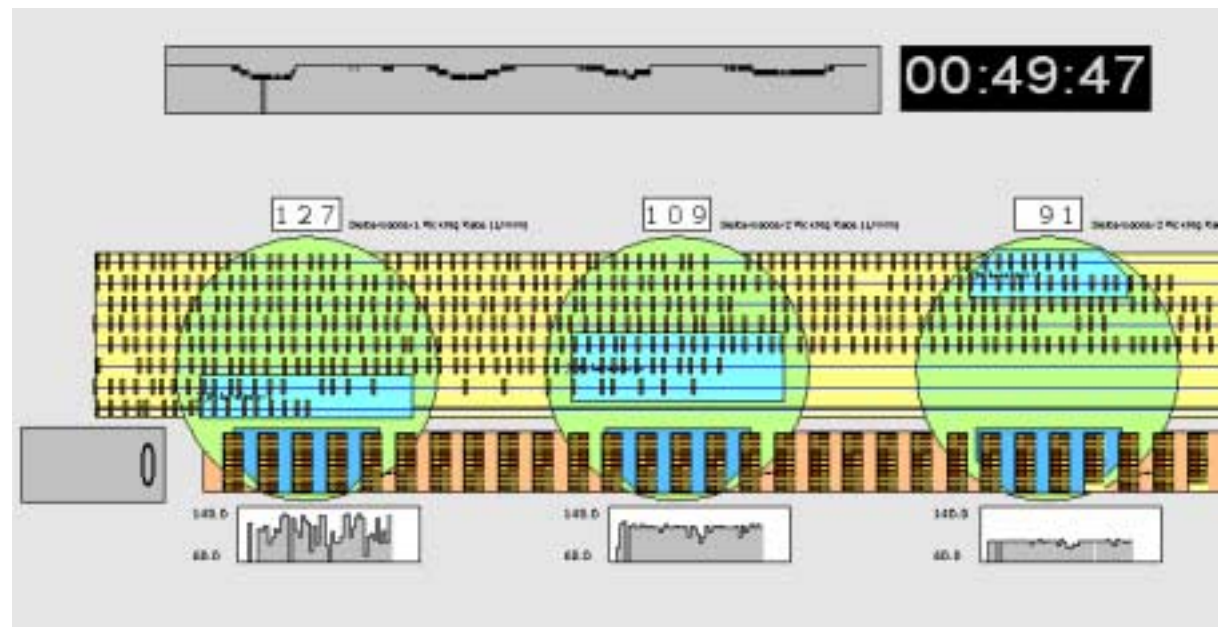


Discrete Event Simulation of Deltarobot Packaging Lines

- ARENA User Meeting 2003 -



Sneaking behind the Curtain

Pulling these things out of the box is quiet well-known...



...but how are they put inside?

Profile of SIG Pack Systems AG

- Leading provider of packaging systems and machines for piece and bulk goods
- Packaging solutions for foodstuff and non-food
- Logistic systems



Mature and „Life Style“ Industries

- Bars, Confectionary and Chocolate
- Biscuit, Baked Goods and Cakes
- Pharma-, Medical und Health Care Products
- Ready-To-Eat and Snacks
- Frozen Food
- Dairy Products
- Non-Food Products



Delta Robot Systems

SIG XR33: Spacious Delta Robot for handling tasks

- Envelope Ø1200 mm
- Approx. 120 cycles per minute
- Max. payload: 1 kg



The Optimization Criteria for Deltarobot Packaging Lines ...

