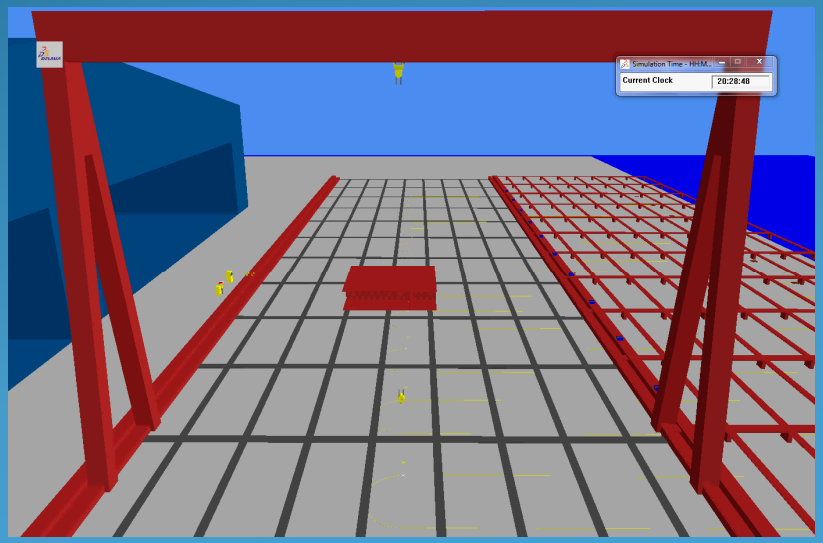
Discrete Event Production Simulation and optimisation



Jean-David Caprace

University of Liège

Federal University of Rio de Janeiro

Berlin – COMPIT'2011

Why Brazil?

for my post PHD

Why Brazil?

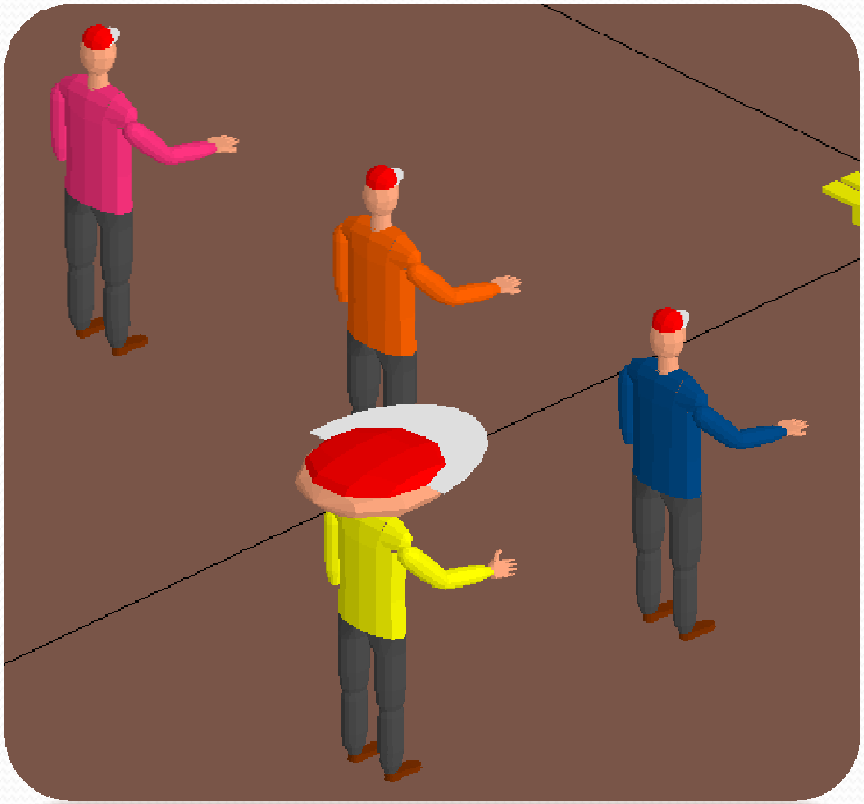
for my post PHD

- Amazing revival of the shipbuilding industry ➔ Offshore industry (Petrobras)
- State policy ➔10 Greenfield shipyards in planning or already constructed
- Amazing opportunity to try to convince new people to use DES

Summary

Content of the presentation

- Introduction
- Production simulation
- Difficulties and challenges
- Coupling optimization and DES
  - Bloc erection sequence
- Conclusion



Introduction

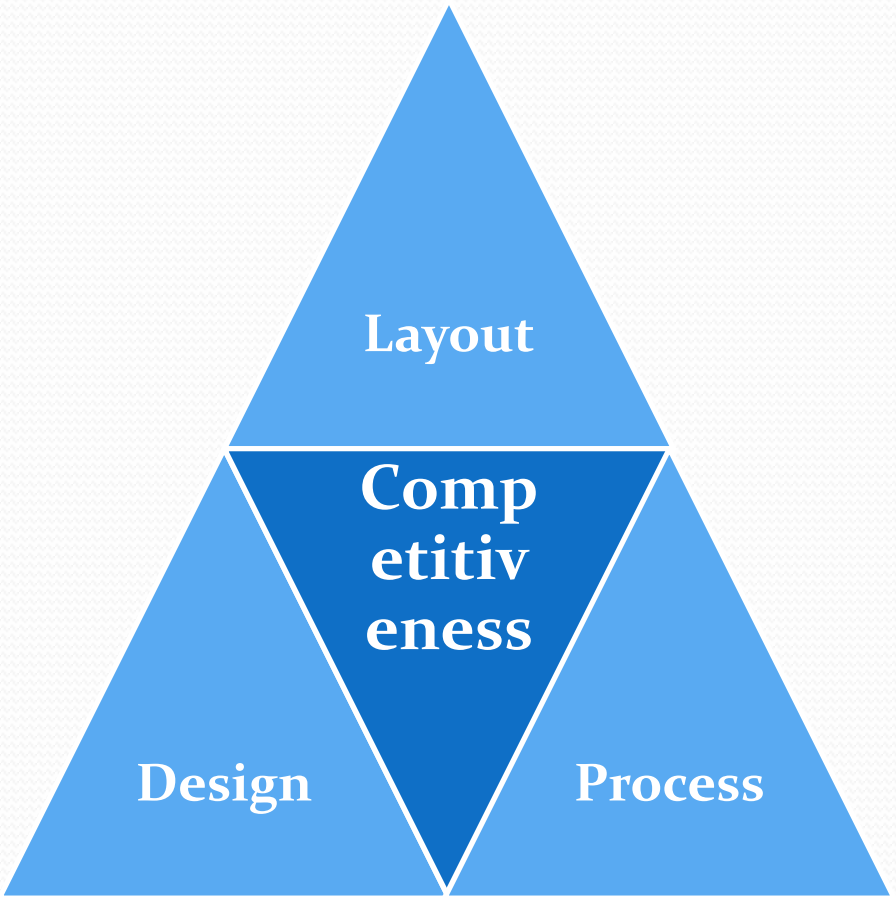
Context of shipbuilding industry

- Shipbuilding = industry of labor
  - ➔Problem for all shipyards
  - ➔ Relocation of ship manufacturers
- Need to improve the shipyard competitiveness

Introduction

Context of shipbuilding industry

- Solutions = optimization of
  - **The industrial layout** – automation, mechanization, etc.
  - **The product design** – design for production, standardization, modularization, etc.
  - **The industrial process** – quality management, 6sigma, lean manufacturing, CAD/CAM, scheduling, sequencing, DES, VR, etc.



Production simulation

What is it?

