

DD2426 – Robotics and Autonomous Systems

Lecture 1: Introduction

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Welcome!

- ▶ Welcome to DD1426 2008
- ▶ Course on Robotics Systems
 - ▶ Lectures on some core topics in robotics (theory)
 - ▶ Build your own “soccer” playing robot (practice)
- ▶ This course has been running in various forms since 1995

The crew

- ▶ Lectures: Patric Jensfelt (patric@nada.kth.se)
- ▶ Project : Mattias Bratt ([mattias.bratt AT gmail dot com](mailto:mattias.bratt@gmail.com))

Registration

- ▶ You need to sign registration list
- ▶ Limited to 32 people this year

Course web page

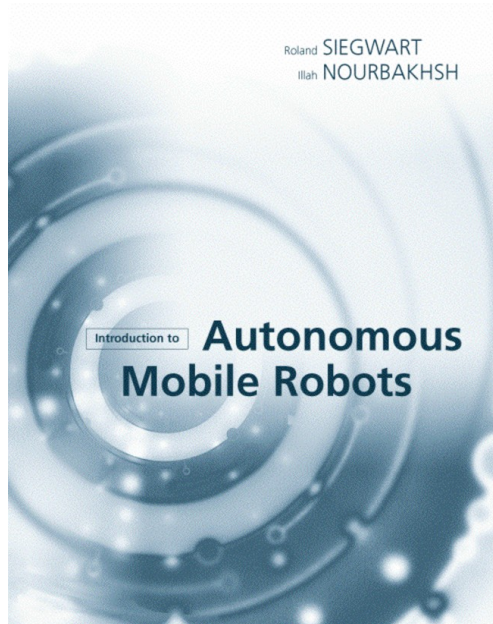
- ▶ News will be posted on course web page
<http://www.csc.kth.se/utbildning/kth/kurser/DD2426/robot08/>

Course material

- ▶ Book
- ▶ Lecture notes
- ▶ Material to build a robot

Course book

- ▶ Siegwart & Nourbakhsh, Autonomous Mobile Robots, MIT press

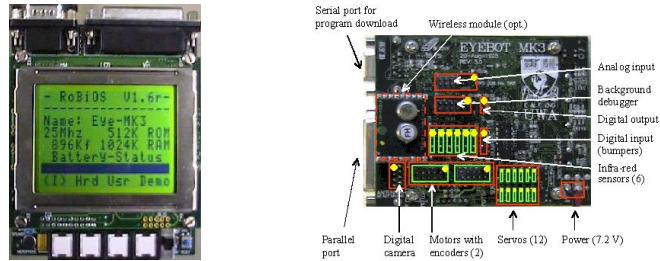


Lecture slides

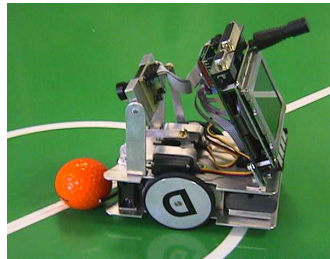
- ▶ Will be available for download in connection with the lecture
- ▶ Please do not print them on the CSC printers!
- ▶ If you do I cannot have them online

Building a robot

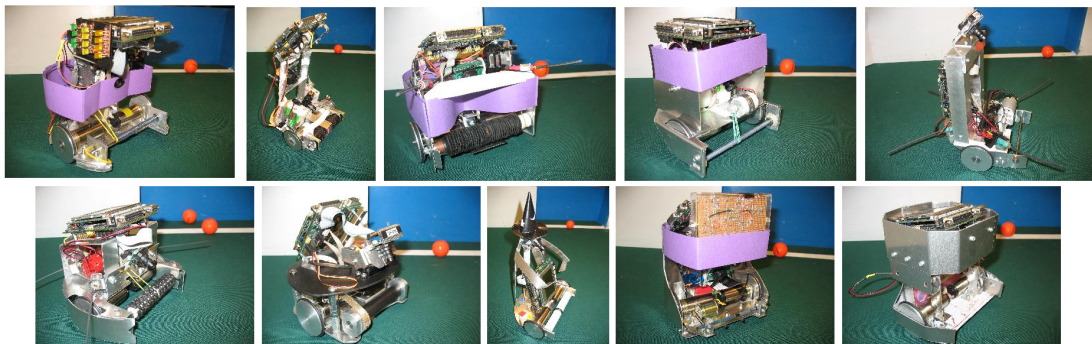
- ▶ Embedded Robot Controller EyeBot system MC68332 Controller



- ▶ Various building material to construct a robot



Robots from last year



Course evaluation

- ▶ From course evaluation from last year
 - ▶ Difficulty: average to difficult
 - ▶ 54% said that < 10% overlap with previous courses
 - ▶ 54% spent 100h or more on the project ⇒ it takes a lot of time!
- ▶ Look at the entire thing at

<http://www.csc.kth.se/utbildning/kth/kurser/DD2426/robot07/kursanalys/>

Forming groups

- ▶ Project carried out in groups of 4 people
- ▶ Two factors to think about
 - ▶ Complementary knowledge (electronics, programming, mechanics, etc)
 - ▶ Matching schedules so that you can work together!!!
- ▶ Groups should be formed no later than April 1 (lecture).
- ▶ Send group formations (names + emails) to patric@nada.kth.se

Course requirements

- ▶ Written exam May 22, 9-12
- ▶ Build a robot that can find a ball and move towards it
- ▶ Project report no later than June 5
Late reports implies chance of getting higher grades from it
Reports from earlier years accessible through course web page!