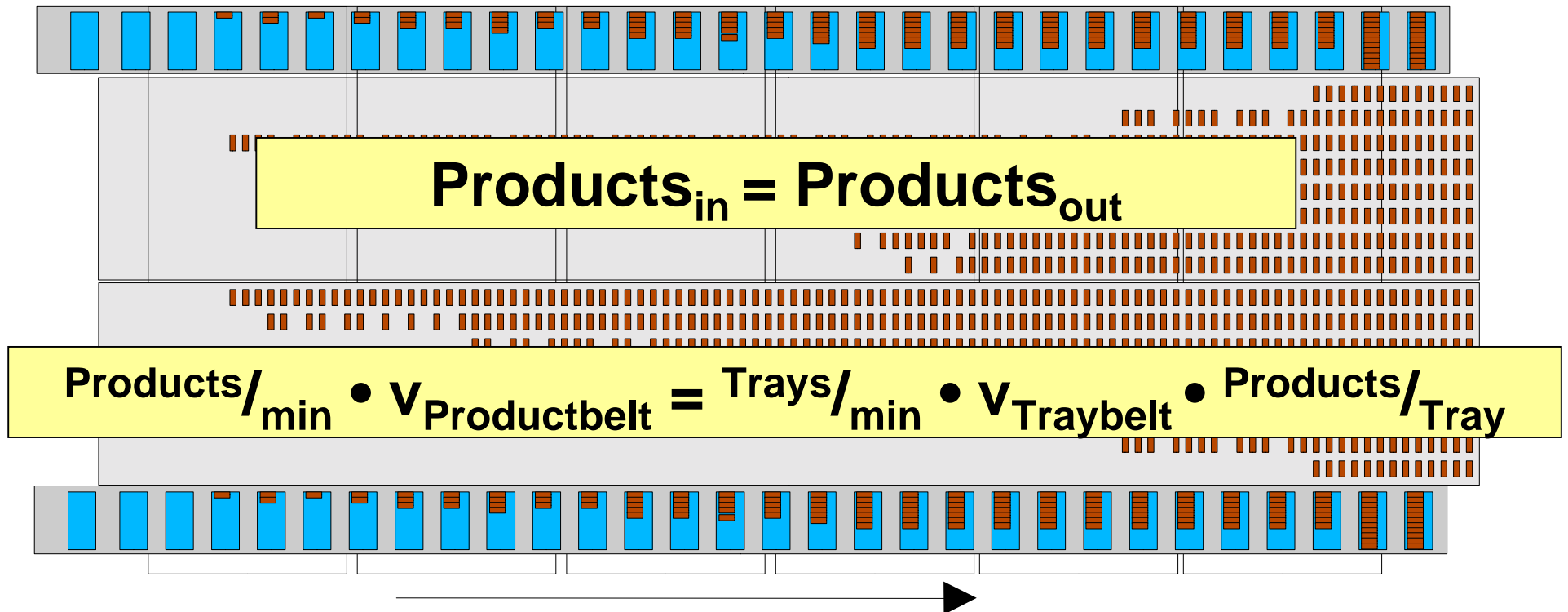
- Highest line / robot performance
- Minimal number of robots
- Highest efficiency / no overflow
- Low robot load (accelerations, speed)
- High reliability and availability
- High redundancy

... are not easy to fulfill due to **Boundary Conditions** and **external Disturbances** :

