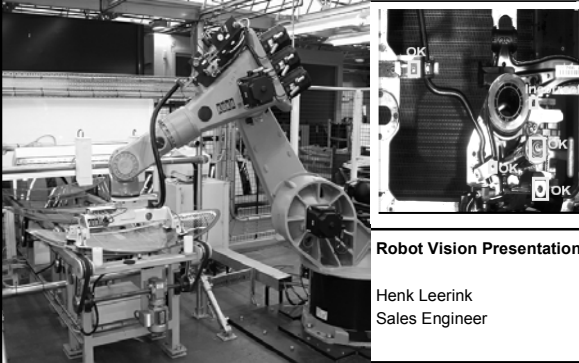


KUKA



Robot Vision Presentation

Henk Leerink
Sales Engineer

BARA Seminar – KUKA Presentation **KUKA**

- Objectives
- KUKA background
- Principles of robotic automation using vision
- Jaguar X202 assembly cell

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Objectives **KUKA**

- To provide information about KUKA & its robotic activities
- To create an awareness in which applications vision systems are useful
- To inform about the Jaguar X202 assembly cell at Pilkington Automotive

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KUKA

KUKA Background Information

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The IWKA AG Group **IWKA KUKA**

IWKA AG
 200 companies
 12,860 employees
 € 2.2 billion sales

Production Technology

Packaging Technology

Manufacturing Technology

Process Technology


Trading Technology

Figures for 2000

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Kuka Roboter GmbH - Key Data **KUKA**

- Established over 100 years ago
- Leading robotic automation supplier
- Manufacturing centre in Augsburg - Germany
- Order intake for 2001: € 292 million
- Represented in 21 countries



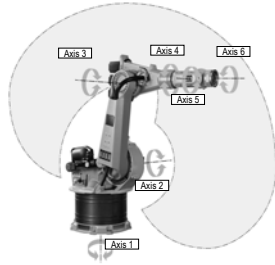
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6-axis Jointed-arm Robot



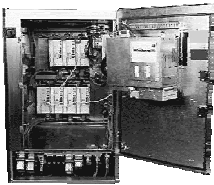
Benefits:

- Single joint design
- Large working envelope
- Mountable in any position
- Modular construction
- Secure cabling solution
- Excellent performance
- AC drives
- High availability
- Track record



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KR C 1 & 2 Robot Controllers



- Standard PC with Windows 95™ interface
- 128 Mb RAM, CD-ROM, floppy & hard disk
- 4.3 Gb hard disk
- Connection to PC monitor
- Robust VxWorks command processing
- Dynamic model

- Configurable
- Compact cabinet
- Easy to service
- Expandable any time



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The KUKA Control Panel (KCP)



- Microsoft Windows 95 interface
- Numeric keypad, keyboard & 6D mouse
- Key switch, E stop & safety switch
- Large 8" VGA colour display
- Ergonomic design



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Principles of Robotic Automation with Vision

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Benefits of Robotic Automation



- Increased productivity
- Improved and consistent quality
- Reduction of scrap
- Reduced dependence on manual labour
- Addresses health & safety issues
- Flexible process
- Just in time production reduces WIP
- Better utilisation of floor space

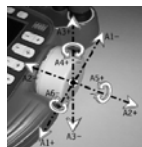


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Robot Programming



Off line using PC software



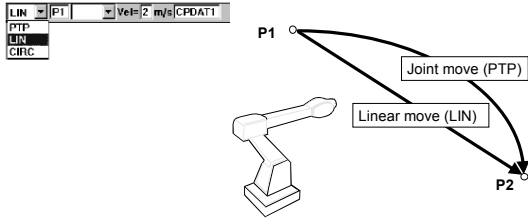
On line using the KUKA Control Panel

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Programming Principles



A program consist of series of points in space with embedded information relating to type of movement, speed, accuracy, acceleration, deceleration, I/O status etc.



