Using the OPC Classic Modelica Library for Model Predictive Control

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Wolfram MathCore

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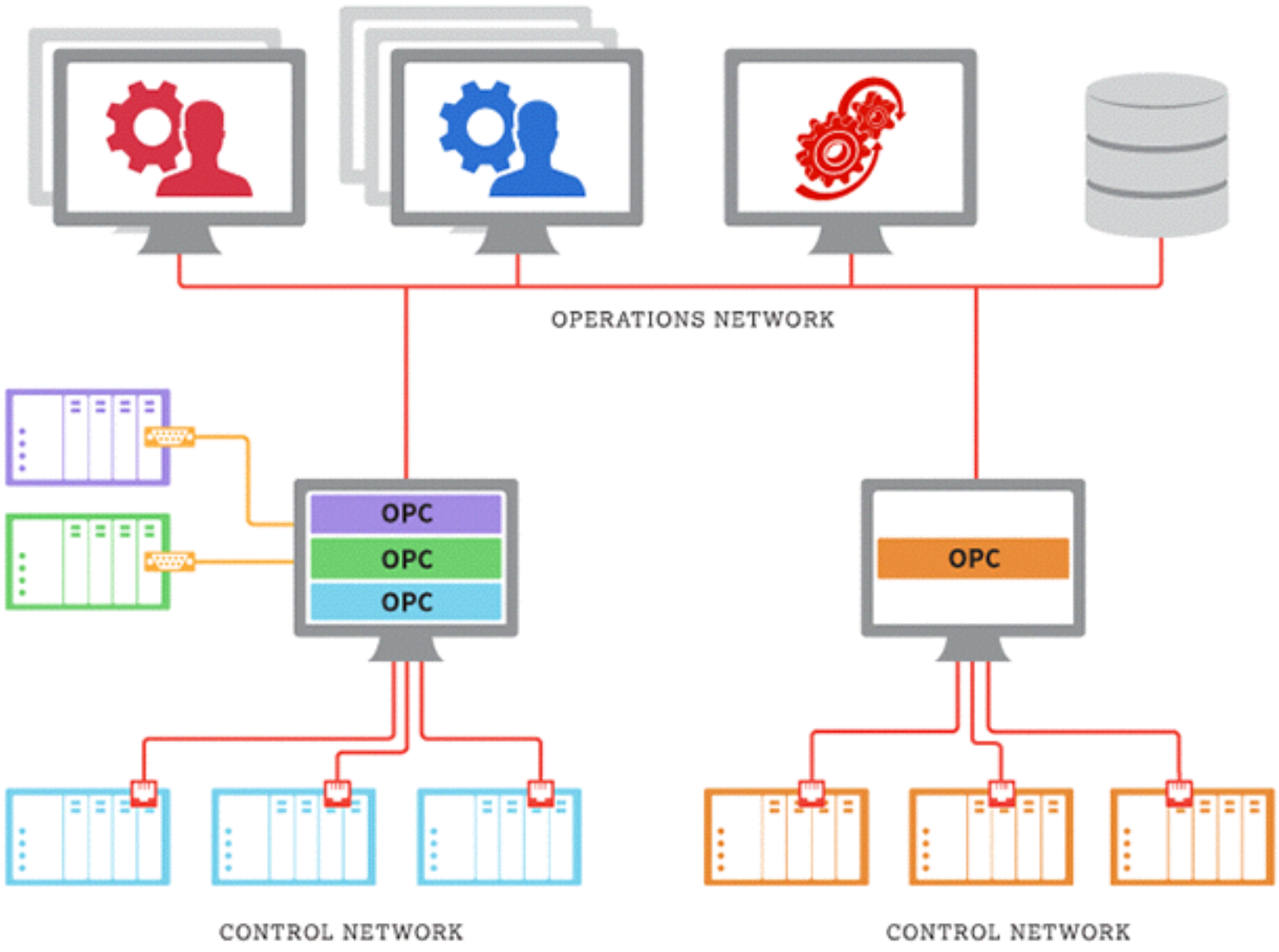
- Introduction to OPC
- OPCClassic library for SystemModeler
- Application to bioethanol production