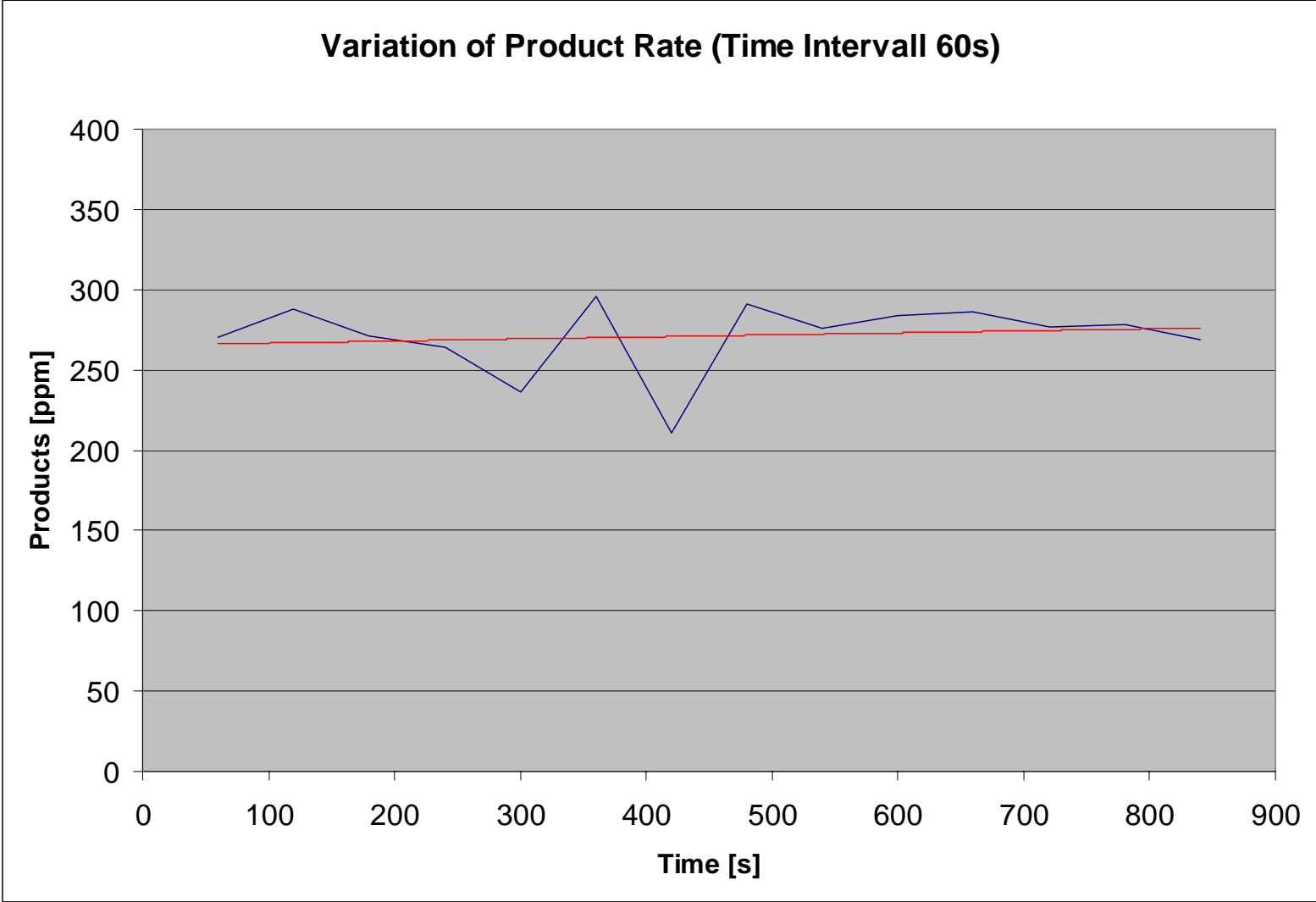
- Mostly given topologies (layout of packaging line)
- Handling of delicate products might be tricky

- Malfunctions of system components
 - Down-Times (TBF, TTR)
- Variations in product and tray flow:
 - Oscillations of product rate (high / low frequency)
 - Missing / bad items
 - Starting up / shutting down a line