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Critical Success Factors



- Acceptance on the shop floor
- Right level of training
- Consistency, consistency & consistency
 - Parts, locations, materials, quality

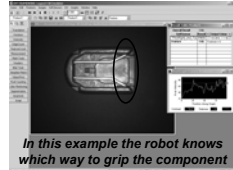
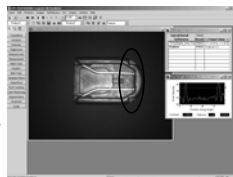
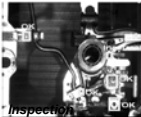
If it is impractical or cost prohibitive to achieve consistency, then a vision systems can provide a solution to make robotic automation still possible

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Most Common Applications for Vision

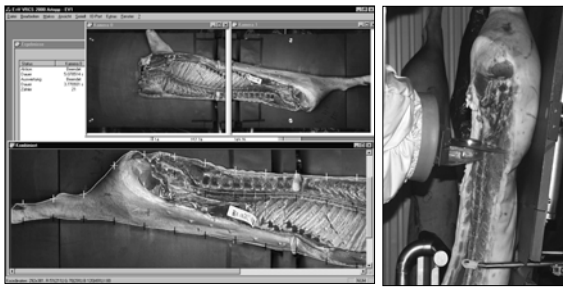


- Inspection
 - Presence of parts or product features
 - Robot program selection
- Location
 - Inconsistent pick up or put down positions
 - Locations can be stationary or moving
- Adaptive adjustment (e.g. welding)
 - Joint location
 - Gap conditions



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Example of Adaptive Adjustment



The vision system is looking for specific features. The robot system then makes the cuts resulting in a higher yielding.

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SWOT Analysis



Strengths

- Relatively low cost
- Integration into KUKA controller
- Vision systems becoming more robust



Weaknesses

- Few references
- Sensing abilities of robots still under developed



Opportunities

- Future trends and applications
- Ability to add value



Threats

- Awareness
- Acceptance in the market place

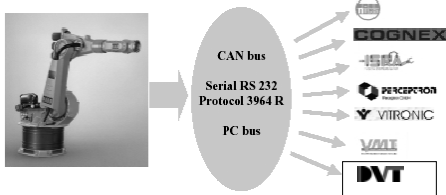


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KUKA's Aims for Vision Systems

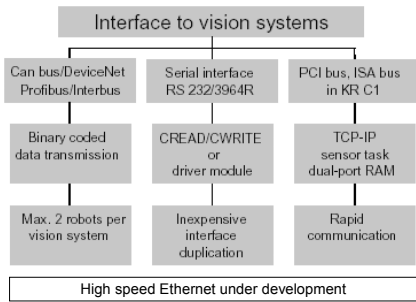


- Openness for all vision systems
- Use of standardized interfaces
- Simple handling during configuration



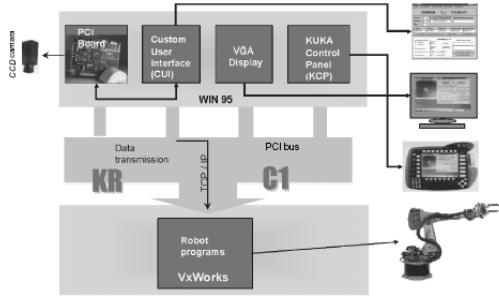
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Sensor Interfacing Options



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Process Technology Sensors



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Jaguar X202 Assembly Cell



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Process Requirements



- To solder contacts onto rear windscreen glass housing elements for the communication and navigation system
- Tolerance better than +/- 0.5 mm
- To distinguish between four variants of screen

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Why Vision



- The contacts need to be soldered onto the screen print rather than the glass
- Unable to mechanically centre the glass as the screen print position is not repeatable

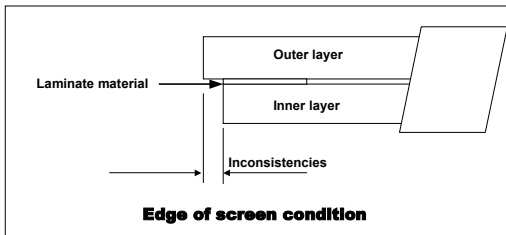


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Additional Inaccuracies



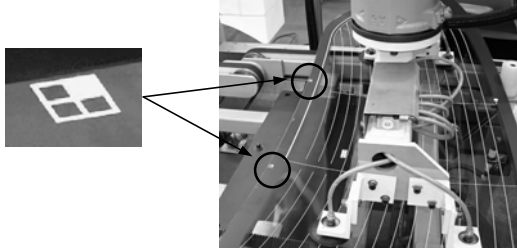
- Laminated screens are not consistent
- Centraliser not suitable in this case



