SKEM4153
ROBOT TECHNOLOGY FOR AUTOMATION

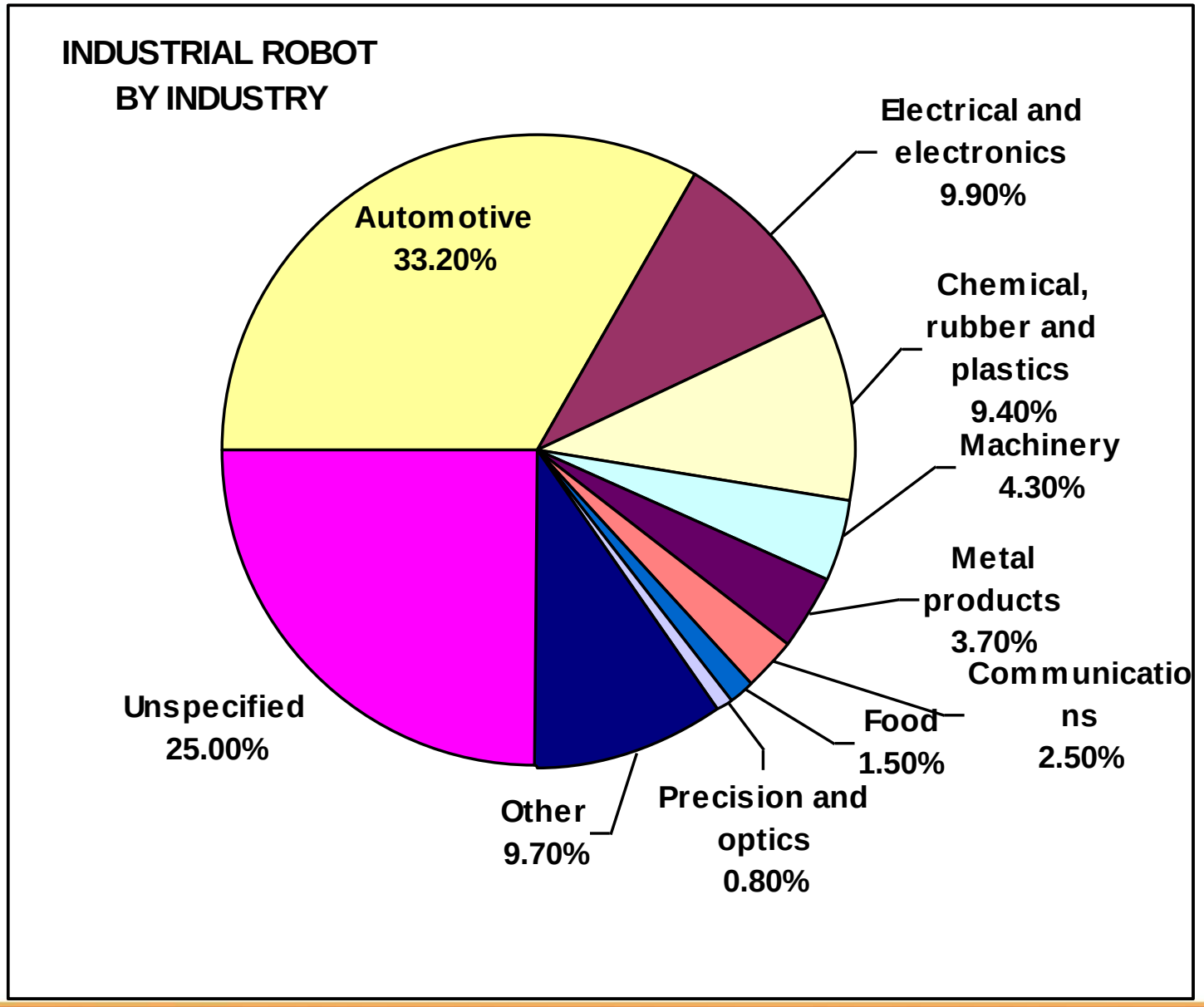
CHAPTER 1
ROBOT APPLICATIONS IN INDUSTRY