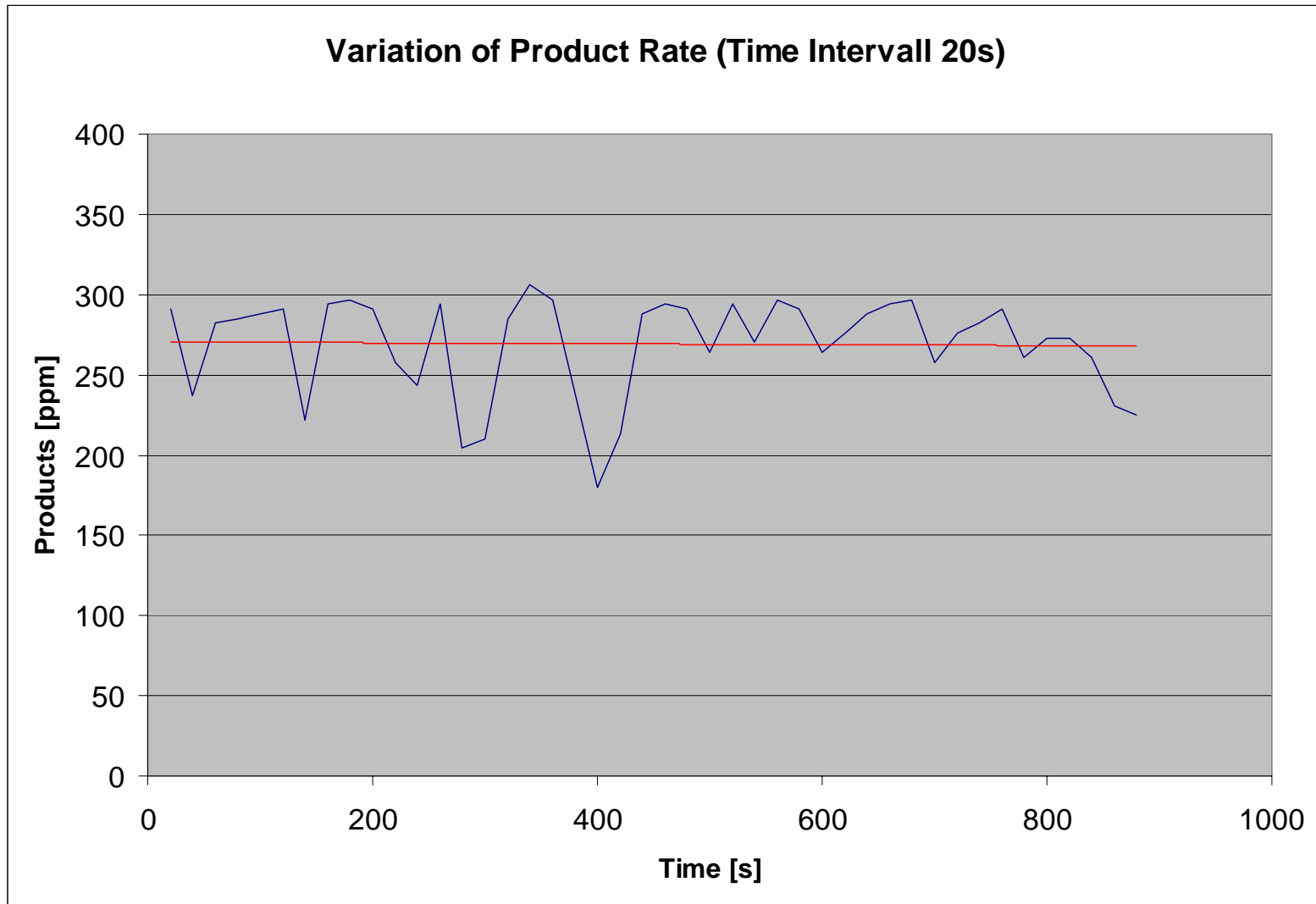
Correlations seem to be simple at first Glance:



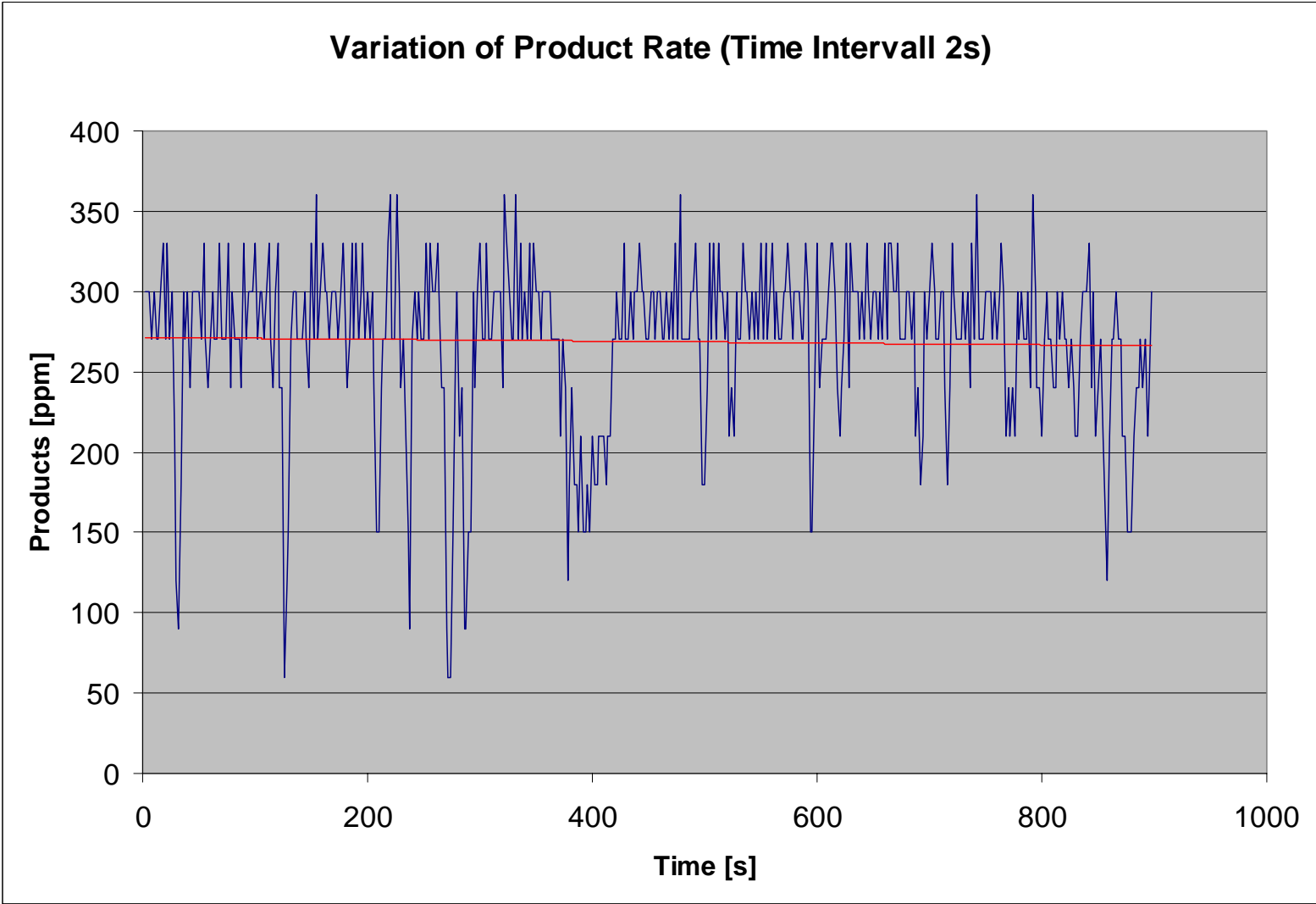
Variations of Product Rate (Time Intervall 60s)