- *"Simulation is the process of designing a **Model** of a real or imagined **System** and conducting experiments with that model"*
- **System** ➔ Boundaries
- **Model** ➔ Assumptions
- **Sufficient accurate at min cost**
- Simulation
  - **Discrete** – Continuous
  - Static – **Dynamic**
  - **Stochastic** – Deterministic
  - **Local** – Distributed

Production simulation

Goals

- **Design and refitting of workshops** — Long term
  - Machine (position, number, capacity, etc.)
  - Simulation before investment (make or buy decision)
- **Definition of the planning's and schedules** — Mid term
  - Validation of production plans
  - Reduction of the lean time (bottlenecks identification)
  - Elaboration of the best production sequence
  - Optimization of space allocation
- **Management of the production** — Short term
  - Smoothing of the workload
  - Improve personnel and resource planning
  - Studying the impact of machine failure and workload variations
  - Reduce the gap between planned and real schedule

Production simulation

Different types of simulation

Long term	Mid term	Short term
Few input DB	Moderate input DB	Large input DB
Low development cost	Moderate development cost	High development cost
Punctual benefits	Monthly benefits	Daily benefits

Production simulation

DES Software's

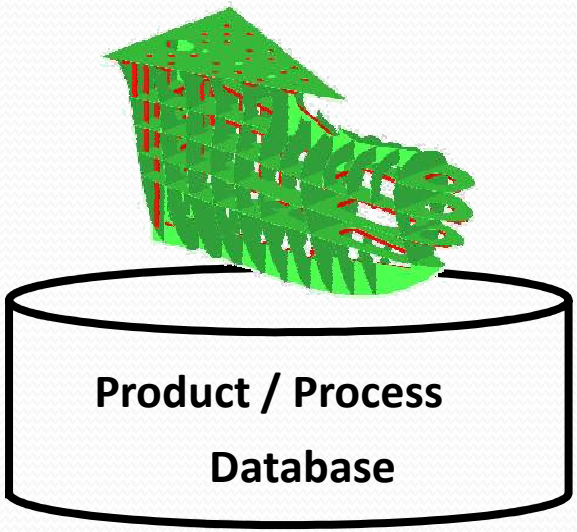
- Arena
- Promodel
- **Plant simulation**
  - STS toolkit
- Flexim
- **Quest**

➔ Qualitative review

	ARENA	PROMODEL	PLANT SIMULATION	FLEXSIM	QUEST
Application Price	Good	Good	Very poor	Poor	Very poor
Easy to Learn	Poor	Very poor	Poor	Average	Average
Custom Extensions	Average	Average	Good	Poor	Very Good
Technical Capacity	Average	Very poor	Very Good	Average	Very Good
Model Visualization	Poor	Very poor	Good	Good	Very Good
Graphical User Interface	Poor	Poor	Average	Average	Poor
Modularity	Good	Good	Good	Average	Good
CAD connection	Average	Average	Good	Good	Good
Thechnical Support	Poor	Very poor	Average	Very poor	Average
Popularity (forums)	Good	Good	Poor	Good	Poor
Compatibility with others softwares	Very Good	Very Good	Very Good	Very Good	Very Good
Reuse of models and objects	Good	Good	Very Good	Poor	Very Good
Statistical Analysis	Good	Average	Very Good	Good	Good
Pre and Post Processing of Data	Very Good	Very Good	Very Good	Very poor	Very poor
Special Features	Input Analyzer, Output Analyzer	Stat-fit, Output Result	DataFit package, Bottleneck analysis, Sankey Diagram (material flow analyses)	Button with direct connection to the Excel program to import data , Gantt Chart, Financial reports	Kinematic geometry to associate with machinery and transport systems

Production simulation

Databases

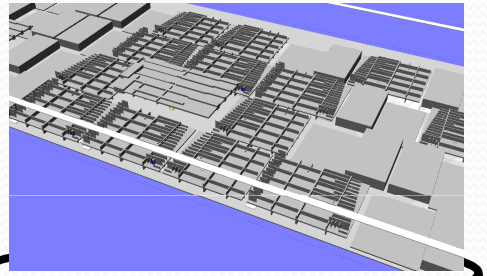


Product / Process Database

- **Ship structure**
- **Production activities**
- **Welds and Seams**

Shipyard Facilities

- **Workshops dimensions**
- **Transport ressources**
- **Human ressources**
- **Working calendar**

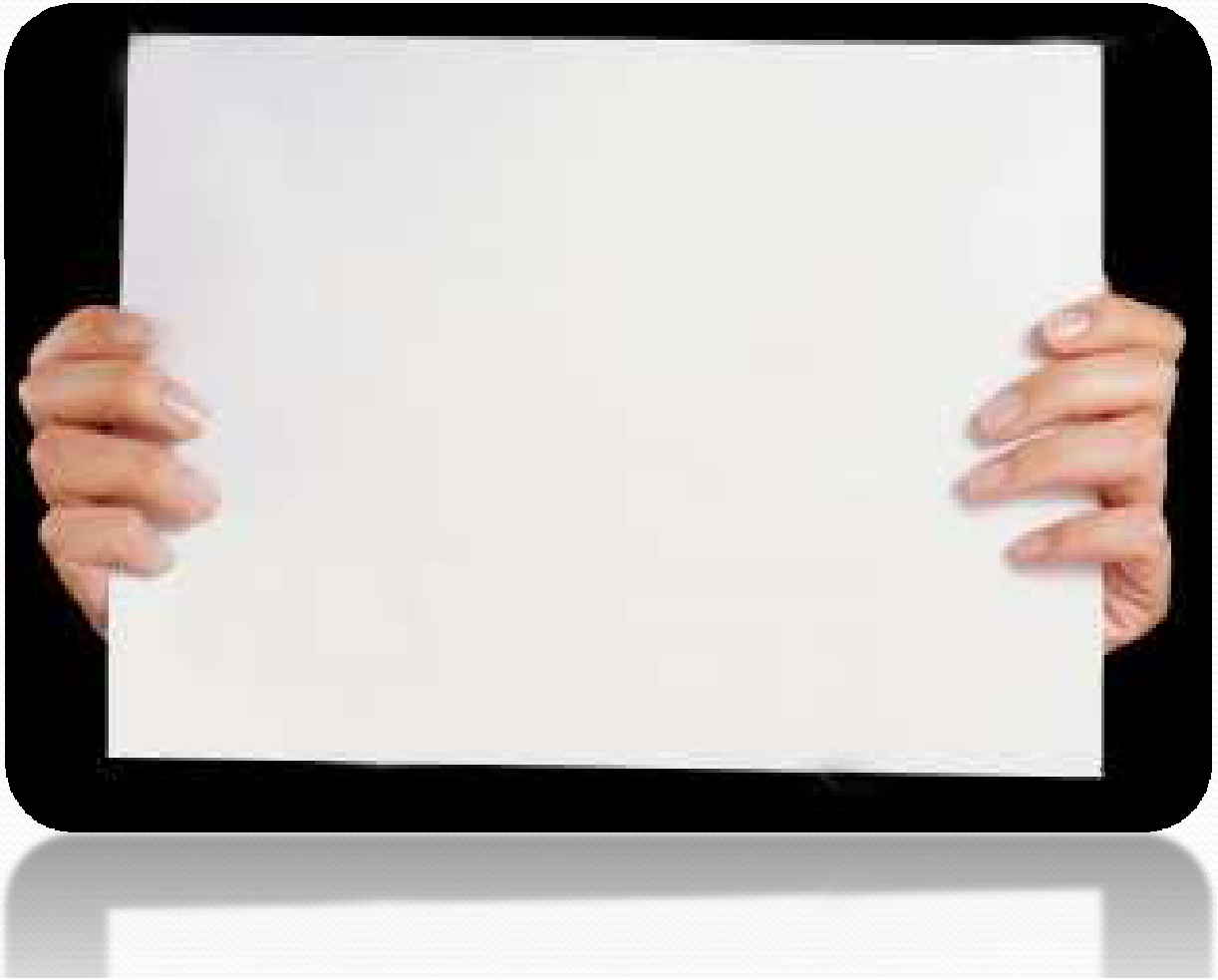


Simulation Database

- **Constraints** (global and local)
- **Assembly strategy**
- **User parameters**
- **Results**

