenues (US$; pro-forma figures for automation divisions)
Robotics Division

Key facts

- 5000 employees in over 48 countries
- Headquarters in Shanghai, China
- Manufacturing in Europe, Asia & America
- Sales & service operations in 49 countries & more than 100 locations
- Introduced painting robots in 1969 and the world’s first commercially available electric robot in 1974
- Over 175,000 robots installed worldwide at end 2009
- Circa 1.2B$ Revenues
UK Robotics Division

HQ- Milton Keynes

Account Management

Robot Sales

Engineered Systems

Customer Service

Stats

Over 65 dedicated staff

- Over 50 Engineering

>5000 robots installed in UK

Committed to local UK engineering and support

ISO 9001, 14001, 18001, Ford Q1
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Industrial Revolution sees widespread development of mechanisation.

This continues through early 20th century with the development of automation systems usually to produce a single commodity.

Consumer demand for choice creates the need for the economic benefits of automation with the flexibility to produce multiple variations of products within families.

Advances in controls technology and electronics leads to the development of “Flexible Manufacturing Systems” (FMS) incorporating CNC technology.

The word ‘Robot’ derives from the Czech “Robota” meaning “forced labour”
Robots
Wrong Perception!

- Delta Robots

Reality

4 Axis Robots

6 Axis Robots
Continuous technology development

- **Hydraulic paint robot**
  - Trallfa TR-200

- **6 axis electric robot**
  - IRB90

- **Joystick motion control**
  - S2 Robot Controller TPU

- **First electric robot**
  - ASEA IRB6

- **AC Servo Drive system**
  - IRB2000

- **Modular Design**
  - IRB6000 range

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Continuous technology development

Open Architecture
S4 Controller

High-speed Picker
IRB340 FlexPicker

MultiRobot control
MultiMove
Modular Controller
Touch screen HMI
IRC5 controller

ForceControl
FC Machining
FC Assembly

Electric Paint Robot
TR5400

Process Arm for AW
IRB1600ID

Dynamic Motion
TrueMove, QuickMove

Arc weld process
simulation
VirtualArc

2nd Generation
Motion control
TrueMove, QuickMove

Next Generation
Safety Systems
SafeMove

Offline Programming & Simulation
RobotStudio

500kg robot
IRB7600

Compact paint robot
IRB52 with integrated IPS

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ABB Robots Overview

- Comprehensive range from 1kg to 650kg payload capacity
- Robust, rigid, reliable, easy to use
- Customization through modular design concept
- Protection with IP67, Clean Room, Foundry Plus, Foundry Prime, Wash Down
The Technology …
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Markets served

Overview

- Automotive
- Plastics
- Foundry & Forging
- Metal fabrication
- Food & Beverage
- Chemical & Pharmaceuticals
- Defence and Aerospace
- Wood
- Machine Tools
- Sanitary/Tableware/Ceramics
- Consumer electronics
- Solar
Industrial Robots Worldwide

![Industrial Robots Worldwide Chart](source: World Robotics 2008)

*forecast
Industrial Robots/10,000 employees
Strongly Growing Markets

- China
- Southeast Asia
- Central/Eastern Europe
- India
- Brazil

Source: World Robotics 2008
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- **Factors Driving Industry**
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Factors Driving Industry

- Pressure on Margins is increasing
- Skilled labour force diminishing – deskillling
- Processes difficult to automate due to component variations/tolerances
- Automation needs flexibility of man and precision of CNC
- Increasing production capacity in “new” countries
- Reduction of run sizes and more varieties
- More Fresh Food demands shorter Time To Market
- Increased H&S legislation
UK Manufacturing – Fighting Back

- UK is 6th largest manufacturing nation in the world
- More people are employed in UK manufacturing today than in the Financial Sector.
- Manufactured goods make up 40% of UK export
- Government recognise the need for a more balanced economy.
- Many customers winning work back from LCC and attracting new work.
‘10 good reasons to invest in robots’

1. Drastically reduced operating costs
2. Improve product quality & consistency
3. Improve quality of work for employees
4. Increase production output rate
5. Increase product manufacturing flexibility
6. Reduce material waste and increase yield
7. Comply with safety rules and improve workplace health & safety
8. Reduce labour turnover and difficulty of recruiting workers
9. Reduce capital costs
10. Save space in high value manufacturing areas
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Case Study – Pancake Packing

• Customer – UK Bakery selling to supermarkets
• Product – Pancakes
• Output – Required 390 a minute into stacks and into a flow wrapper – Actual achieved – 440 a minute – Improved productivity by 12%
• World First – Overlapping product recognised and picked by the robots
• Faster product changeover – A simple press of a touch screen
• Replaced manual labour – 8 operators a shift (2 shifts)
• Improved hygiene – no human hands touch the pancakes until the packets are opened by the final customers
• Improved quality - Vision inspection of each pancake, checking for size.
Case Study – Pancake Packing
Case Study small robot system