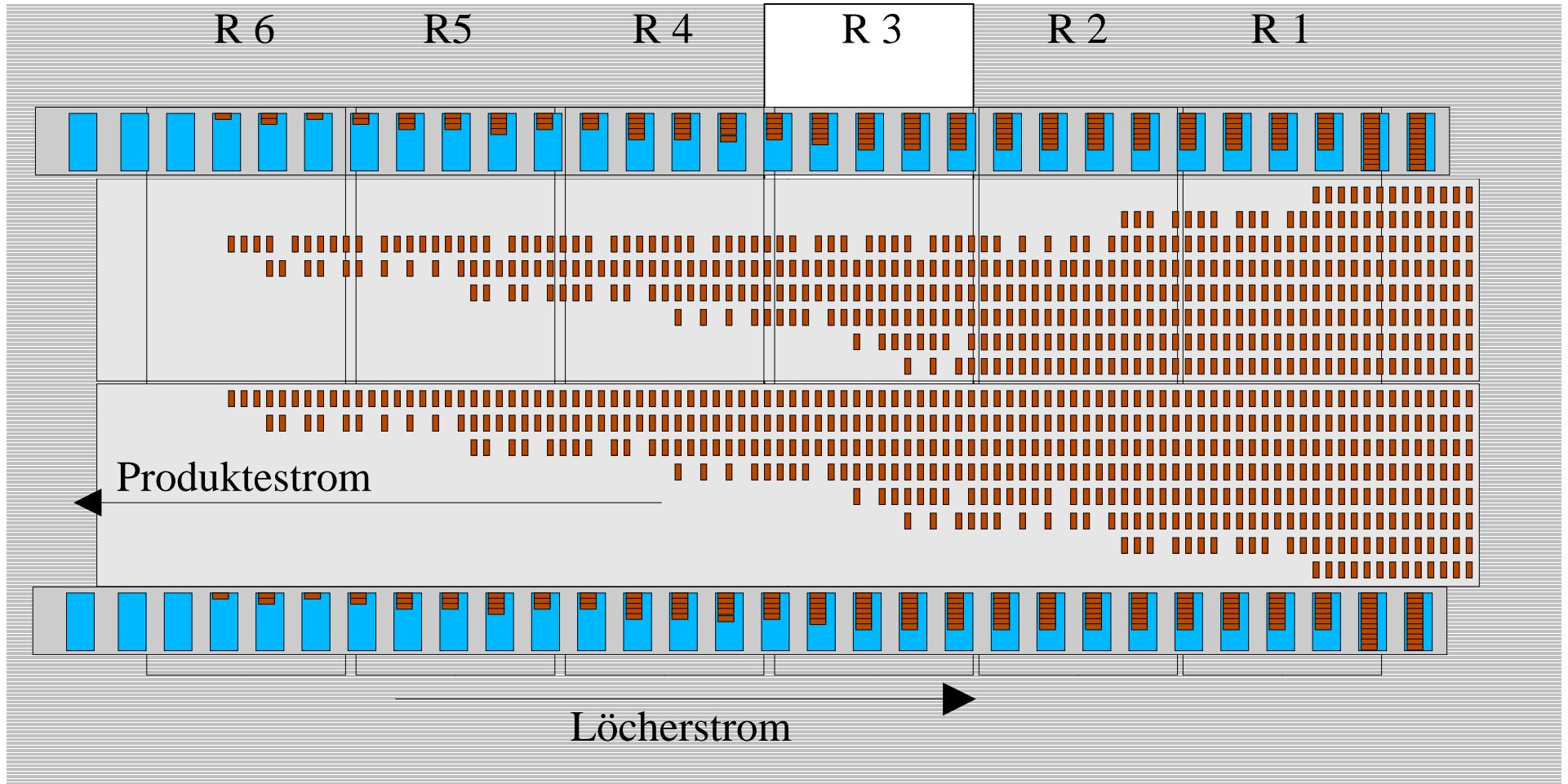
Variations of Product Rate (Time Intervall 20s)



Variations of Product Rate (Time Intervall 2s)

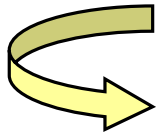
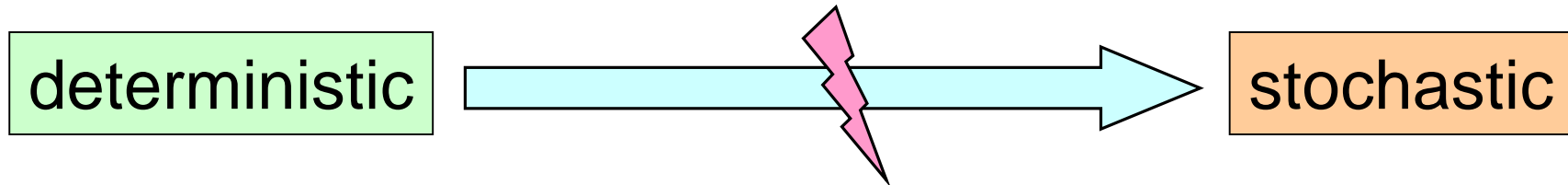


The „blinder“ View of Robots

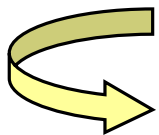


Conclusion

Input parameters / characteristics



Behavior of Deltarobot packaging lines
can be hard or even impossible to predict



Discrete Event Simulation enables
to monitor and quantify dynamic effects

“Pick and Place Strategy”: What is it ?