What is OPC

- Open Platforms Communication
- Industrial communication standard
- “Internet of Things” for the industry
- Allows communicating machines with IT and OT

Example OPC Architecture

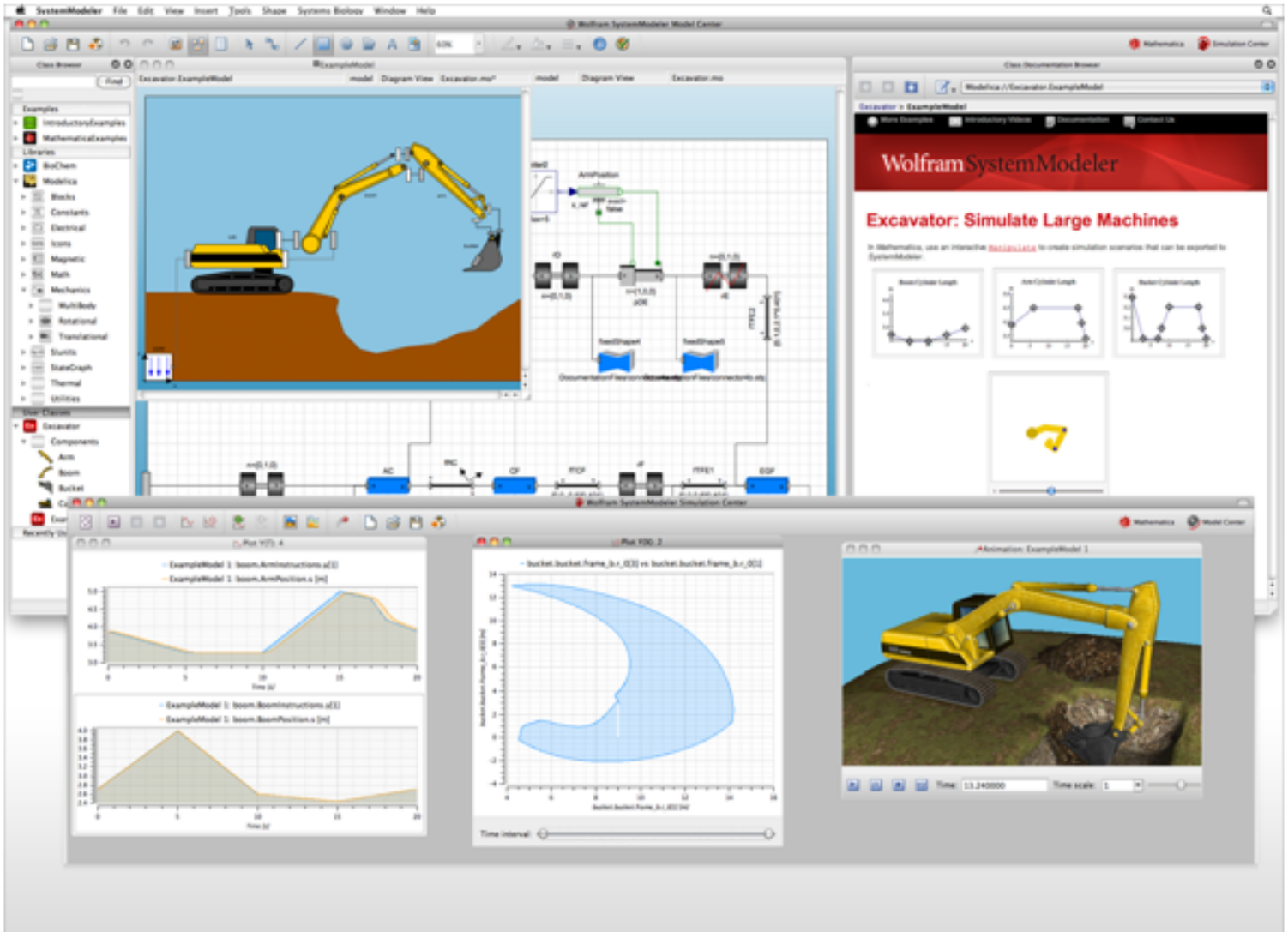