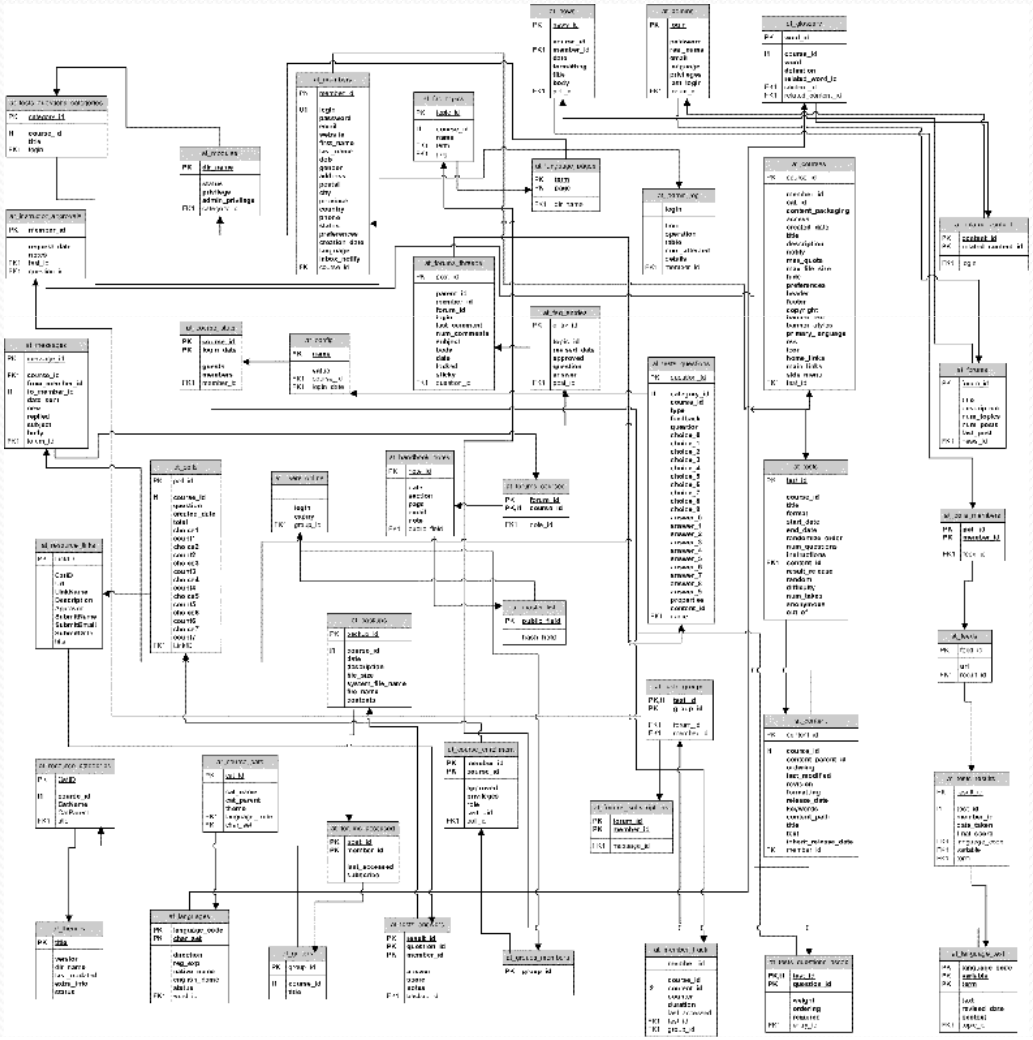
Challenges of DES

Data management problems – Lack of available data



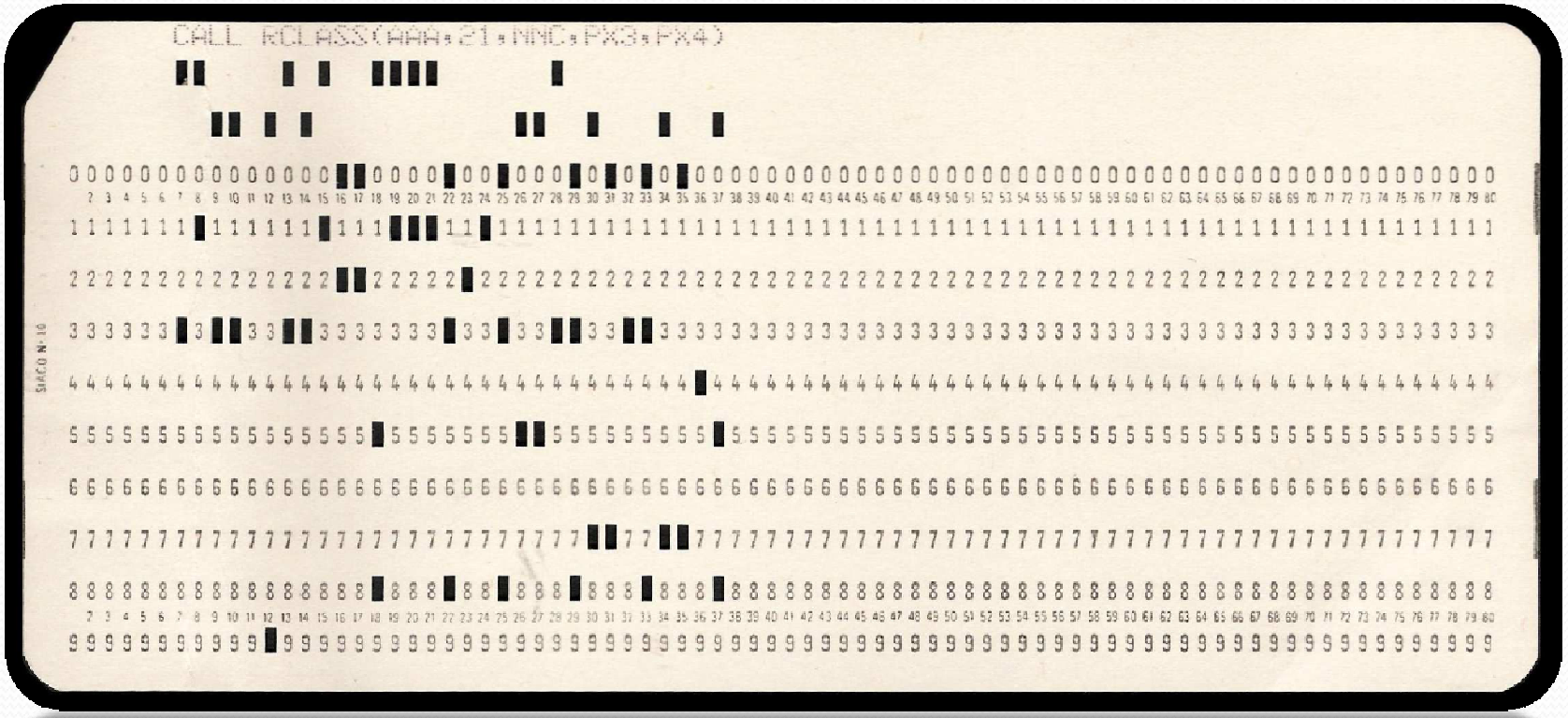
Challenges of DES

Data management problems – Insufficient data definition



Challenges of DES

Data management problems – Insufficient data format

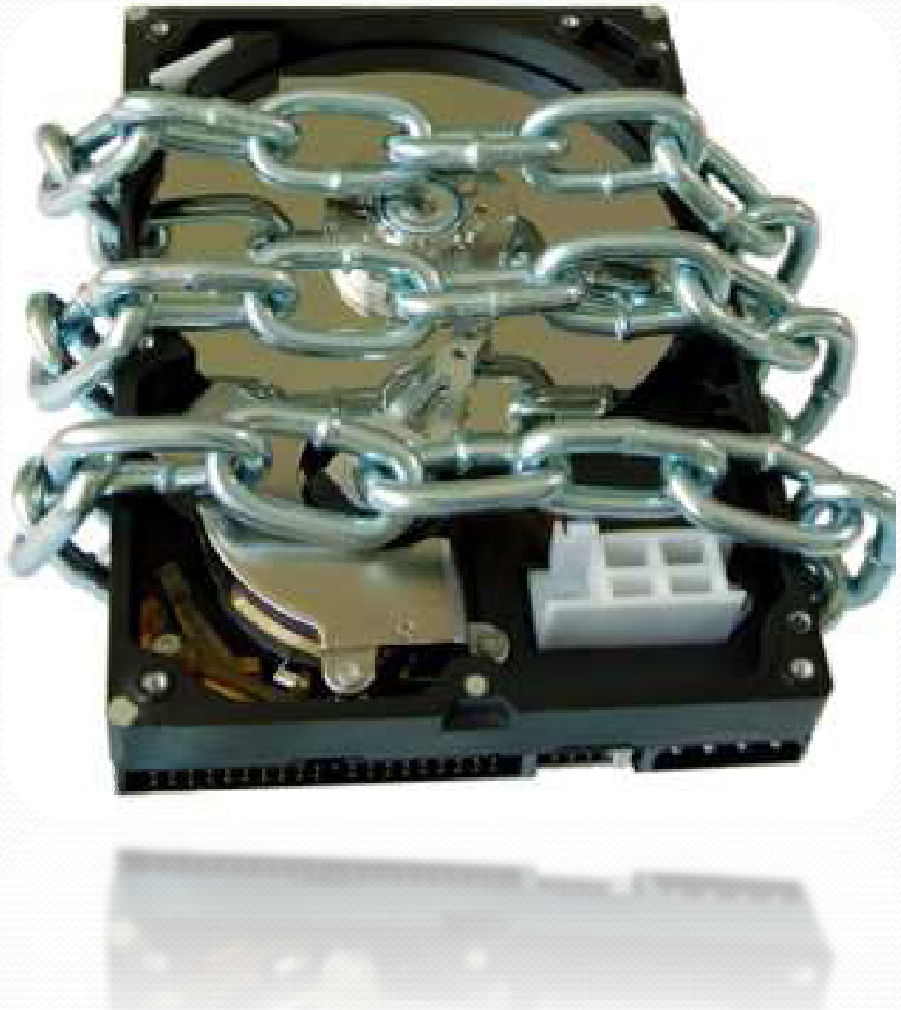


Challenges of DES

Data management problems – Unknown validity of the data

Challenges of DES

Data management problems – Inaccessibility of the data

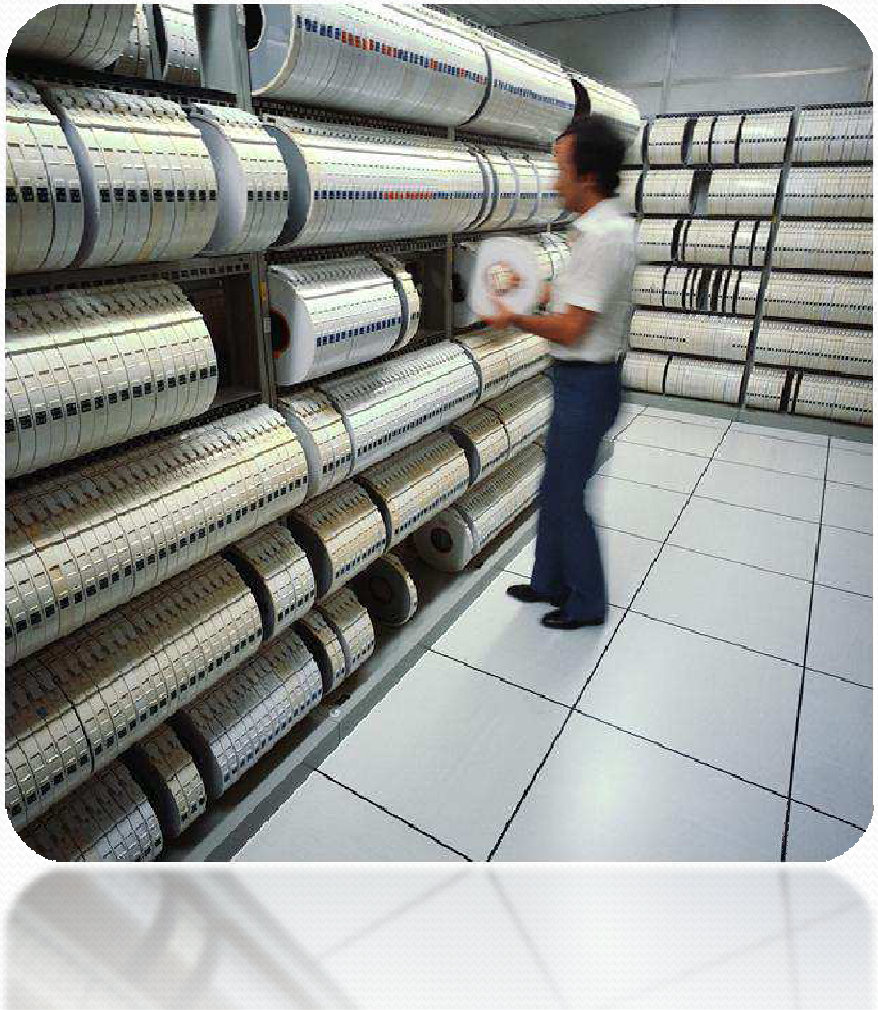


Challenges of DES

Data management problems – Quality of the data

Challenges of DES