“Which product will be picked as next and where does it have to be placed ?“

A decision each robot makes independently

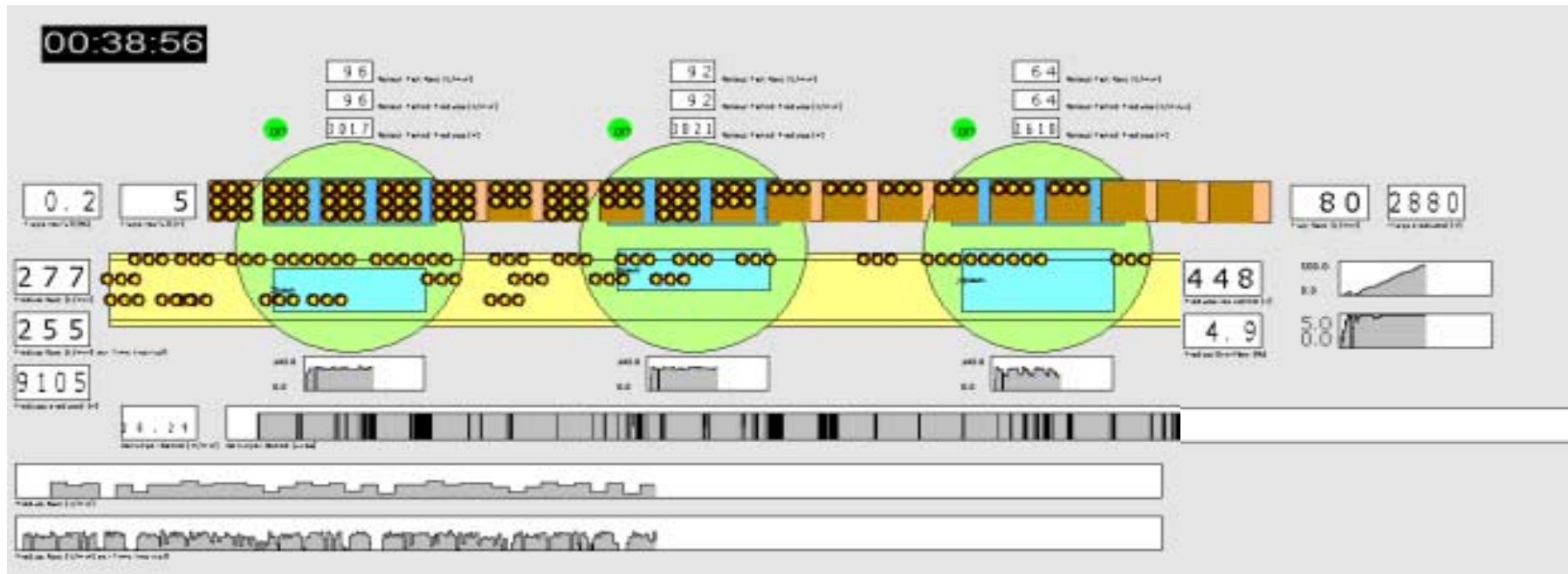
- Shortest traveling distance
- Operation in center of work range
- High level of „order“ in the product stream for the consecutive robots

Typical Questions

- What are the parameters for the highest efficiency?
 - Tray belt speed and control strategy
 - Size and position of Pick and Place windows
 - Pick and Place strategies for each robot
- How much is the overflow...
 - ... with the given product flow?
 - ... if one robot goes down?
 - ... when implementing different control strategies?
- Does a buffer, one robot more, a second tray belt, ... improve the efficiency?