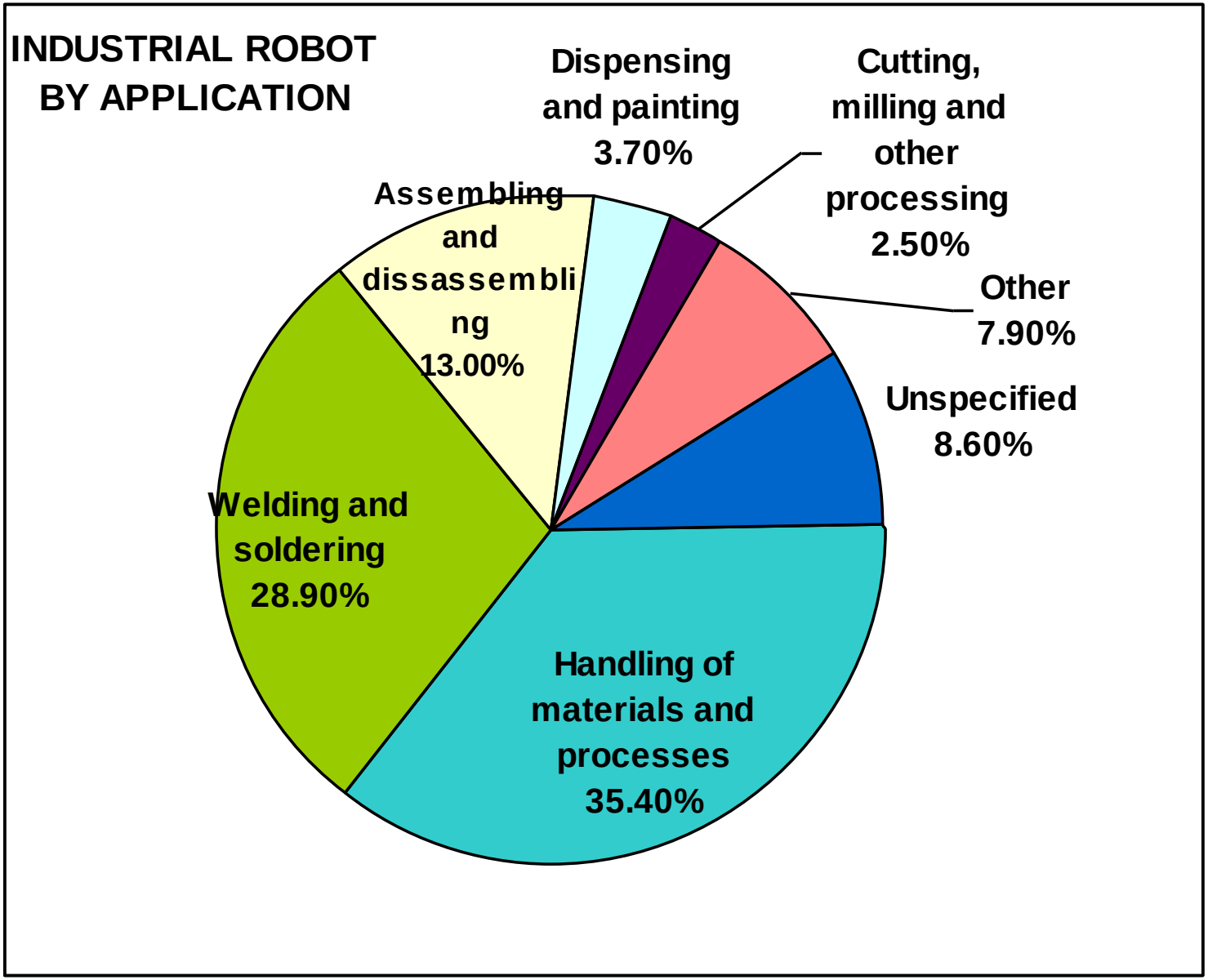
Prof. Dr. Shamsudin H.M. Amin
Ir. Dr. Mohd Ridzuan Ahmad
(mdridzuan@utm.my)

Industrial Robot Definition

Industrial Robot can be defined as a general-purpose, programmable machine possessing certain anthropomorphic characteristics