Data management problems – High quantity of the data



Challenges of DES

Data management problems – Data integrity

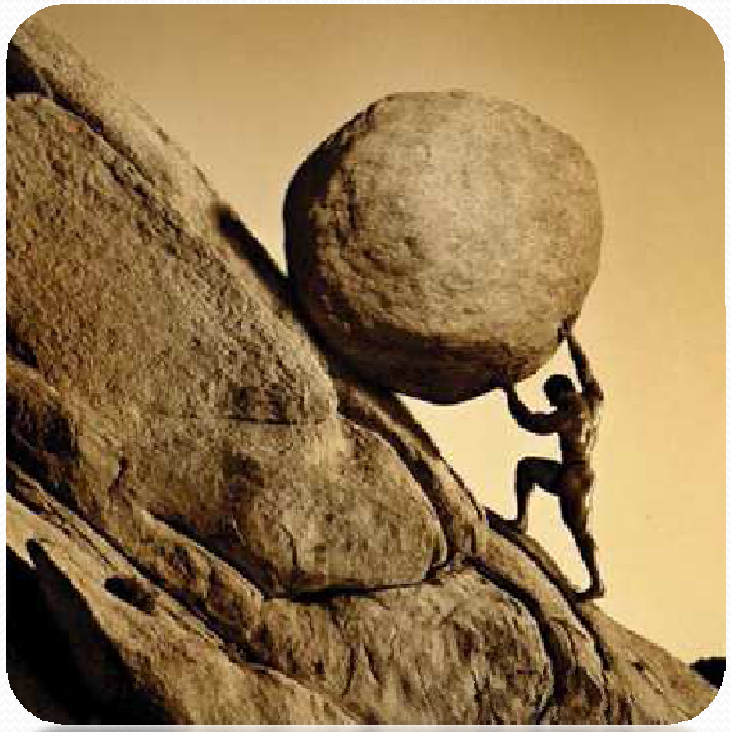
Challenges of DES

Data management problems – Data temporal heterogeneity

Challenges of DES

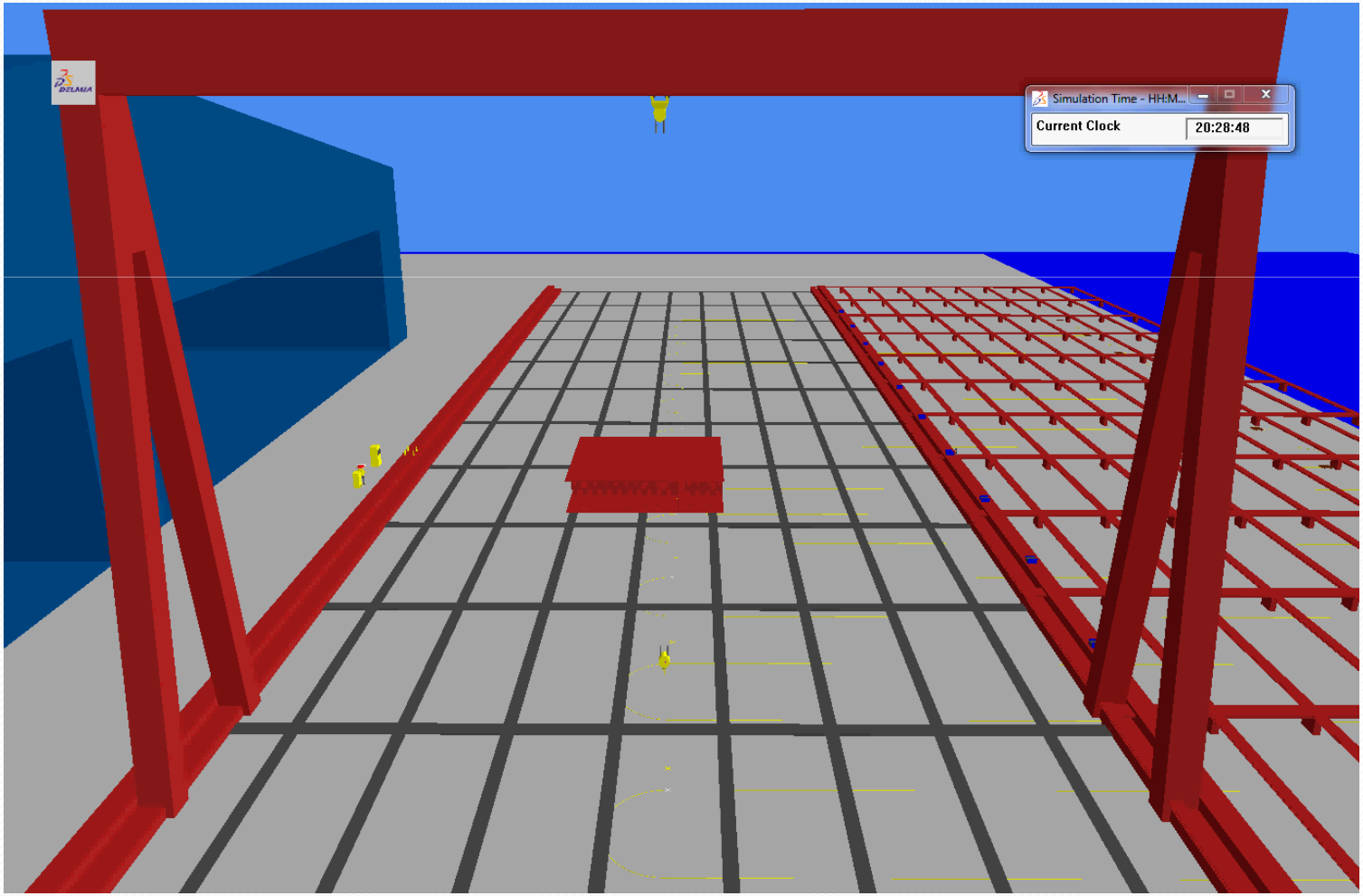
Other issues

- Cost of some DES softwares
- High skilled people are required to develop and maintain the models ➔ High investment
- Modeling time remain a big issue for small and medium size shipyards
- It is still difficult to integrate perfectly the production simulation with the CAD/CAM and ERP systems ➔ No efficient commercial interfaces