**Client**
Characteristix
Cornwall

**Application - Injection Moulding**
Plastic, injecting moulding specializing in badges, pendants, pencil toppers and fridge magnets
*System installed by GeKu*

**Key Drivers & Benefits**
- Huge decrease in downtime
- Improved efficiency and costs reduced by 5%
- Performance up more than 100 per cent
- 33,000 pieces produced per day
- Employees newly motivated

“I am so impressed with the ABB cell that we will install a second by the end of the year and full ‘lights-out’ operation will follow that.”

Andy Knight, Characteristix
Small Robot application
Improved product quality & consistency

Using ABB Force Control for Machining

Application
De-Burring of Pump castings

Key Drivers & Benefits
✓ Enables automation of manual operation
✓ Accurate and consistent process
✓ Small batch sizes-frequent change-over
✓ Shorter cycle times
✓ Better surface finish
✓ Handle variation in parts
✓ Reduced Tooling wear-hence cost
✓ Massive reduction in programming time
ABB’s robotized machining strategy

RobotWare Machining FC (Force Control)

Flexibility supports in both directions Accuracy

Manual machining

CNC-machine

Today
**Position Control vs. Force Control in Machining**

**Normal Position control**
- Path and speed is constant independent of the contact forces.
- Bad quality and risk of burning the material and damaging the tool or the robot.

**Position control**
- Path and speed is constant independent of the contact forces.
- Bad quality and risk of burning the material and damaging the tool or the robot.

**Force control**
- Force in the sensor controlled direction and speed along the surface is constant.
- Path is adapted to curvature of the surface.
- Controlled Material Removal Rate.

**Force Control**
- Force in path direction is constant. The speed is variable.
- Path is constant.
- Controlled Material Removal Rate.

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5. Increased product manufacturing flexibility **TrueView™**

**Application – Engine Assembly**

Automated solution with **TrueView TM**

Single Camera 3d Vision guided Robotics

**Key Drivers & Benefits**

- Expensive fixtures eliminated
- Automates operations that previously required human intervention
- Improved efficiency
- Flexible system as Robot can react to changes in the environment
- No pre-arranging or pre-placing required
- AutoCal for easy integration
Robots getting ever more cost competitive

- In the period 1990 to 2005, the average hourly wage of a typical worker increased by 74%
- In the same period, the real price of robots REDUCED by 50%

Source: IFR World Robotics report 2006
Consider this….

- Typical hourly operating expense per employee per hour:
  
  £12.45

- Typical hourly operating expense per robot per hour:
  
  £5.00 !
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Technology/Developments

- Robots reacting to their environment
  - Tactile/Vision guided
- Robots interacting with Robots
  - Multimove system for welding application
  - Simulation/Flexframing of vehicle bodies
- Robots interacting with humans
  - Safemove
- Use of External metrology
- Remote service
Robots interacting with Robots
Robots interacting with humans
Use of External Metrology

- Robots are excellent at positional repeatability
  - Typically 0.03 – 0.1 mm
- Robots are not accurate machines within their entire working envelope

= 5-15 mm
Metris ARC Technology

- Solid-state
- Optical
- High Frequency serial IR-LED strobing (upto 1KHz)
- More than 3 LEDs give 6D tracking
- Multiple frame tracking (eg 2x 6D basis of Adaptive Control)
ABB with Adaptive Control

- Integrating Metrology inside a robot cell improves drilling/riveting accuracy to below 8/1000” (0.2mm)
- Concession free
Remote Service
The technology, lowering environmental impact

Technologies:
- Secured VPN access
- GPRS wireless data transmission
- Customer web interface

Features:
- Optimize robot work cycle
- Real time alarm monitoring & notification
- Diagnostic for predictive maintenance
- Predictive failure indication
- Online access via MyRobot to analyze and solve failures
Future?

- Random Bin Picking
  - No need for;
    - Unscrambling
    - Collating
    - Datum positioning

- System becomes;
  - Smaller,
  - Cheaper
  - and far less elements
Summary

- Industrial Robot systems are widely used across industry for high volume-low cost and low volume-high cost manufacture.
- The use of Vision guided and tactile sensing is enabling robots to become more reactive to their environments and less reliant on component characteristics.
- More use of robots as ‘intelligent’ fixturing will make systems more flexible and give faster product change over times.
- External Metrology will open up many applications where robots have previously not been sufficiently accurate.
- Opportunity for more human interaction in a safe environment to maximise productivity.
- From Automation to Autonomation?