Project

- ▶ Build a robot
- ▶ Try to meet milestones along the way
- ▶ Football competition at the end for fun

Milestones

- ▶ Three milestones are defined along the way toward a football playing robot
 - ▶ Milestone 0: Control motion of the robot
 - ▶ Milestone 1: Find a ball and drive towards it (Course requirement)
 - ▶ Milestone 2: Score a goal without opponent
- ▶ Each one met in time gives 2 bonus credits on the exam
- ▶ For more details see course homepage

Some topics covered on lectures

- ▶ Locomotion principles
- ▶ Robot Kinematics
- ▶ Robot Control
- ▶ Sensors and sensing systems
- ▶ Mapping and Estimation
- ▶ Planning
- ▶ Navigation

Date for competition

- ▶ Preferable to have competition before exam
- ▶ Tentative dates
 - ▶ May 13, 14-17
 - ▶ May 14, 14-17
 - ▶ May 15, 14-17
- ▶ Please cast your vote at
<http://www.doodle.ch/d9a7i2gehmxwxy7y>
- ▶ Voting closes at Wednesday 26/3 at 15:00

This course

- ▶ The lectures covers
 - ▶ Locomotion principles
 - ▶ Basic control and kinematics
 - ▶ Sensors for mobile systems
 - ▶ Mapping and Localization
 - ▶ Planning and supervision
- ▶ Will be tested on the exam

This course cont'd

- ▶ Design of a robot system to play “soccer”
 - ▶ Basic locomotion
 - ▶ Detect ball and opponent
 - ▶ Plan to score a goal
- ▶ Design of system, basic electronics and interface
- ▶ Programming in C

Lab Space

- ▶ Two rooms in main building
 - ▶ Programming, development and testing
Room 1535
1 PC per group
 - ▶ Workshop for construction of the robot
Room 1621

Opening up the lab

- ▶ Will open the lab 15-17 on Tuesday next week, April 1
- ▶ Is this a good time for most people?

Competition

- ▶ Fun to compare your robot with others
- ▶ Steps
 - ▶ Unopposed scoring (for seeding)
 - ▶ Group play
 - ▶ Semi-finals between 4 best teams from group play
 - ▶ Final

Last Years Competition

- ▶ 10 teams
- ▶ Videos available at

<http://www.csc.kth.se/utbildning/kth/kurser/DD2426/robot07/robots2007/>



Outline

- ▶ Examples of swedish robotics
- ▶ Some application domains
- ▶ A case study
- ▶ Video from last year

Swedish robotics

- ▶ Sweden has traditionally be quite strong in robotics
 - ▶ ABB - industrial robots
 - ▶ Electrolux - vaccuum cleaner
 - ▶ Husqvarna - lawnmower

ABB - Industrial robots

- ▶ Car industri for spot welding, spray painting, ...



Husqvarna - Autonomous Lawnmower

Robotic Lawnmowers



 **Husqvarna**



Electrolux Autonomous Vacuumcleaner Trilobite



Autonomous?

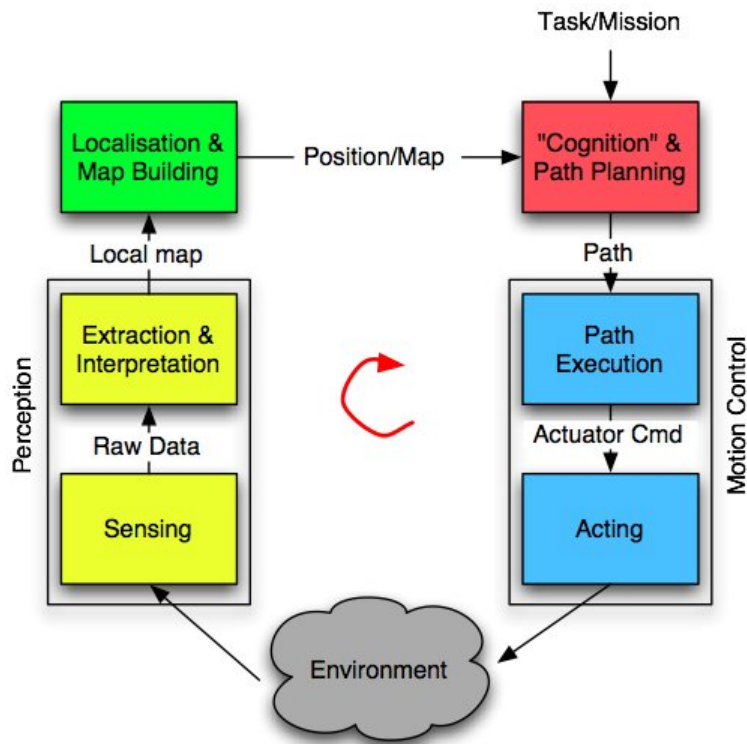
- ▶ The robot should be able to operate in an environment where not everything is known a priori
- ▶ React to unforeseen events
- ▶ Make decision based on sensor input