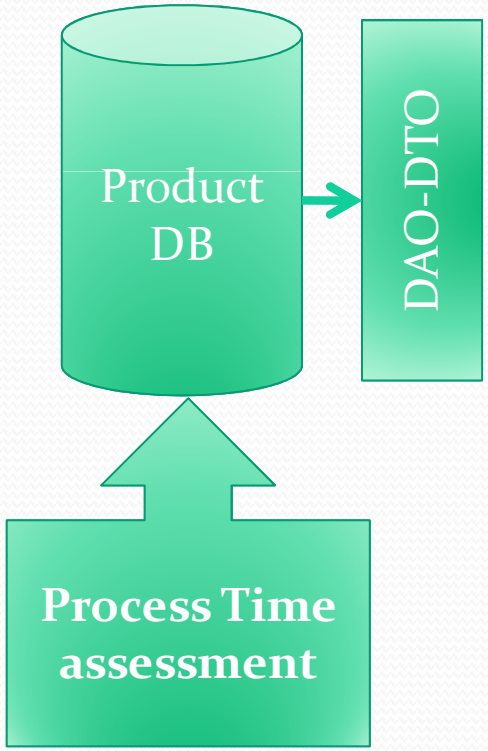
Coupling optimization and DES

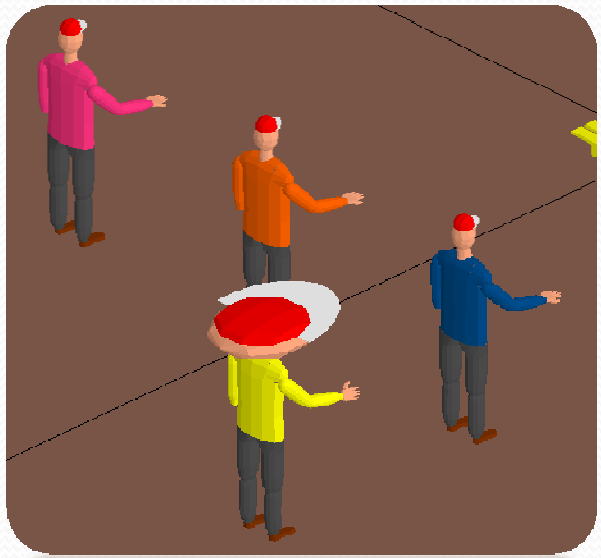
Video of a simple model

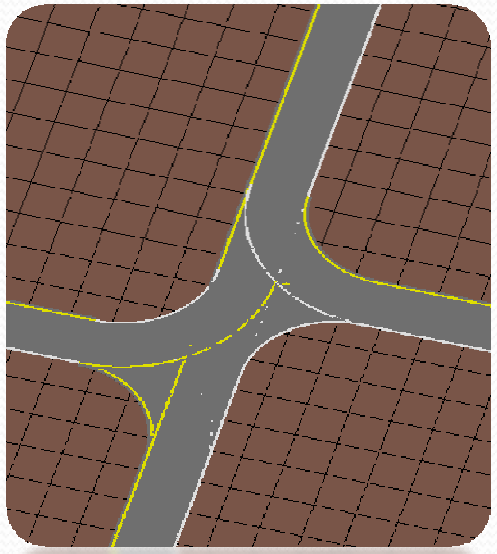


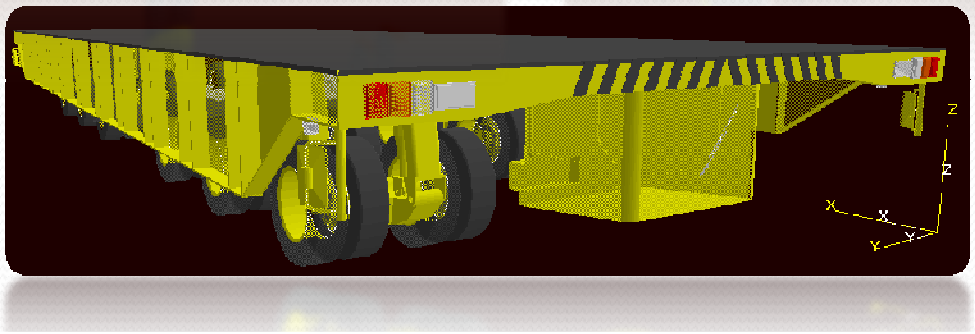
Coupling optimization and DES

Development of a shipyard toolbox for Quest



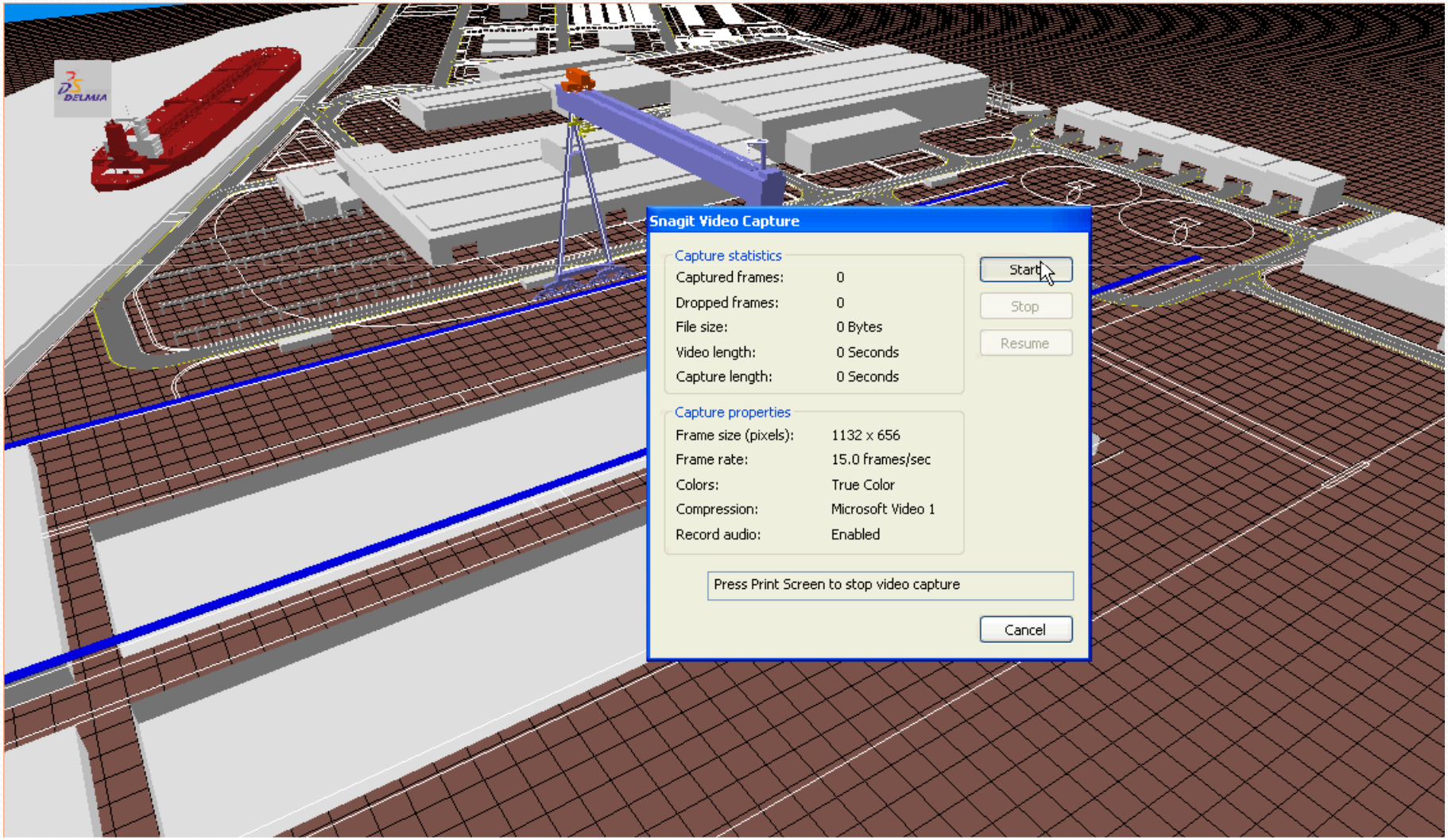






Coupling optimization and DES

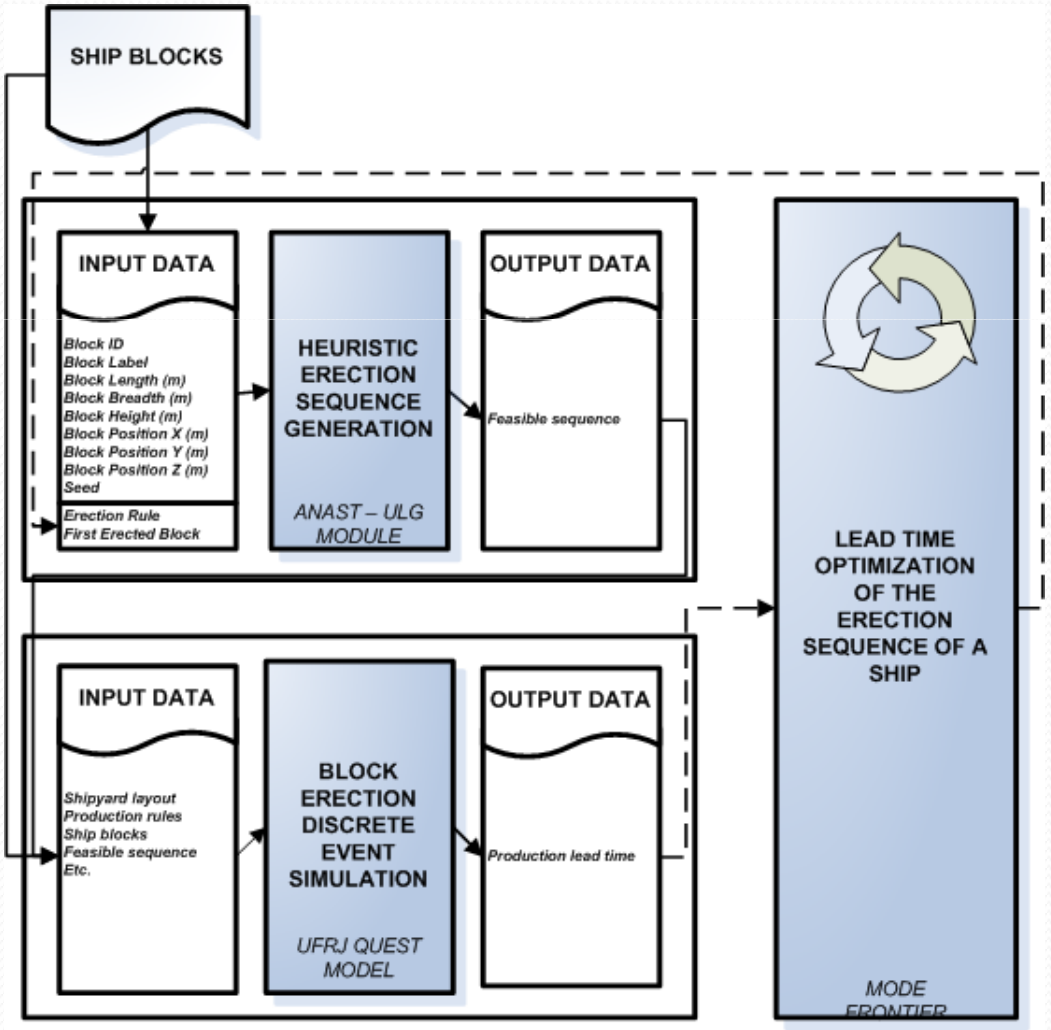
Video of a full model



Coupling optimization and DES