- Hazardous work environments
- Repetitive work cycle
- Consistency and accuracy
- Difficult handling task for humans
- Multi shift operations
- Reprogrammable, flexible
- Interfaced to other computer systems


INDUSTRIAL ROBOT
BY INDUSTRY
Automotive
33.20%
Electrical and
electronics
9.90%
Chemical,
rubber and
plastics
9.40%
Machinery
4.30%
Metal
products
3.70%
Communicatio
ns
2.50%
Food
1.50%
Precision and
optics
0.80%
Other
9.70%
Unspecified
25.00%


INDUSTRIAL ROBOT BY APPLICATION
Dispensing and painting 3.70%
Cutting, milling and other processing 2.50%
Other 7.90%
Unspecified 8.60%
Handling of materials and processes 35.40%
Welding and soldering 28.90%
Assembling and dissassembling 13.00%

Laws of Robotics

Isaac Asimov (a well known science fiction writer) proposed three "Laws of Robotics":

- **Law 1**: A robot may not injure a human being or through inaction, allow a human being to come to harm
- **Law 2**: A robot must obey orders given to it by human beings, except where such orders would conflict with a higher order law
- **Law 3**: A robot must protect its own existence as long as such protection does not conflict with a higher order law

History and Development of robots and robotics system

- Joseph Engelberger (dubbed as the father of industrial robots) and George Devol (known as the grandfather of industrial robots) were the pioneers in the area of industrial robots and their applications in the industry (started in 1951).

- The first industrial robot, a Unimate from Unimation, was installed in 1961 at a General Motor (GM) plant for unloading a die casting machine.

- Most early installations were in automotive industries in the USA and Japan (from 1980's), particularly in the areas of:
  - machine loading and material handling
  - spot welding
  - spray painting

History and Development of robots and robotics system (cont.)

- Robots with greater precision, complex control algorithm and advanced sensory capabilities begin to be built in the mid-70's. In 1978, a PUMA (Programmable Universal Machine for Automation) robot by Unimation was installed in a GM plant. Vision, tactile sensing and intelligent control then become important research topics.
- In the mid-80's, there are 16,000 industrial robots in the USA alone and 35% of them were in automotive assembly plants.
- In the US history, robot applications increased the productivity by up to 30%, especially when the robots were integrated into an automated system.
- In Japan, 60,000 industrial robots have been installed by the mid-80's. The Japanese government had a special program for robotics and they are now the world leader in the usage of robots in the industry. Japanese industries lead the American's because of their extensive use of robots in their plants.

DEALING WITH ISSUES OF INDUSTRIAL RELATION

When robots were first introduced, there was a lot of apprehension and resistance coming from the labour work force. They were concerned that usage of robots would mean loss of jobs as robots would be replacing humans in carrying out industrial tasks. To allay those fears and resistance, in the USA, the RIA (Robotics Industries Association) has put up the following promise for the opponents of robot usage in the industry:

- Not to replace workers, only replace equipment.
- Use only for hazardous, boring, demoralizing, and repetitive tasks.
- Only if it can result in shorter work week, higher pay, and better working conditions for human.

Today, robots are seen as helping humans with hazardous tasks, repetitive and boring tasks, making life more comfortable for humans. Robots are now widely accepted at the work place as just like other pieces of equipment.

Benefits of Industrial Robots Applications

(the following are the most common benefits)

- Increased output rates.
- Elimination of dangerous or undesirable jobs for human.
- Improved product quality.
- Increased manufacturing flexibility.
- Reduced material wastage.
- Easier to compliance with standard regulations e.g. OSHA
- Reduced labor turnover.
- Lower capital cost.
- Controlled and faster inventory turnover.