SystemModeler OPCLibrary

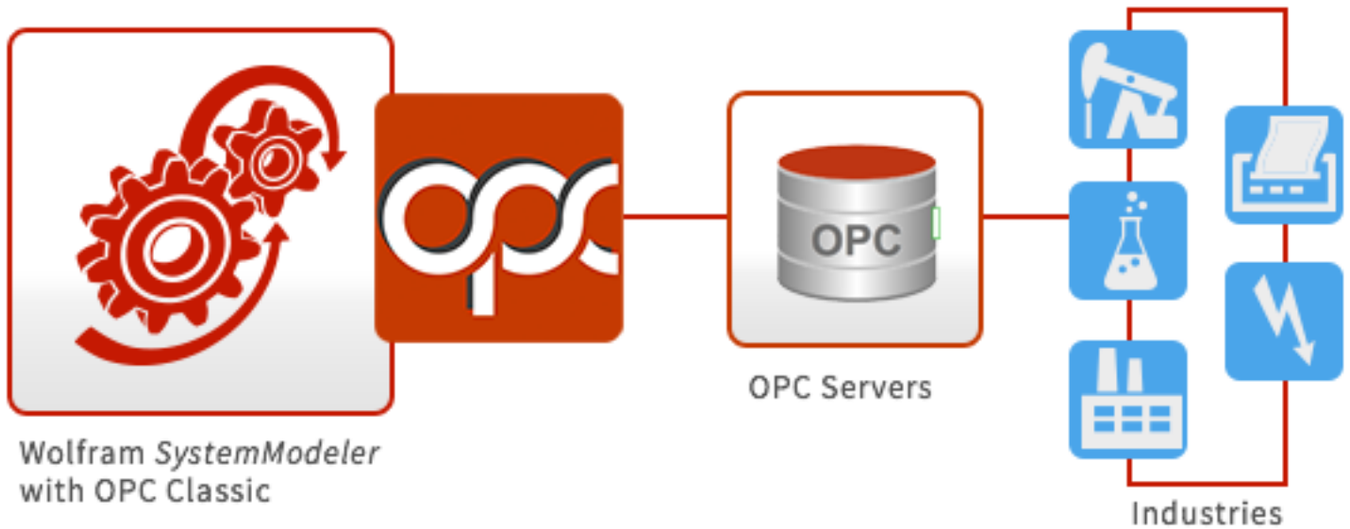
Connecting simulations to industrial systems

SystemModeler

- Multidomain Simulator
- Modelica based
- Mechanical, electrical, chemical and many other systems
- Integrates with Mathematica