To find the best erection sequence

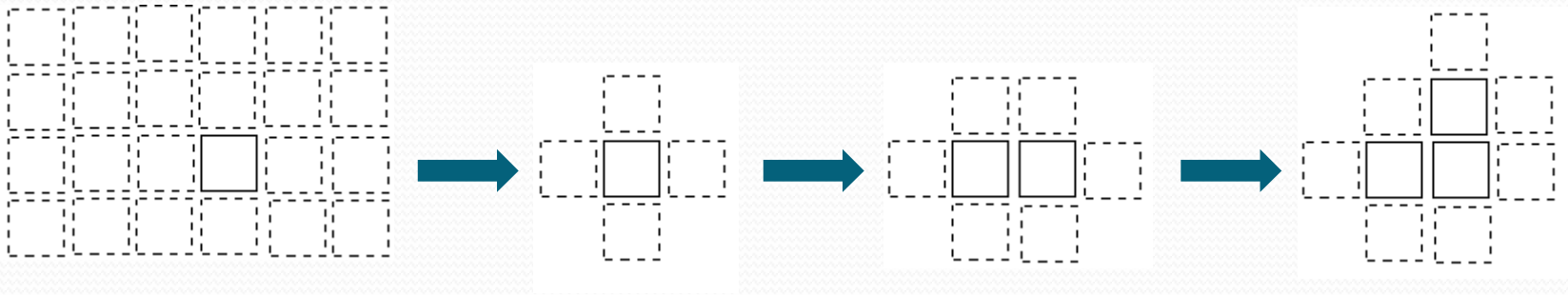
- 3 softwares
  - Quest – DES
  - ModeFrontier for the optimization
  - Heuristic erection sequence generator (in-house development)



Coupling optimization and DES

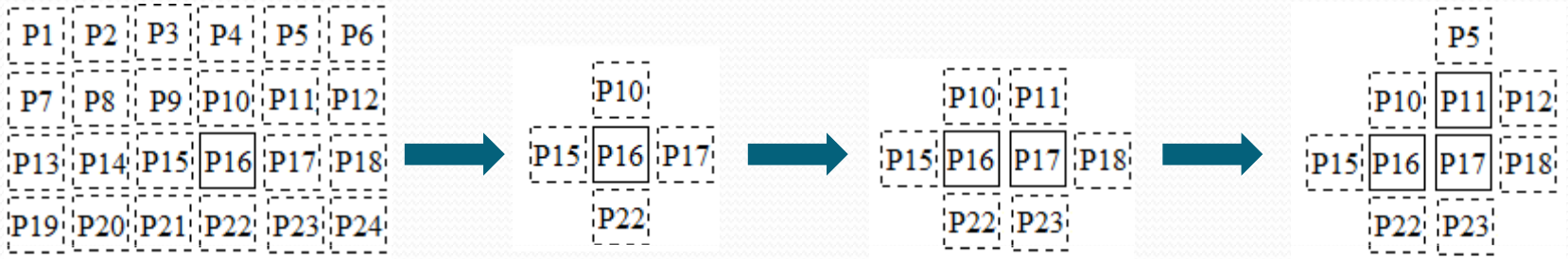
A heuristic sequence generator

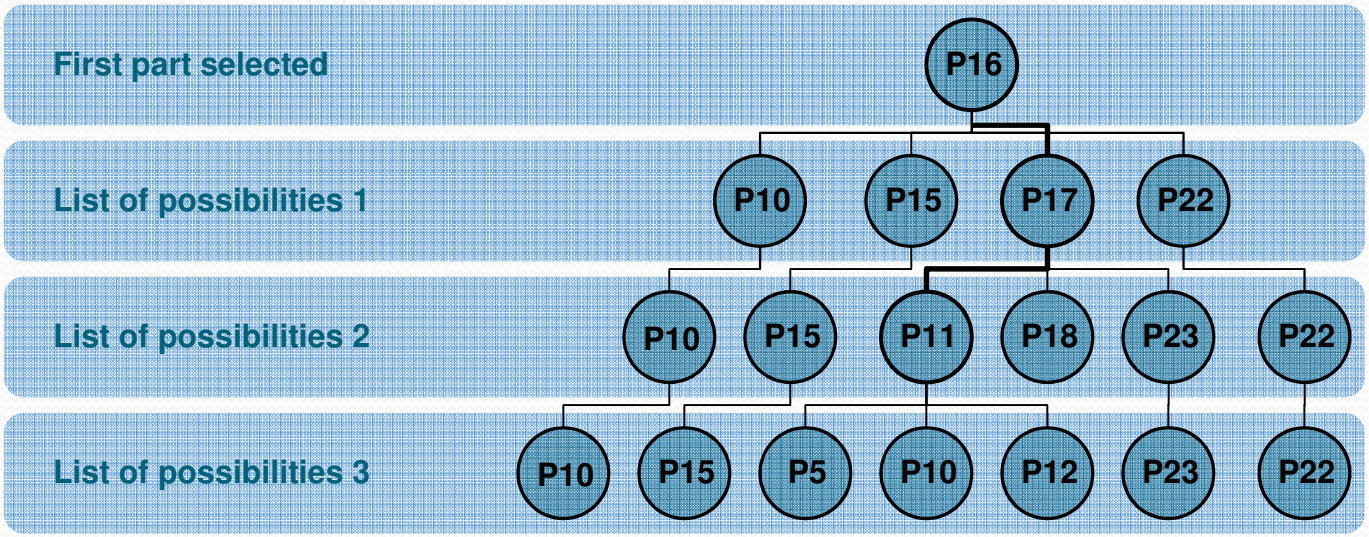
- Objectives
  - Use only feasible sequence during the optimization
  - Reduce the computation time