MAN vs. ROBOT

HUMAN FACTORS

- Mental and Physical Fatigue
- Interruptions due to personal problems
- Interactions with others
- Easily affected by adverse conditions
- Always demand higher pay

GIVE RISE TO PROBLEMS

- Inconsistent Work Quality
- Unstable Production
- High Labour Turnover
- Delay in Product Delivery
- Escalation in production cost

HUMAN vs ROBOT

ROBOT ON THE OTHER HAND:

- Does not tire out
- Not emotional
- Does not take holidays
- Does not demand higher pay
- No Monday morning, Friday afternoon syndrome
- Does not argue with superiors
- Does not form Trade Unions

Table on Standards and Codes for industrial robots

Group	Standard	Subject
1. ANSI/RIA	R1056-1986	American national standards for industrial robots and robot systems
2. BSR/RIA	BSR/RIA R15-06-19XX	Proposed standard for industrial robots and robot systems
3. ANSI/RIA	R15.02-1990	American national standard human engineering design criteria for hand-held robot control pendants
4. OSHA	Pub. 2254 (revised)	Training requirements in standards and training guidelines
5. NIOSH	Pub. 88-108	Safe maintenance guidelines for robotics workstations
6. OSHA	Pub. 8-1.3, 1987	Guidelines for robotics safety
7. OSHA	29 CFR 1910.147	Control of hazardous energy source (lockout/tagout final rule)
8. AFOSH	127-12, 1991	Occupational safety machinery

ANSI/RIA = American National Standards Institutes/Robotics Industrial Association.

BSR/RIA = Bureau of Standards Review/Robotics Industrial Association.

NIOSH = National Institute for Occupational Safety and Health.

OSHA = Occupational Safety and Health Administration.

AFOSH = Department of the Air Force.

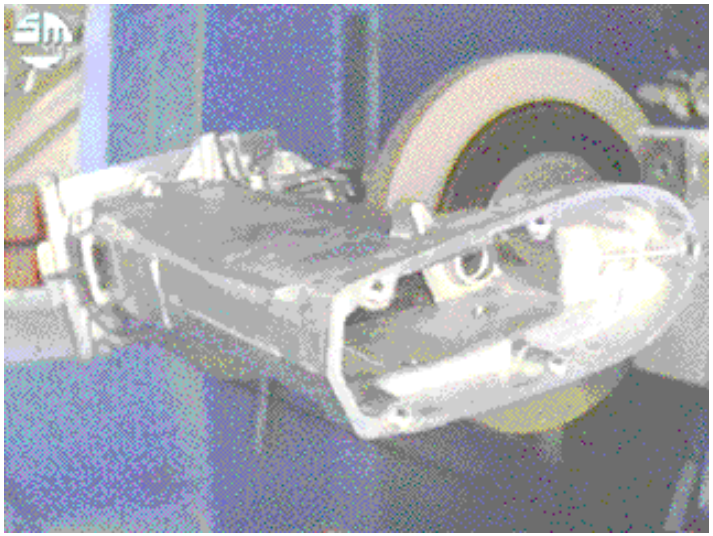
Some Examples of Industrial Robot Applications

AEROSPACE TECHNOLOGY

- Robots being use extensively especially for flexible aircraft assembly– use fixtures for temporary fastening, the permanent fastening must be drilled and parts dissembled for deburring and cleaning, finally parts are reassembled and permanently fastened.
- It was reported that, in many installation around the world in Aircraft Manufacturing, the following improvements have been achieved :
  - Reduced cost
  - Shorter cycle time
  - Improved control
  - Increased throughput and surge capability
  - Improved quality