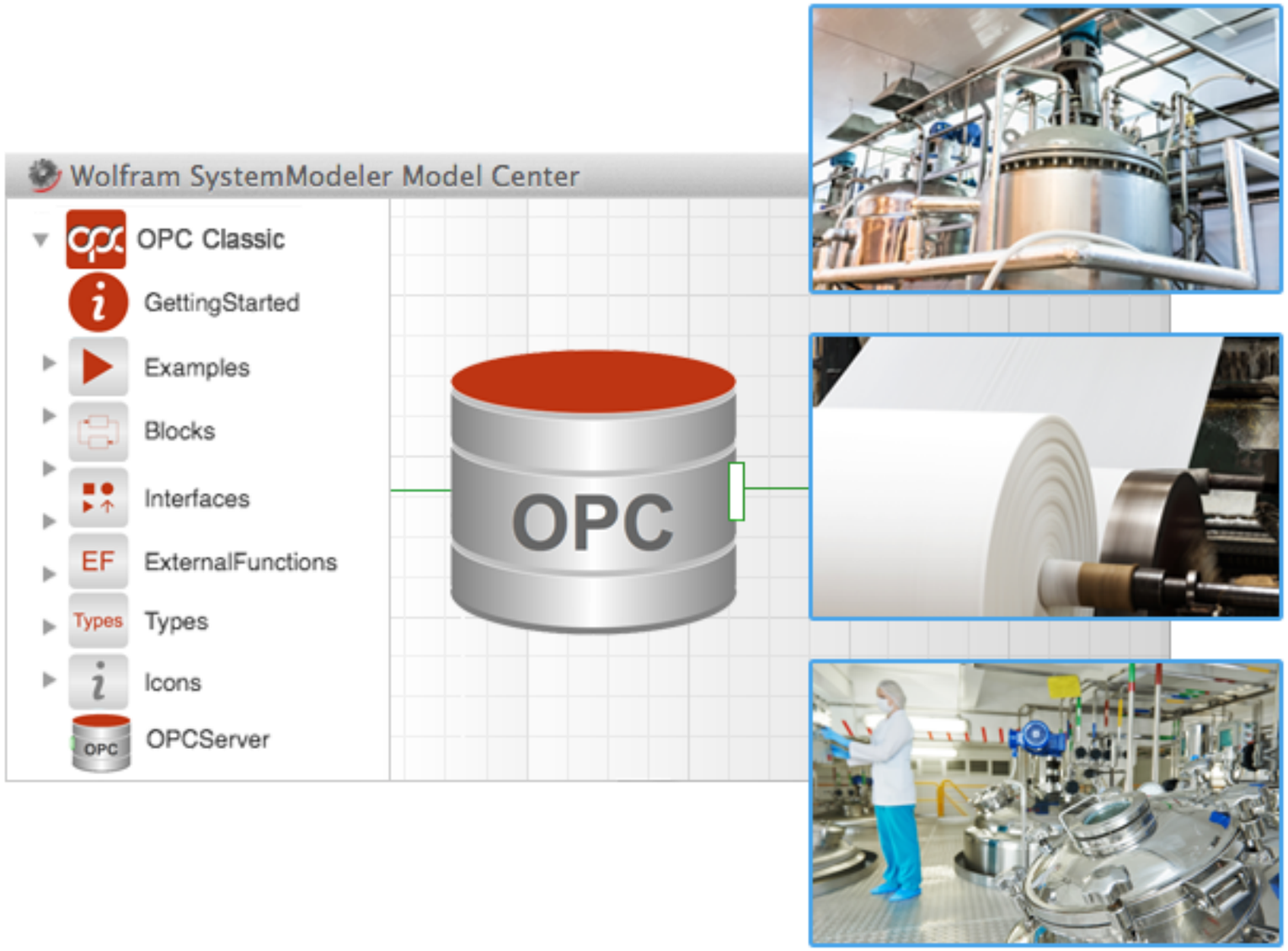


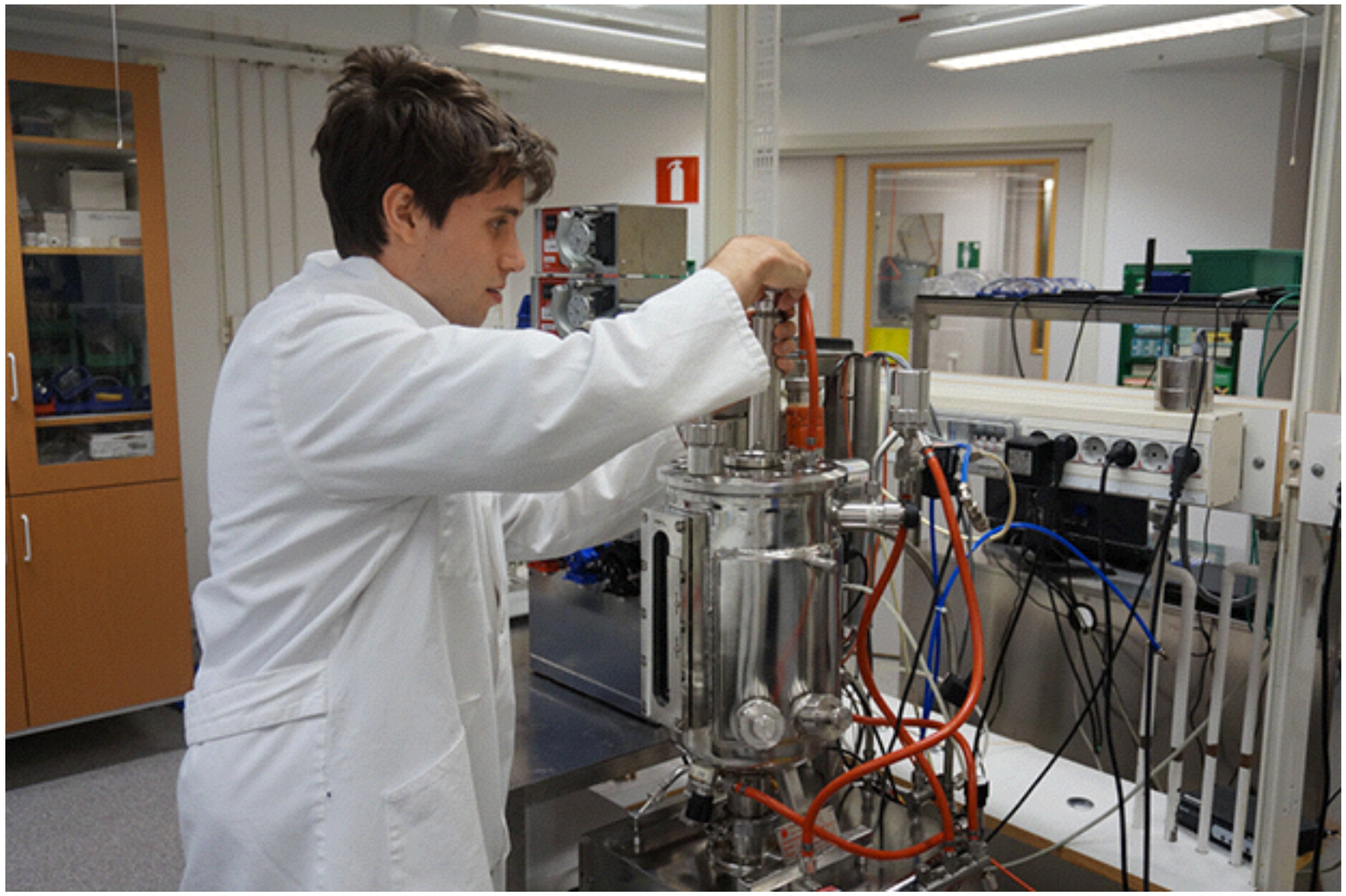
OPCClassic Library



- OPC Classic protocol
- Connects to multiple OPC components
- Suitable for real-time simulations

Library Overview





Example Application

Optimisation of bioethanol production

Basics of Bioethanol Production

- Similar to producing alcoholic beverages
- Use yeast to convert sugar into ethanol
- The mix comes mainly from cereal grains, corn and sugar cane

Main Problems

The mix (glucose and maltose) have large variability

- Quality of the crops
- Seasons
- Type of crops

The yeast performance can change

Optimisation Problem

Observed variables:

- Glucose
- Maltose
- Ethanol
- Yeast

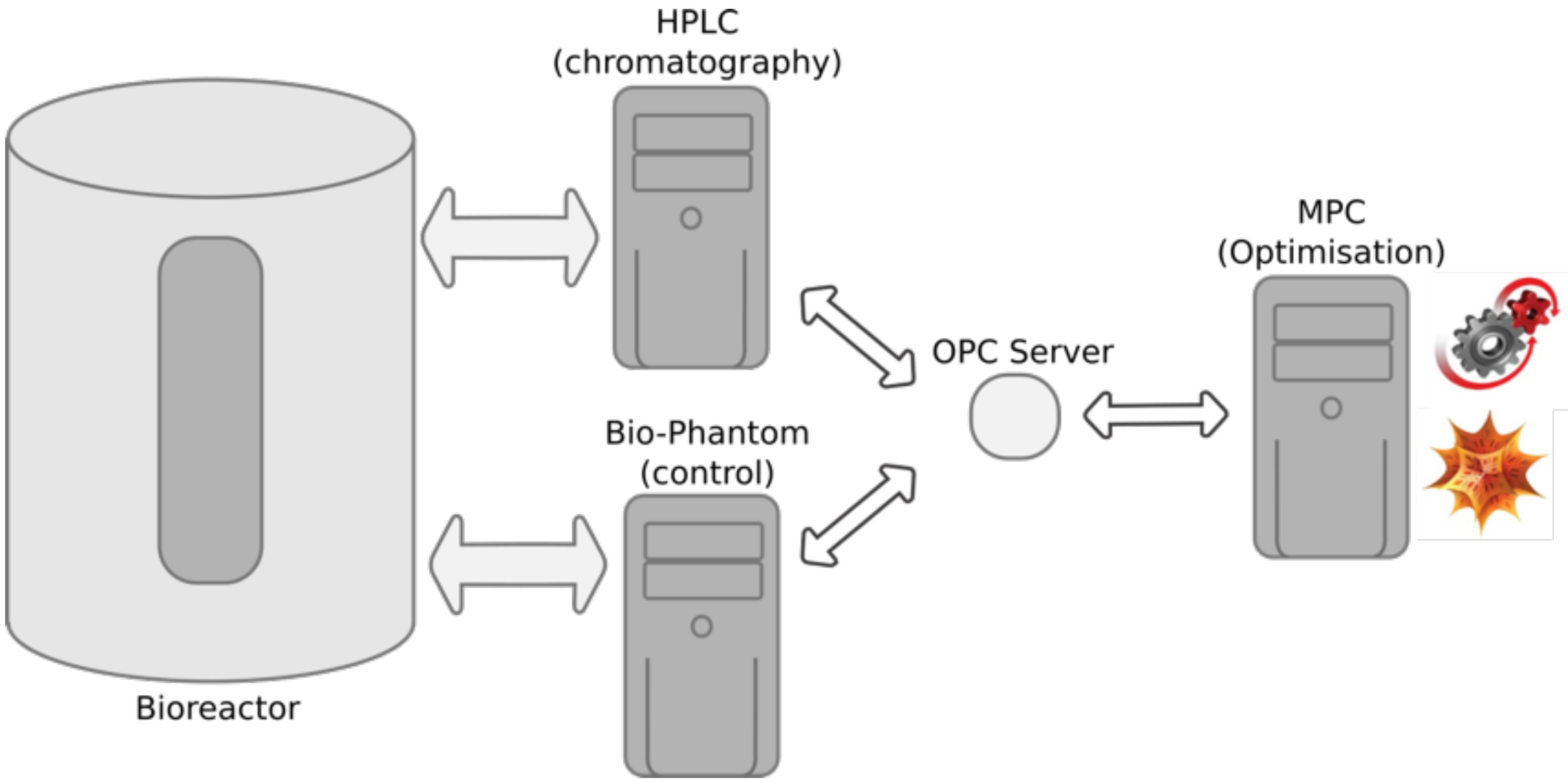
Controlled variables:

- Oxygen (stir)
- Temperature

Target:

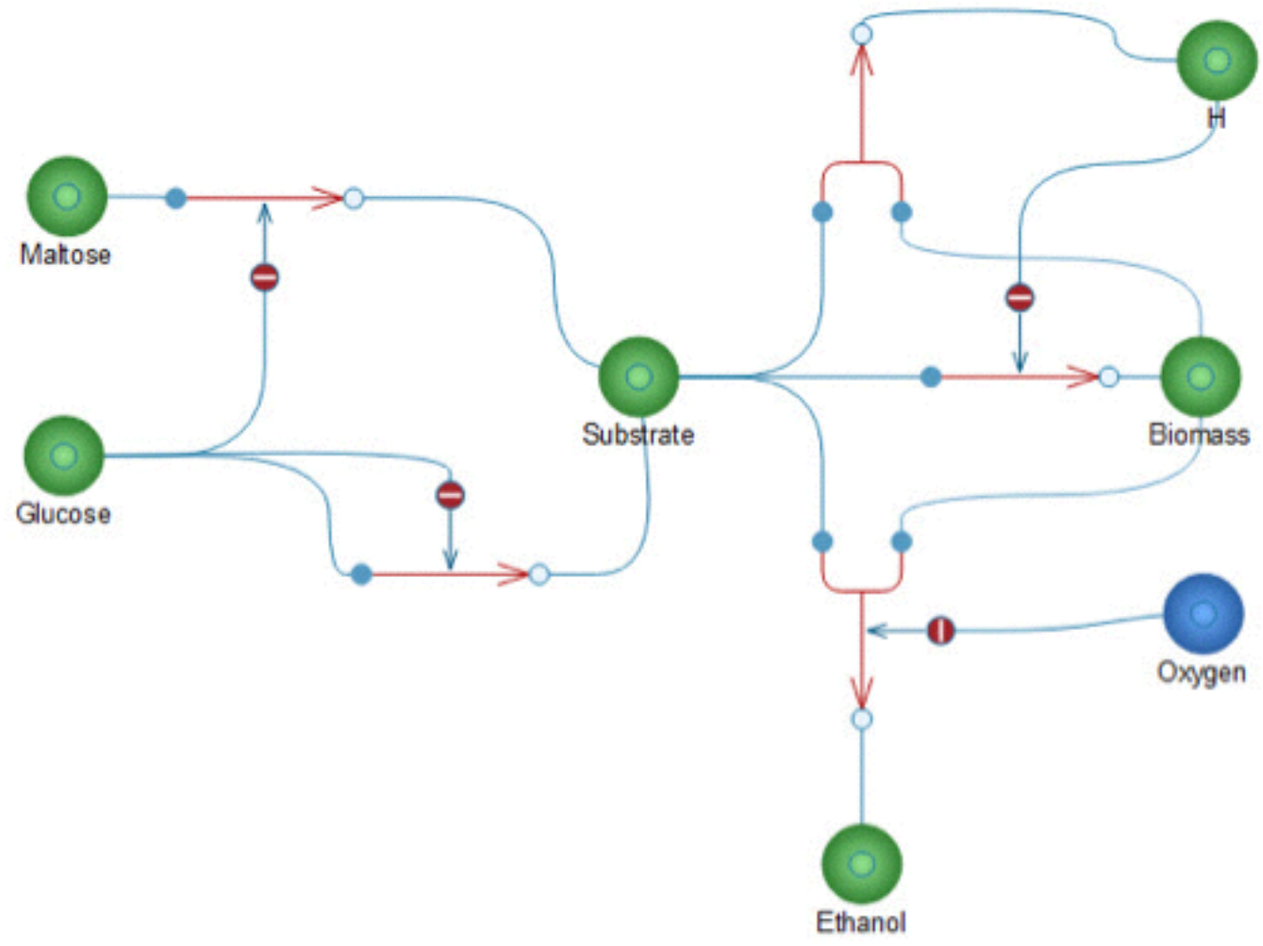
- Maximize ethanol

Lab Setup


HPLC
(chromatography)
OPC Server
MPC
(Optimisation)
Bio-Phantom
(control)
Bioreactor

