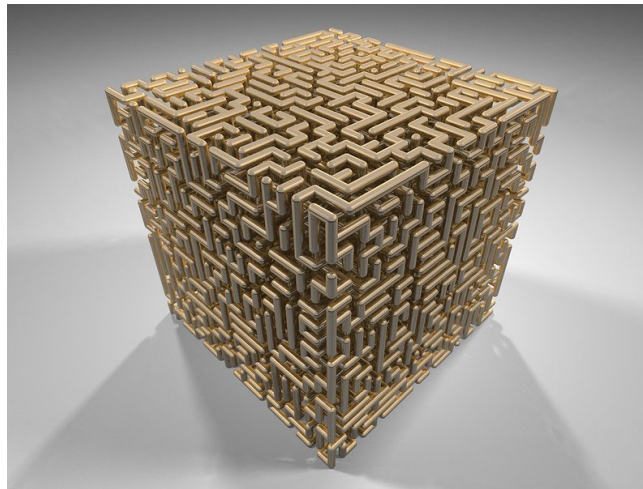


"Connex labyrinth" by fdecomite is marked with [CC BY 2.0](#).

# Welcome to: Automation in Complex Systems



Gunnar Lindstedt IEA, Lund University  
[gunnar.lindstedt@iea.lth.se](mailto:gunnar.lindstedt@iea.lth.se)

automation in complex systems 2022

# Overview of the course

- Lectures Including exercises
- Simulation/computer exercises
  - Dynamic systems (stiff solvers and DAE solutions)
  - Process monitoring (multivariate processes)
- Project
  - The conveyer process

# Lectures

- Dynamic systems, Queuing theory
  - Ulf Jeppsson
- Process monitoring and operator support
  - Christian Rosén
- Plant wide control
  - Christian Rosen

# Lectures (cont.)

- Complexity in automation
  - Gustaf Olsson
- Data bases and human machine interface
  - Gunnar Lindstedt

# Lectures (cont.)

- Guest lectures:
  - Thomas Gillblad (communication and complexity)
  - Charlotta Johnsson (Batch & Industry 4.0)
  - Tobias Antius (Digitalization)

# Simulation exercises

- Available on the web site [www.iea.lth.se/aks](http://www.iea.lth.se/aks)
- Deadlines Friday 8/4 (#1) and Wednesday 4/5 (#2)
  - Keep the deadlines!
  - If not, maybe not until next year!
- Supervisor: Ulf Jeppsson

# Project

- Start up lecture Wednesday 23/3
- Groups of four (end goal: demonstrate solution + written report)
- Project based on the conveyer system
- Present plan for the project
  - Time and resource plan
  - Structure of the solution
- Presentation on Wednesday week 20
- Project supervisor: Ramesh Saagi

# Literature

- Olsson and Rosen (same as for Automation)
- Scientific papers (will be downloadable and handed out)
- Lab manual (will be downloadable and handed out)



# Finally

- This is an advanced course:
  - Try to take active part in the lectures!
  - We will try to make room for discussions
  - Be prepared
  - Lectures often complementary to literature

# Course goals

Knowledge/understanding about:

- Characterizing industrial processes based on complexity and realize how complexity affects the application of automation
- Account for how to use mathematical models to solve typical automation problems
- Understand and use terms like stability, real-time demand, capacity, stationarity, dynamical stiffness, etc

automation in complex systems 2022

# Course goals

Skills and ability of how to:

- Formulate and structure a mathematical model of a larger industrial process based on given information of processes and how they interact
- Use this model to analyze important characteristics of the process
- Structure a control system for an industrial process made up of several sub-processes
- Use PLC programming to solve control problems when several parallel processes take place at the same time

automation in complex systems 2022

# What is complexity?

**Complicated** versus **Complex**

Complex engineering systems

Complex dynamical systems

automation in complex systems 2022

# Automation challenges

- 1000s of control loops - how to handle many loops
- 100000s input and output signals – how to organize and extract relevant information
- Time scales from ms to weeks within same system – stiff systems, hard to simulate and harder to control
- Significant interactions between sub-systems – requires a holistic view
- Uncertainty, estimation, prediction, identification etc.

If you can grasp it – it is not complex!

automation in complex systems 2022

# Dealing with complexity

- Brute force (i.e. supercomputing) using conventional tools. Combinatorial explosion!
- Approximation (i.e. linearization)
- Divide and conquer (e.g. modularization)
- Change of view – new tools

# Coming up

- Lecture Wednesday Start of project.  
**Highly recommended that you join the session! Group configuration!**
- Lectures this and next week – Ulf Jeppsson  
Simulators and queuing theory.

automation in complex systems 2022