- Input parameters
  - Erection rule (vertical, horizontal, piramidal)
  - First erected block
  - Seed



Coupling optimization and DES

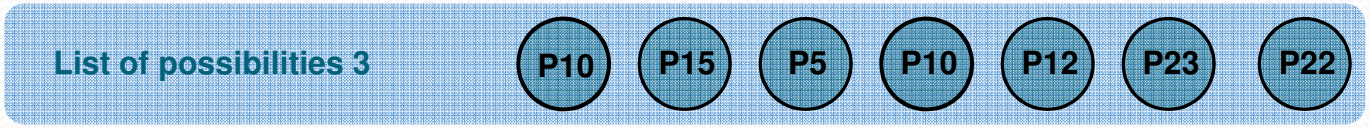
A heuristic sequence generator



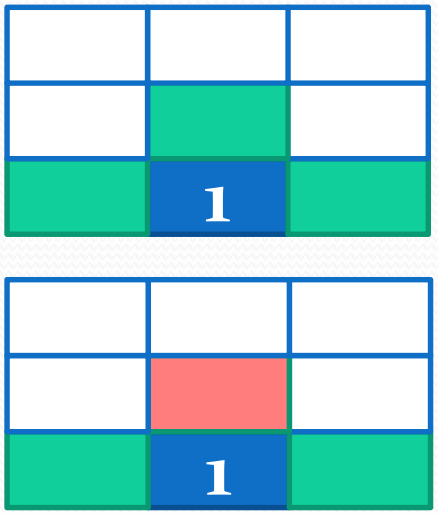


Coupling optimization and DES

A heuristic sequence generator



Example of the horizonal rule



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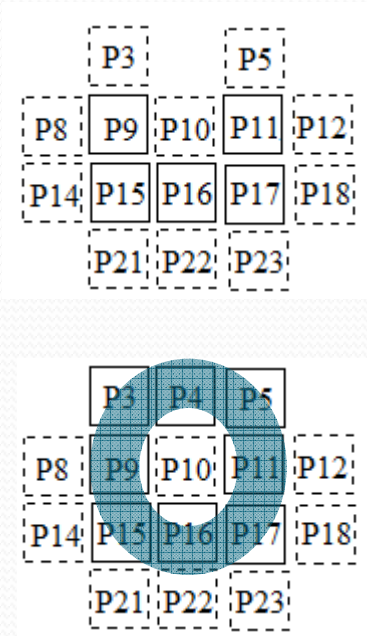