Mobile?

- ▶ Traditional (industrial) robots are bolted to the floor
- ▶ Are very good at what they do, but
- ▶ They cannot move!

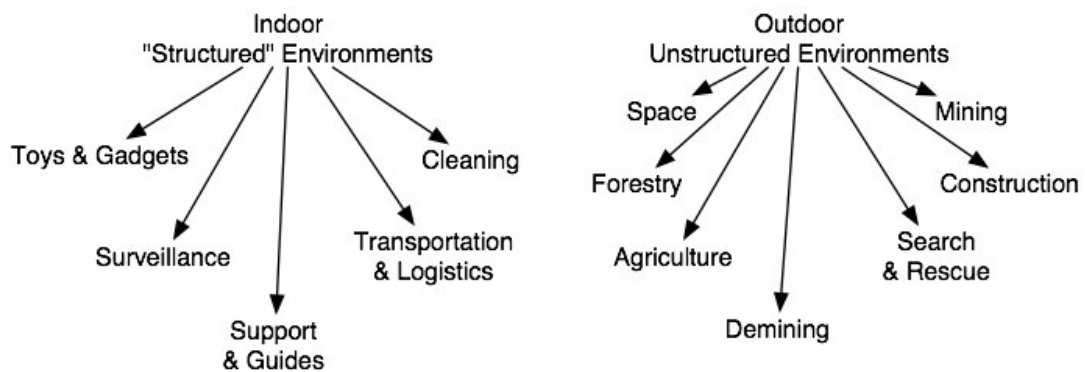


System overview



Applications

- Applications quite different indoor and outdoor



Toy example

- ▶ The Sony AIBO indended initially as a companion
- ▶ Price about \$2000
- ▶ RoboCup 4-legged league
- ▶ Now discontinued



More toys

Entertainment-Robots



SONY QRIO (J)



Sanyo Flatthru (J) auf der ROBODEX, 2003



Sony AIBO, ERS-7M2 (J)



Partner-type Personal Robot (PaPeRo), NEC System Technologies, Ltd. (J)



TOYOTA MOTOR CORPORATION (TMC), (J)



Mona, Oskar, Opel Rüsselsheim (D)



"Banryu", tmsuk Co., LTD. and Sanyo Electric (J)



Wakamaru, MHI (J)



RoboX, Bluebotics S.A. (CH)

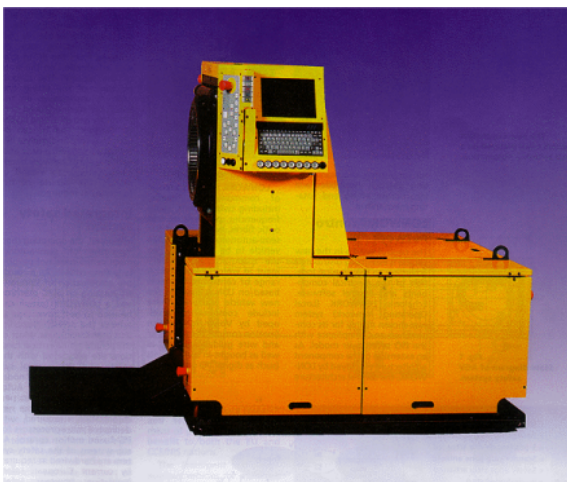
Guide robots

- ▶ Popular at museums
- ▶ Helps for elderly



Logistics and transportation

- ▶ In Volvo Factories many of the transportation tasks are automated such as motor transport, supply chain , etc. AGVs for special purpose platforms for transportation of goods
- ▶ More than 4000 vehicles in use by Volvo at its factories



Logistics and Transportation

- ▶ Material delivery in hospitals
 - ▶ Nurses spend > 10% of their time on transportations



Cleaning

- ▶ One of the first application domains
- ▶ Electrolux first on the market
- ▶ Now many different brands