Examples of Industrial Robot Applications

POLISHING



BUFFING

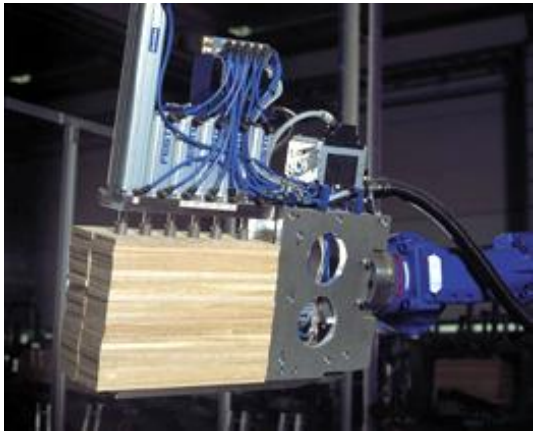
DEBURRING & POLISHING

Examples of Industrial Robot Applications

MATERIAL HANDLING

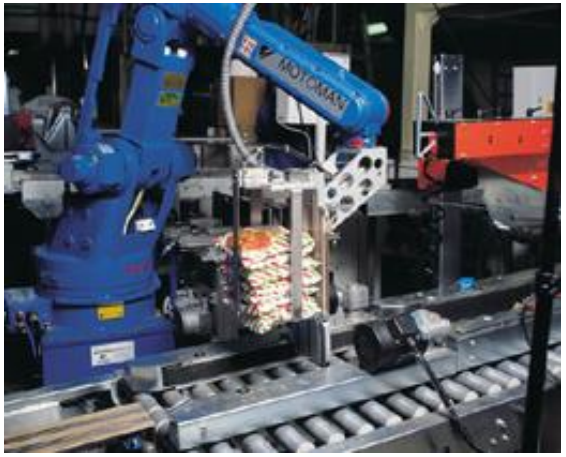
Handling bottles from the filling machine into trays.

Feeding the parquet grinding machine with a pile of parquet blocks.



Arranging packets to be put into cardboard boxes.

Arranging sacks from filling machine onto a conveyor.



Examples of Industrial Robot Applications

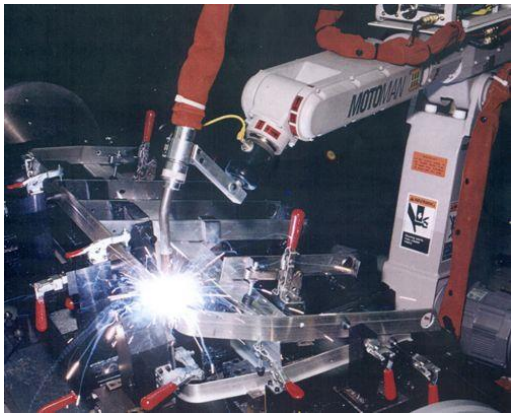
PALLETISING & DEPALLETISING

Press brake operation.

Palletising of cardboard boxes.

Examples of Industrial Robot Applications

WELDING



Examples of Industrial Robot Applications

Waterjet Cutting

Examples of Industrial Robot Applications

Labelling application

Labelling of pallets. A sensor in the labelling tool measure the surface of the pallet. The robot controller calculates the exact position of the labels. Standard labelling tool for up to A3-size.Cycle time for two labels is about 15 seconds.