Deltarobot Line Simulation:

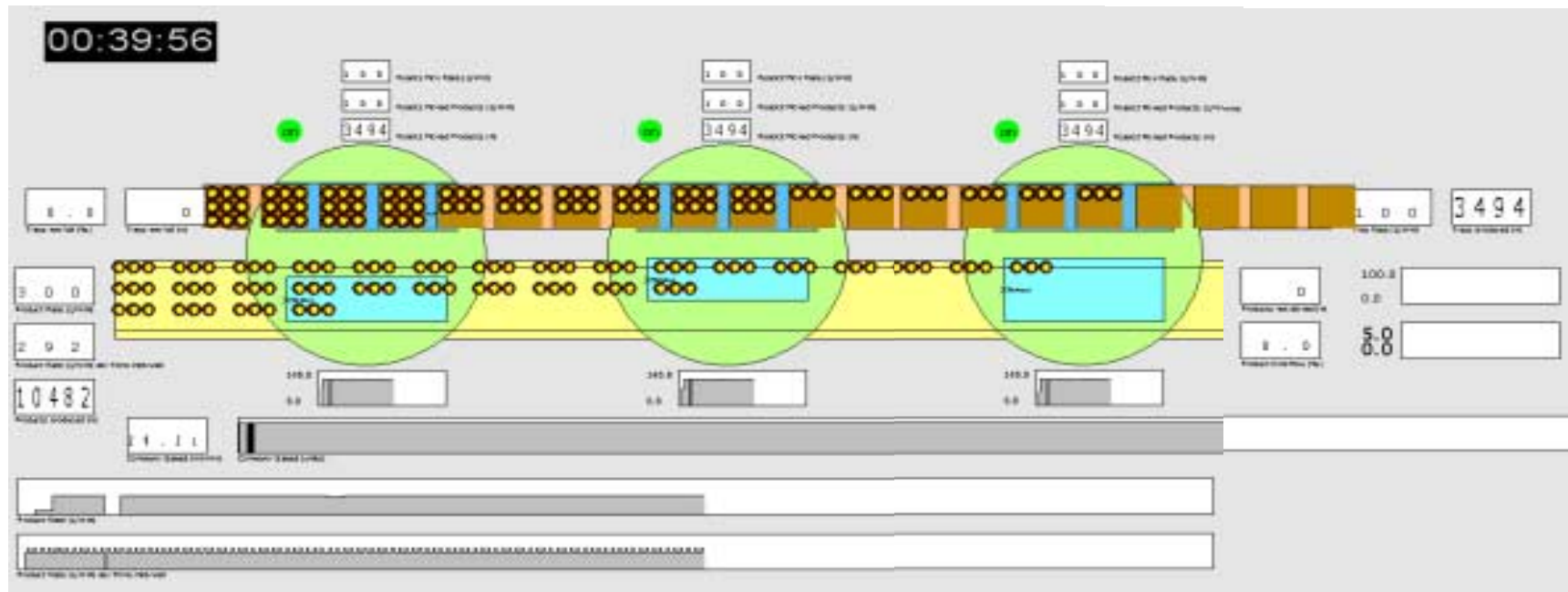
Inconsistent Product Flow (mean 270 ppm)



- High product overflow (5%)
- Frequent stops of tray belt
- Varying performance of robots (65 – 95 ppm)

Deltarobot Line Simulation:

Constant Product Flow (mean 300 ppm)



- No product overflow
- No stops of tray belt
- Equal performance of robots (100 ppm)

Benefits of Deltarobot Line Simulation

Using known technology

- Verifying & quantifying the concept of offers
- Presenting concepts to the customer
- Support IBN / IBS (Line Balancing)
- ➔ Backed-up data, „Facts & Figures“

Developing new technology

- Developing new Pick&Place strategies
- Concepts for Line Controlling
- ➔ empirical testing is too costly & time-consuming
- ➔ gained experience can be used for programming