Roomba and Scooba from iRobot



- ▶ Over 2 million Roombas sold

Commercial cleaning

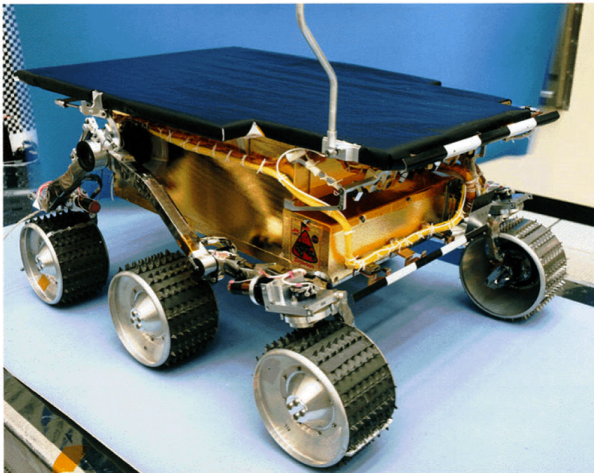


Outdoor applications

- ▶ Forestry
- ▶ Search and rescue
- ▶ Space and exploration
- ▶ 3D: Dull, dangerous and dirty

Space exploration

- ▶ Sojourner, Spirit, Opportunity
- ▶ Go beyond human reach



Search and rescue

- ▶ 8 robots were used at WTC 13 Sept 2001
- ▶ “Bomb” robots (used by police, firedepartment and military)
- ▶ Often teleoperated



Some robots at KTH



Robot technology in everyday products

- ▶ Robot technology is sneaking up on us
- ▶ Small steps at a time
- ▶ What was science fiction yesterday is everyday technology today
 - ▶ Car keeping distance automatically, collision checking
 - ▶ Quality control
 - ▶ Navigation systems for cars, planes and boat
 - ▶ ...

Androids



by Hiroshi Ishiguro

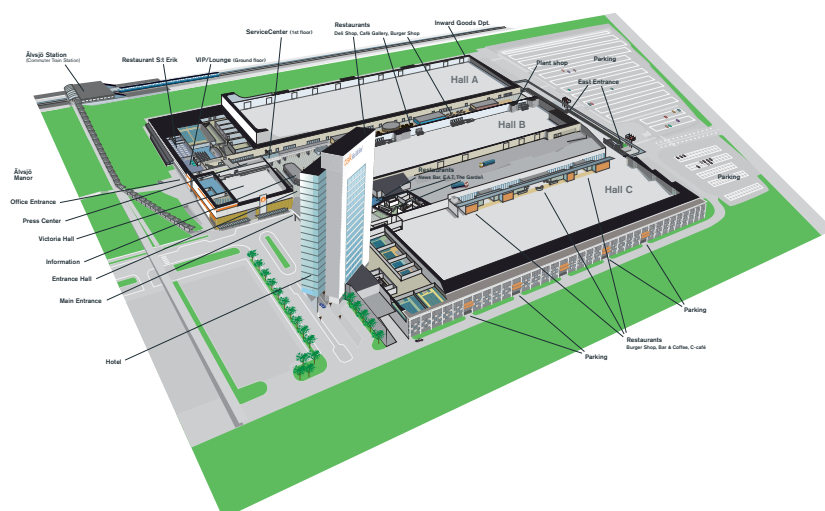
Raises questions about ethics. What are we allowed to do with robots?

Building a robot system

- ▶ Many components are needed to build a robot system
- ▶ The field is highly inter-disciplinary
- ▶ Study a “simple” test case

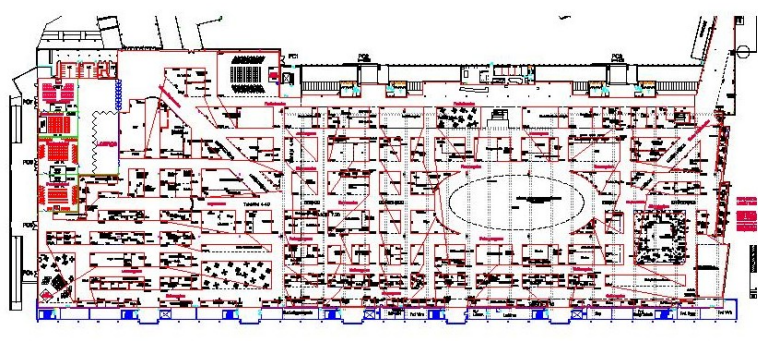
Floor marking at Stockholm International Fairs

- ▶ 70 regular fairs
- ▶ 1.000 congresses, conferences and seminars a year.
- ▶ 3 main halls, total 56,500m²