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Fiducials to Reference the Screen Print

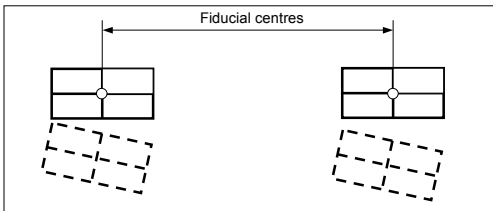
Two uniquely identifiable marks were added to the screen print design at 400 mm centres



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Function of the Fiducials

- ❑ Reference the screen print processing the information from 2 separate cameras to the KUKA KRC 1 control system and KCP
- ❑ Compensate for the glass curvature when picking up the screen and manipulating the screen through the soldering machine
- ❑ Identify the screen variant



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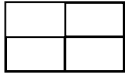
Display on KUKA Control Panel



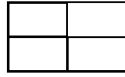
The operator has full control over the vision system via the KCP. There is no need for a separate monitor.

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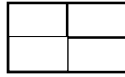
Identification of Screen Variants



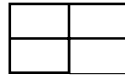
Variant A



Variant B



Variant C



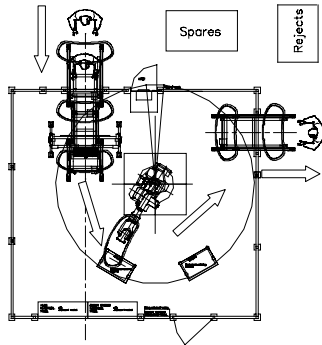
Variant D

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Layout



- 1 x KUKA KR125 Robot
- 1 x gripper
- 2 x Gognex vision systems
- 1 x High frequency lighting
- 1 x 14" monitor
- 1 x input conveyor
- 1 x output conveyor
- 2 x soldering & abrading equipment
- 1 x electrical control system
- 1 x guarding system



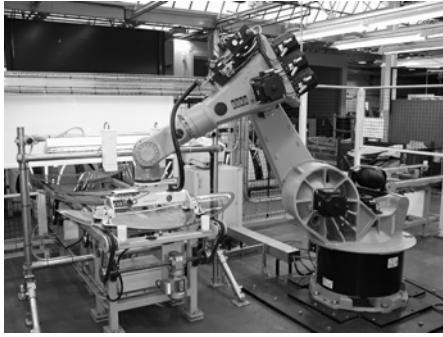
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Overall Cell



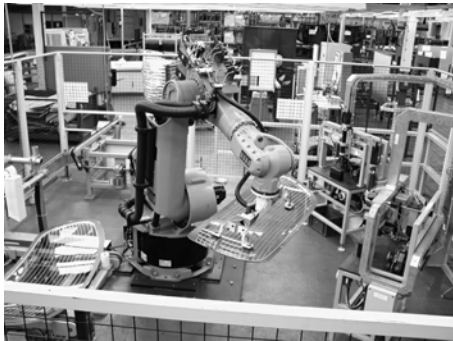
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Collection at Infeed Conveyor



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Move to Soldering Machine



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Manipulation through Soldering Machine



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Soldering Process



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Deposit at Output Conveyor




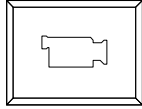
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Fault Diagnosis – Conveyor stops



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Video of the Jaguar X202 Assembly Cell 



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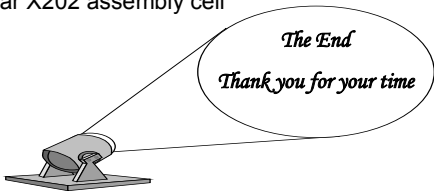
Critical Success Factors 

- KUKA adopted “can do” attitude
- Solution developed in close partnership with Pilkington Automotive
- Connectivity of KUKA KRC 1 controller allowed easy integration of the vision system
- Vision software runs on KRC 1 MS Windows allowing set up and viewing of images via the KUKA Control Panel
- Additional value added by monitoring process (missing or badly soldered contacts) and by accommodating Jaguar build order

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