Examples of Industrial Robot Applications

APPLICATIONS IN AGRICULTURAL INDUSTRY

Motoman UP200 robot spot welds large agricultural equipment assemblies

Walking forest harvester prototype by Plustech Ltd., today part of John Deere

Examples of Industrial Robot Applications

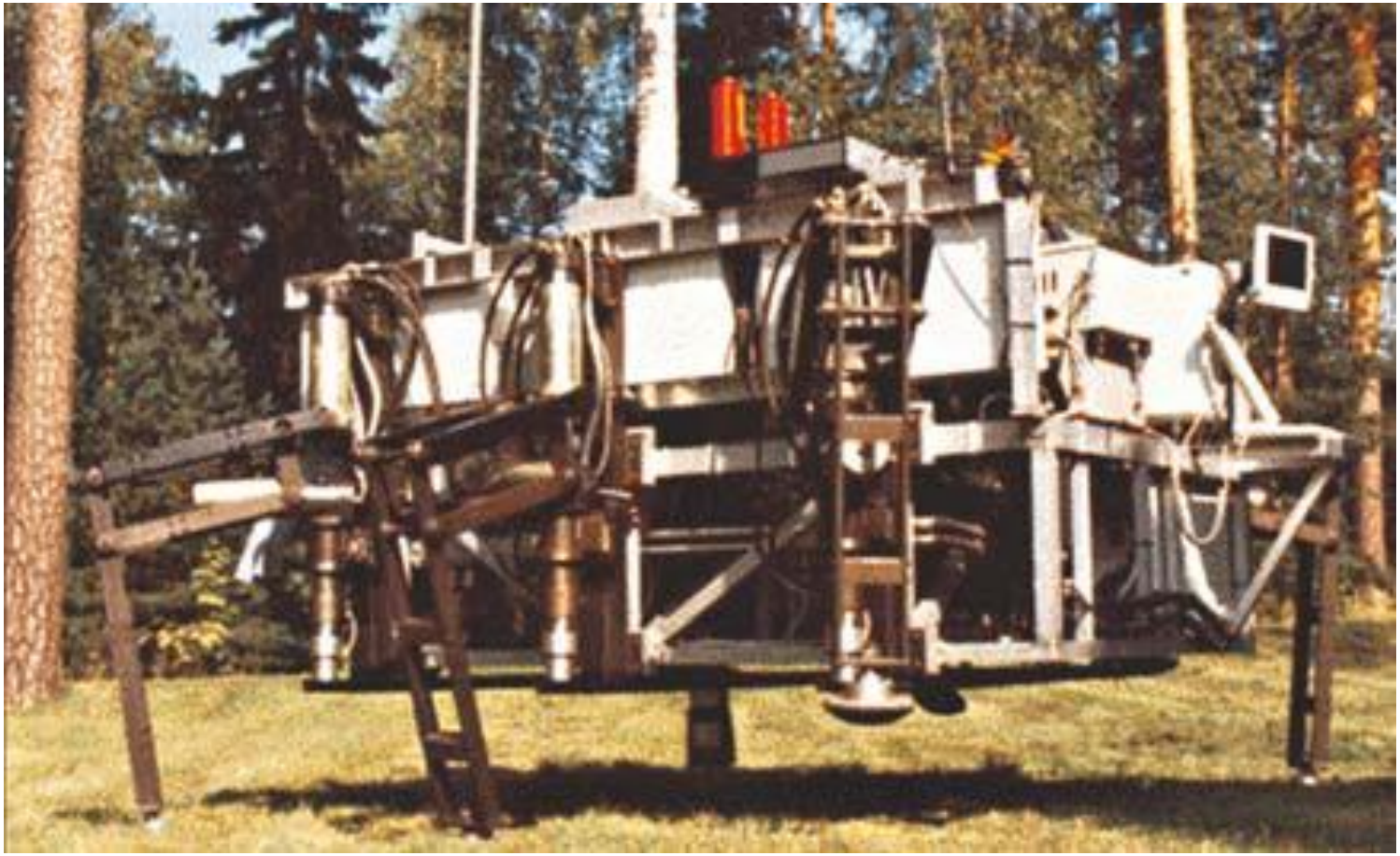
APPLICATIONS IN AGRICULTURAL INDUSTRY (cont. 1)

Cut-to-length (CTL) harvester made by Ponsse Oy Ltd.

CTL Forwarded

Examples of Industrial Robot Applications

APPLICATIONS IN AGRICULTURAL INDUSTRY (cont. 2)



MECANT walking machine by Halme et al. at TKK.

Examples of Industrial Robot Applications

APPLICATIONS IN AGRICULTURAL INDUSTRY (cont. 3)

Macadamia nut sorter with camera (tomato, broccoli, apple sorters)

Examples of Industrial Robot Applications

APPLICATIONS IN CONSTRUCTION INDUSTRY

Concrete panel installation robot
(courtesy Fujita Research)

Large scale pipe manipulator

Large manipulator system
(courtesy Shimizu Corp.)

Examples of Industrial Robot Application

APPLICATIONS IN CONSTRUCTION INDUSTRY (cont.1)