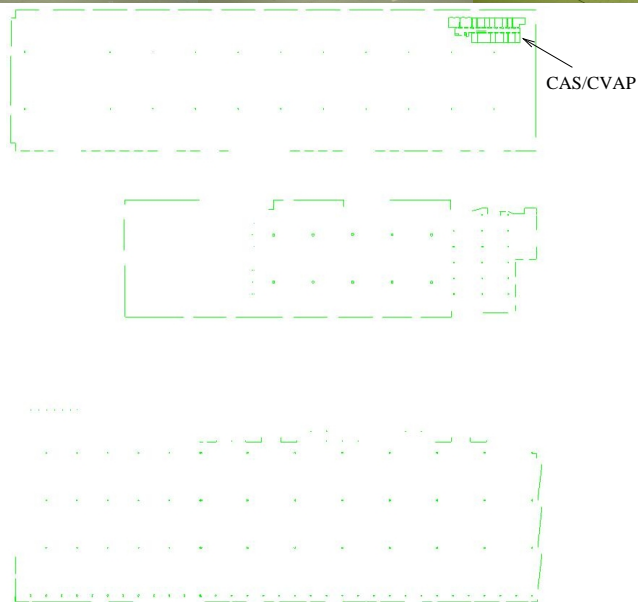


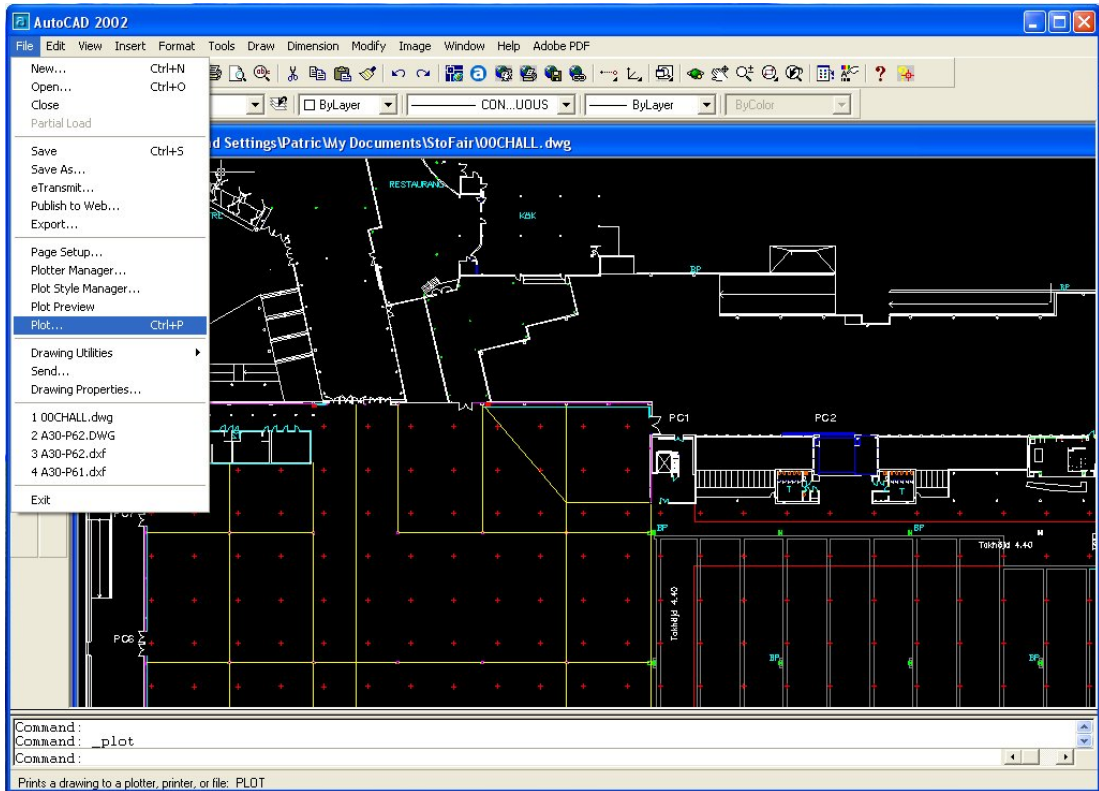