Model of the Biochemical Reaction

- Allows simulating the ethanol production
- Created using the BioChem library



Optimisation Steps

1. Perform initial measures

2. Run IPOPT* (optimisation) with Mathematica + SystemModeler

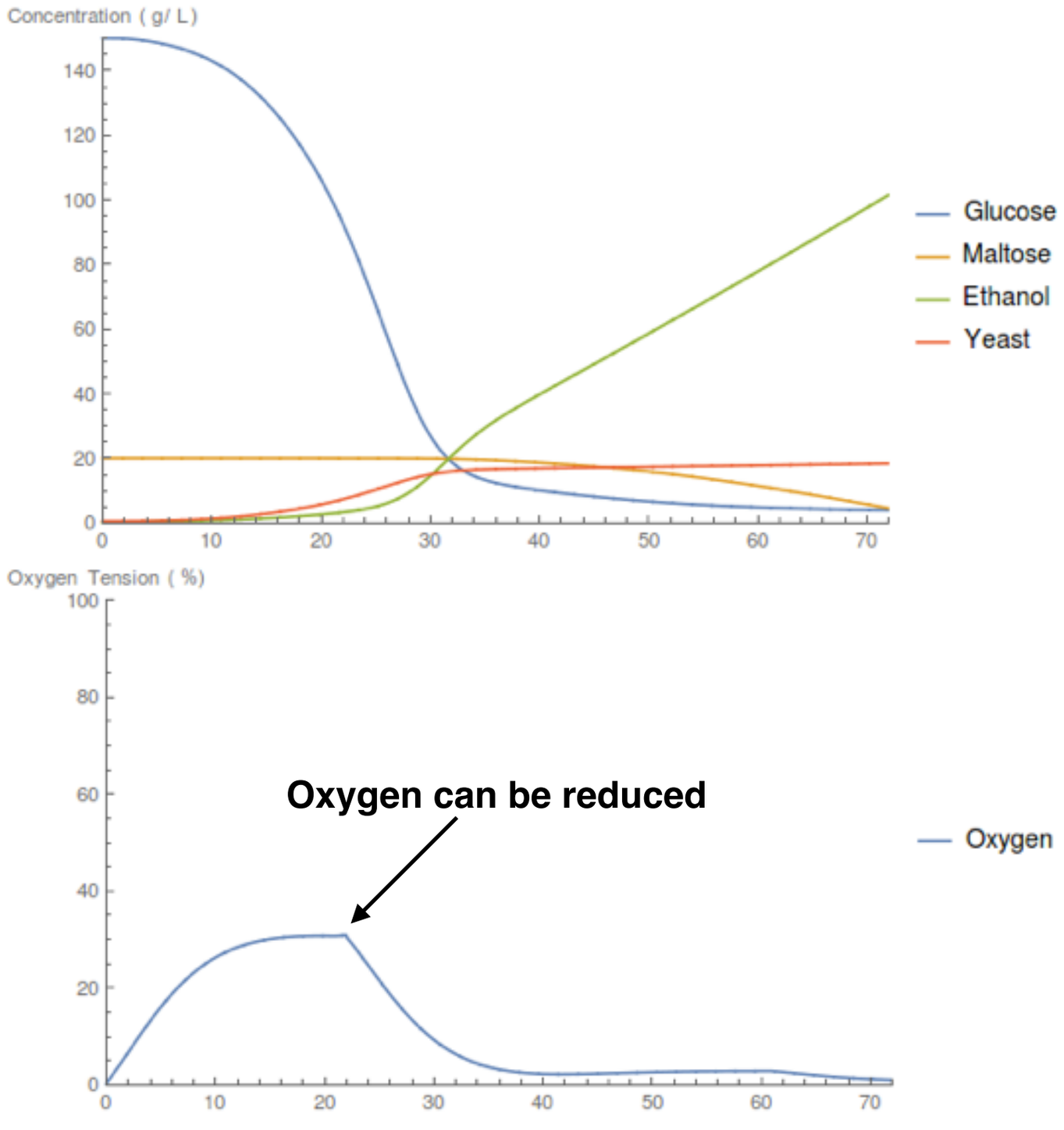
3. Set desired oxygen level (controlling the stir in the reactor)

4. Wait for next measure and repeat step 2

5. Stop when most of glucose and maltose has been consumed

* IPOPT: Interior Point Optimiser

Results for a Single Run



Conclusions

- Bioethanol production is an interesting optimisation problem:
  - The crops, and yeast have high variability
  - Maximises bioethanol but also reduces byproduct (glycerol)
- The OPCClassic library makes easy to integrate industrial proceses with complex optimisation algorithms
  - Model Predictive Control with Mathematica and SystemModeler

Thank you for listening!

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