Autonomous Excavator Robot

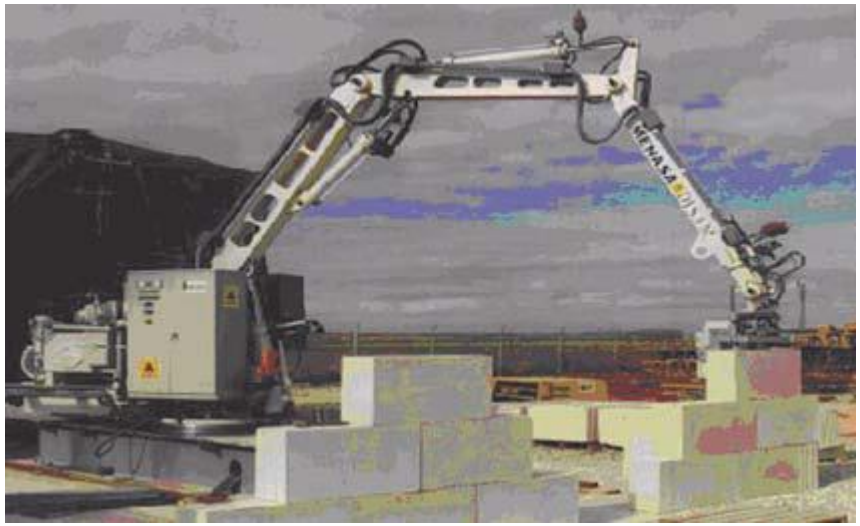
Concrete surface finishing robot

Teleoperated concrete spraying robot
(courtesy MEYCO Equipment)

Examples of Industrial Robot Applications

APPLICATIONS IN CONSTRUCTION INDUSTRY (cont.2)

Teleoperated pothole patching robot



Concrete block laying robot

Hard rock automated drilling robot

Examples of Industrial Robot Applications

APPLICATIONS IN FOOD/BAKERY PRODUCTS MAKINGS

Examples of Industrial Robot Applications

What else?

ROBOT PACKAGING

PRINTED CIRCUIT BOARD'S COMPONENT INSERTION

PHARMACEUTICAL MANUFACTURING

APPLICATIONS IN TEXTILE INDUSTRY

APPLICATIONS IN BRICK INDUSTRY

APPLICATIONS IN GLASS INDUSTRY

PRINTING & PUBLISHING INDUSTRY

And Many More!

AN APPROACH ON INSTALLATION OF ROBOTS

A logical sequence of steps to implement a robotic program in its operations:

- Initial familiarization with the technology
- Plant survey to identify potential applications
- Selection of the applications
- Selection of the robot
- Detailed economic analysis and capital authorization

ROBOT INSTALLATION PROCEDURE

1. PLANNING

Introduction
Task Force
Master and Detail Schedule
Documents Preparation
Material Preparation
Tool Preparation
Layout Preparation
Job Sharing
Safety Meeting

ROBOT INSTALLATION PROCEDURE

2. INSTALLATION

Measurements
Material Orientation
Electrical Wiring
Mechanical Fitting
Accessories
Robot Tool Fitting
Alignment
Safety Fence
Robot Programming
PLC Programming
Discussion, Problem Sheet, Reporting, Dress-up

ROBOT INSTALLATION PROCEDURE

3. INSPECTION

Static, Dynamic,
Electrical, Mechanical,
Safety Inspection
Inspection Sheet &
Robot Inspection

4. TRIAL

Manual, auto operation
Sequence Check
Low/High Speed
Accuracy Check and confirmation
Quality and Cycle-time confirmation
Up-date standard operation

ROBOT INSTALLATION PROCEDURE

5. MODIFICATION AND RETRIAL

Immediate and Long-term Action
Scheduling
Retrial
Overall Confirmation

6. ENDURANCE TEST

Reliability, Variance Test
Problem Detection
Performance Test
Safety Test

ROBOT INSTALLATION PROCEDURE

7. TRAINING

Operators,
Supervisors,
Engineers,
Managers

8. FINAL REPORT

Technical report & documentation

TEXT AND REFERENCE BOOKS

Textbook:

1. James A. Rehg: Introduction to Robotics in CIM Systems. Fifth Edition, Prentice-Hall. 2003.

Reference book:

1. Mikell P. Groover: Automation, Production Systems, and Computer Integrated Manufacturing, Second Edition. 2004.
2. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey: Industrial Robotics: Technology, Programming, and Applications, McGraw-Hill. 1986.
3. Farid M. L. Amirouche: Computer-Aided Design and Manufacturing. Prentice-Hall.
4. Richard K. Miller, Industrial Robot Handbook. Van Nostrand Reinhold, N.Y. (1987).