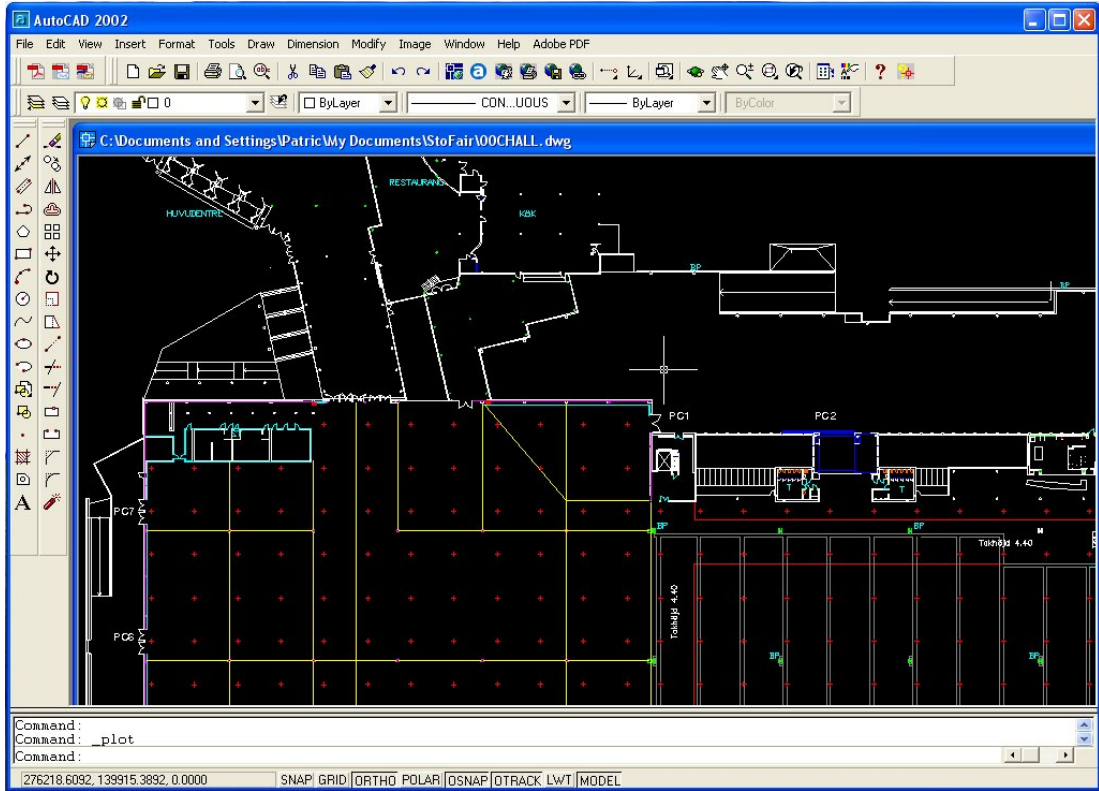
Marking the stands

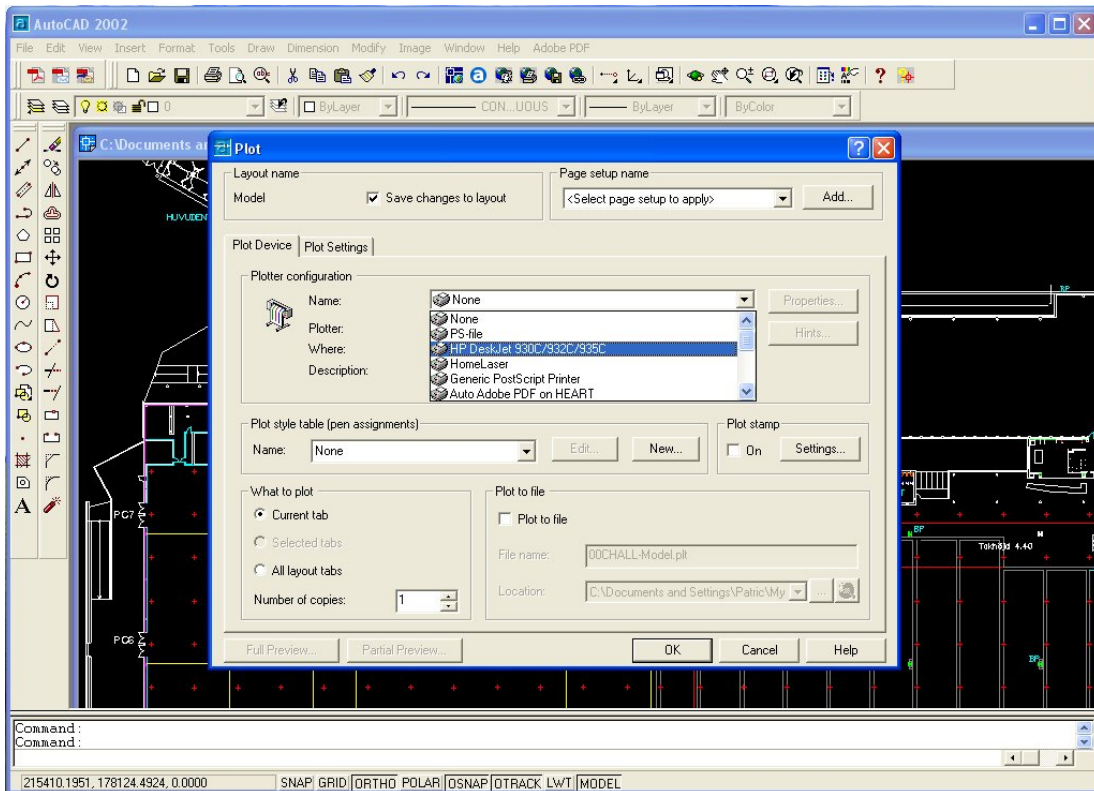
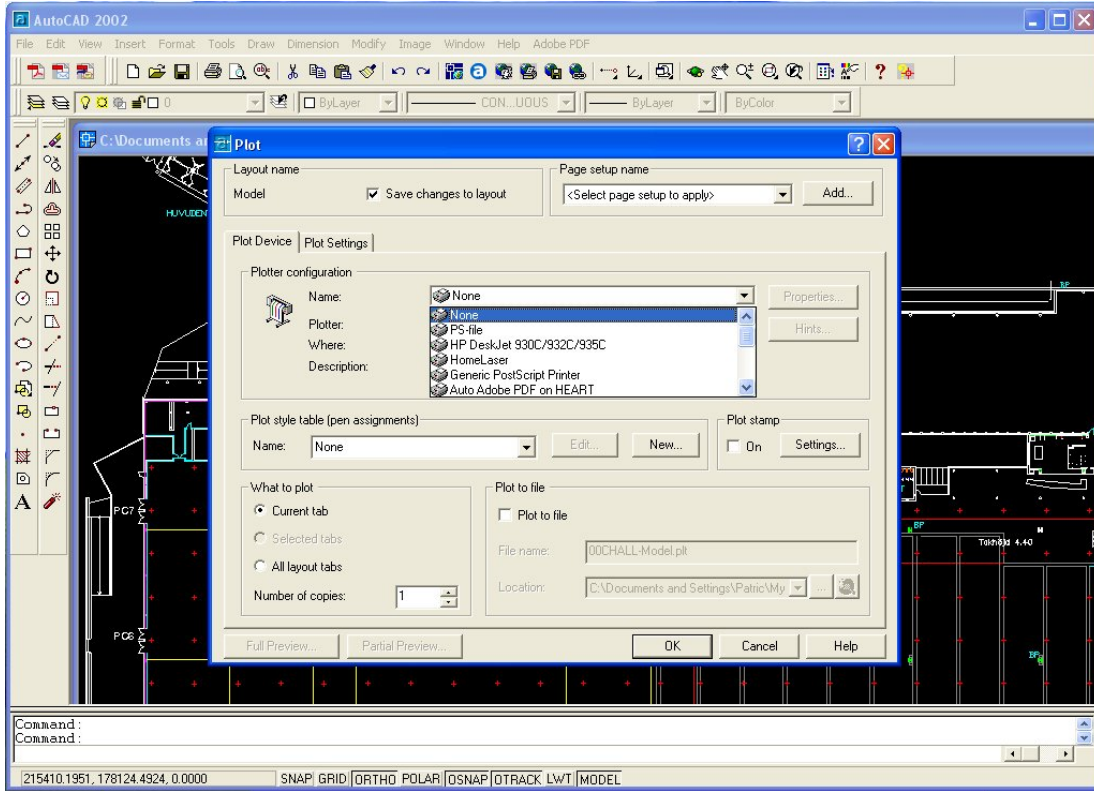
- ▶ Flexible layout
- ▶ Manual labour with tape measure and tape
- ▶ Can be hundreds of stands per fair and in the order of a thousand points to mark
- ▶ Often odd hours (e.g. nights)
- ▶ Very tedious and boring

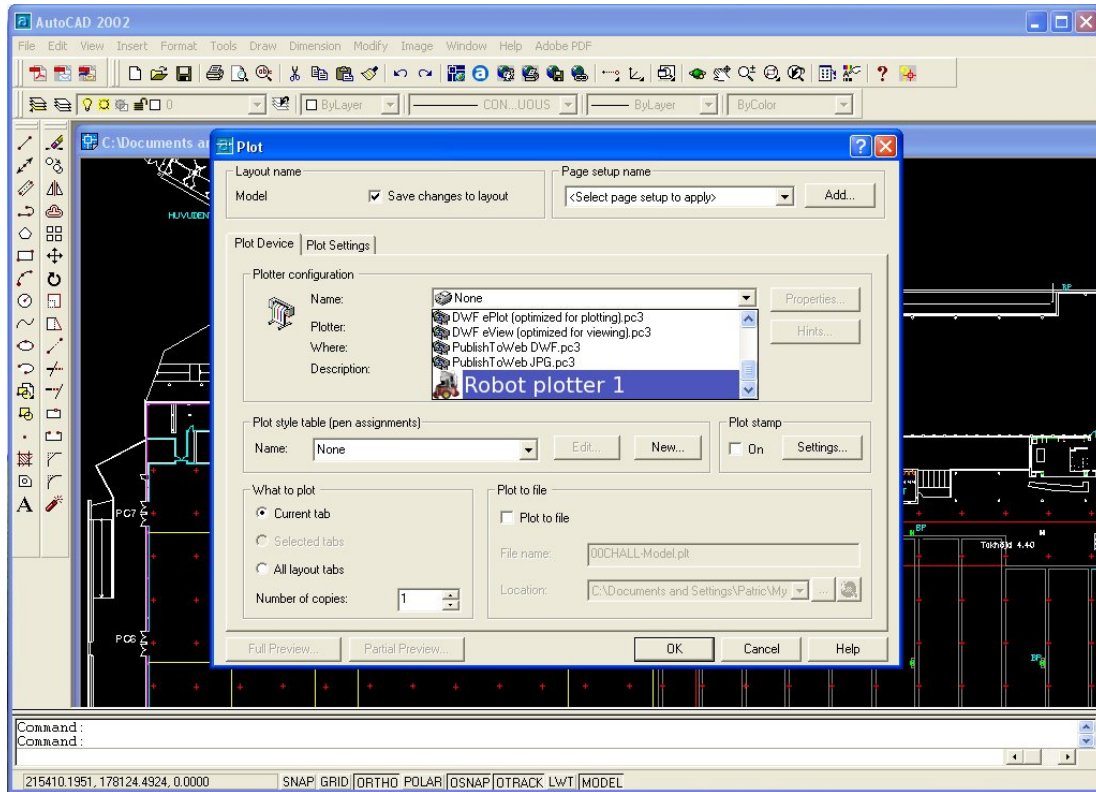


The StoFair Environment

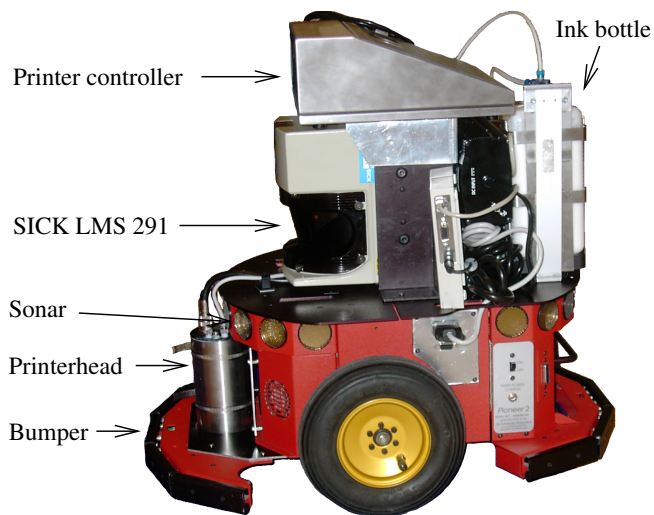




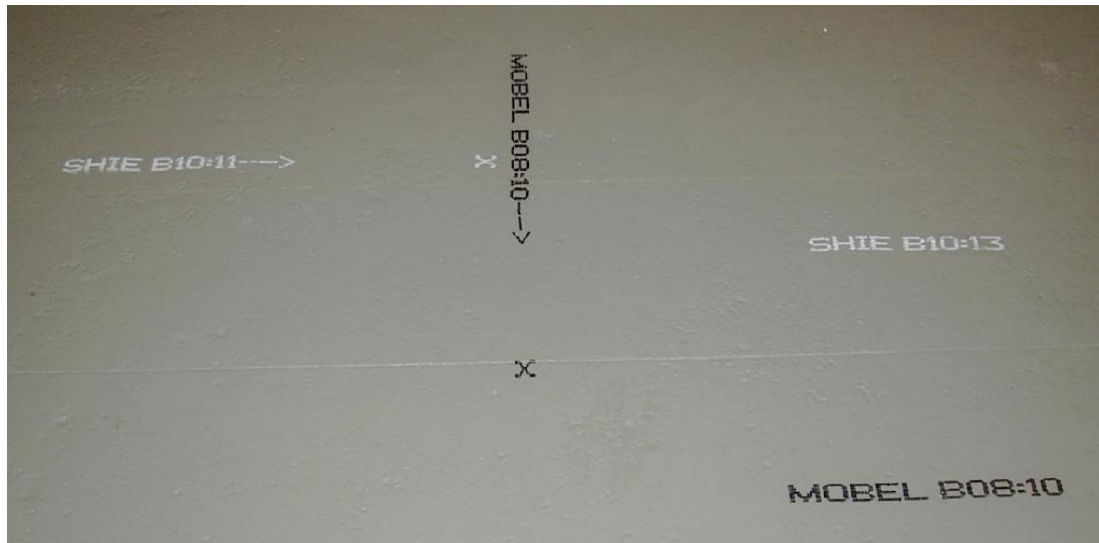




Meet Harry Plotter and friend!



Example mark



Harry plotting

Harry following Erik

Results

- ▶ Gain in productivity
 - ▶ Before: 2 people 8h
 - ▶ Now: 1 robot + 1 operator 4h
- ▶ Been running in production since August 2003

Main components in StoFair system

- ▶ Positioning system (where is the robot)
Where am I?
- ▶ Marking device (mark on the floor)
Actuation in general. Manipulation, etc
- ▶ Obstacle avoidance (don't run into things)
Navigation
- ▶ Trajectory planning (what order to mark, "TSP")
Planning, reasoning, etc
- ▶ User interface (how to operate it)
How to communicate?

TODO

- ▶ Form groups until next Tuesday
- ▶ Cast your vote in the poll for competition date
<http://www.doodle.ch/d9a7i2gehmzwx7y>