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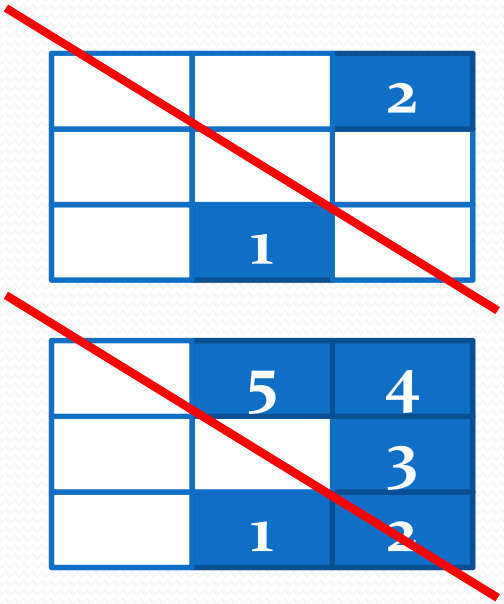
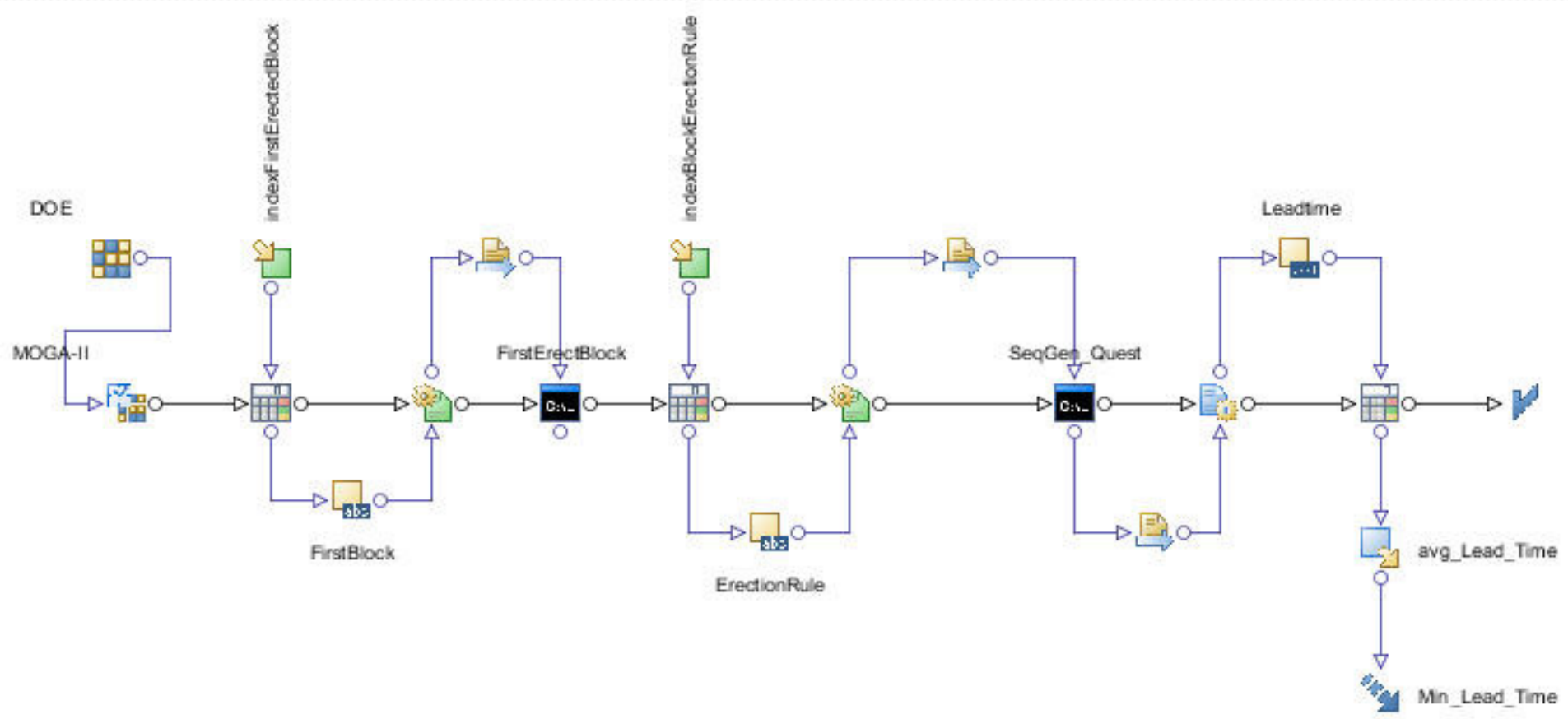


Coupling optimization and DES

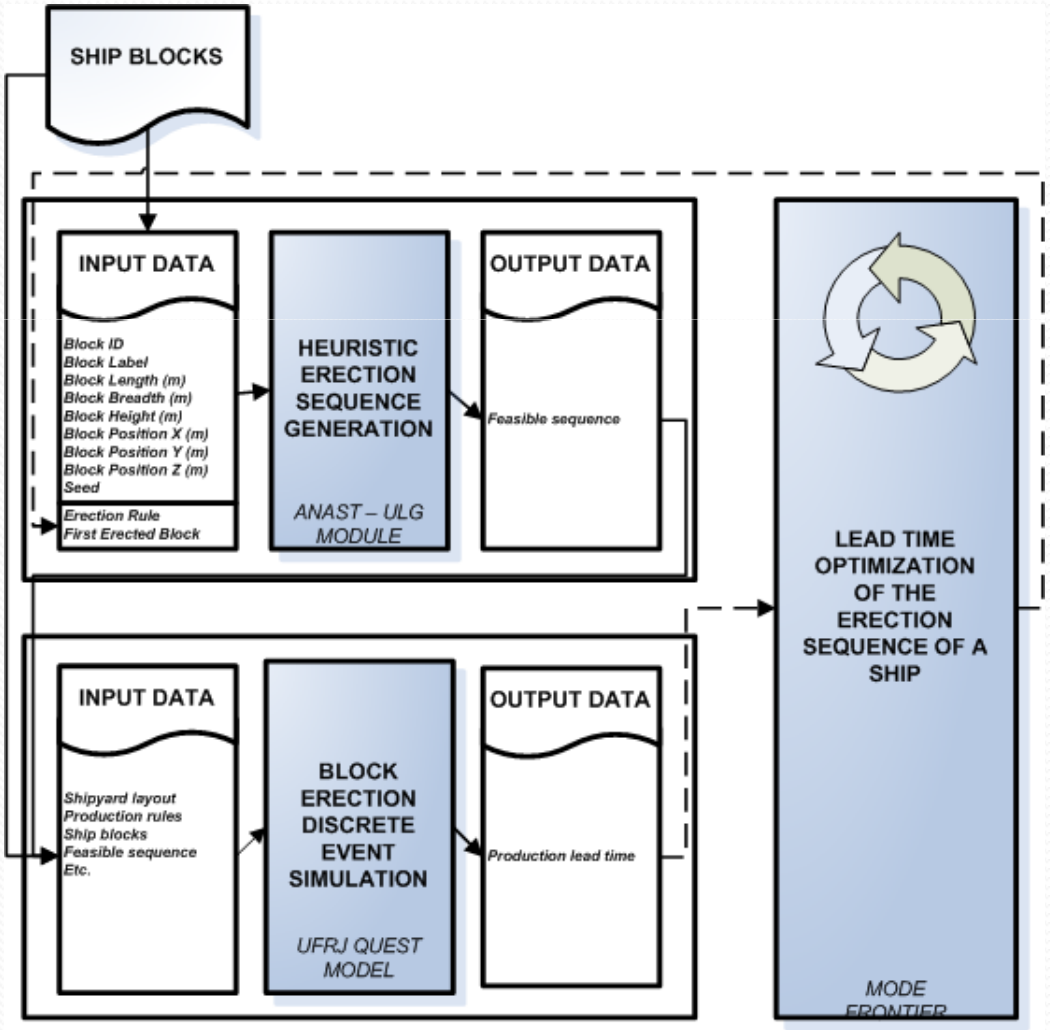
ModeFRONTIER workflow



Coupling optimization and DES

Sequence optimization – To find the best erection sequence

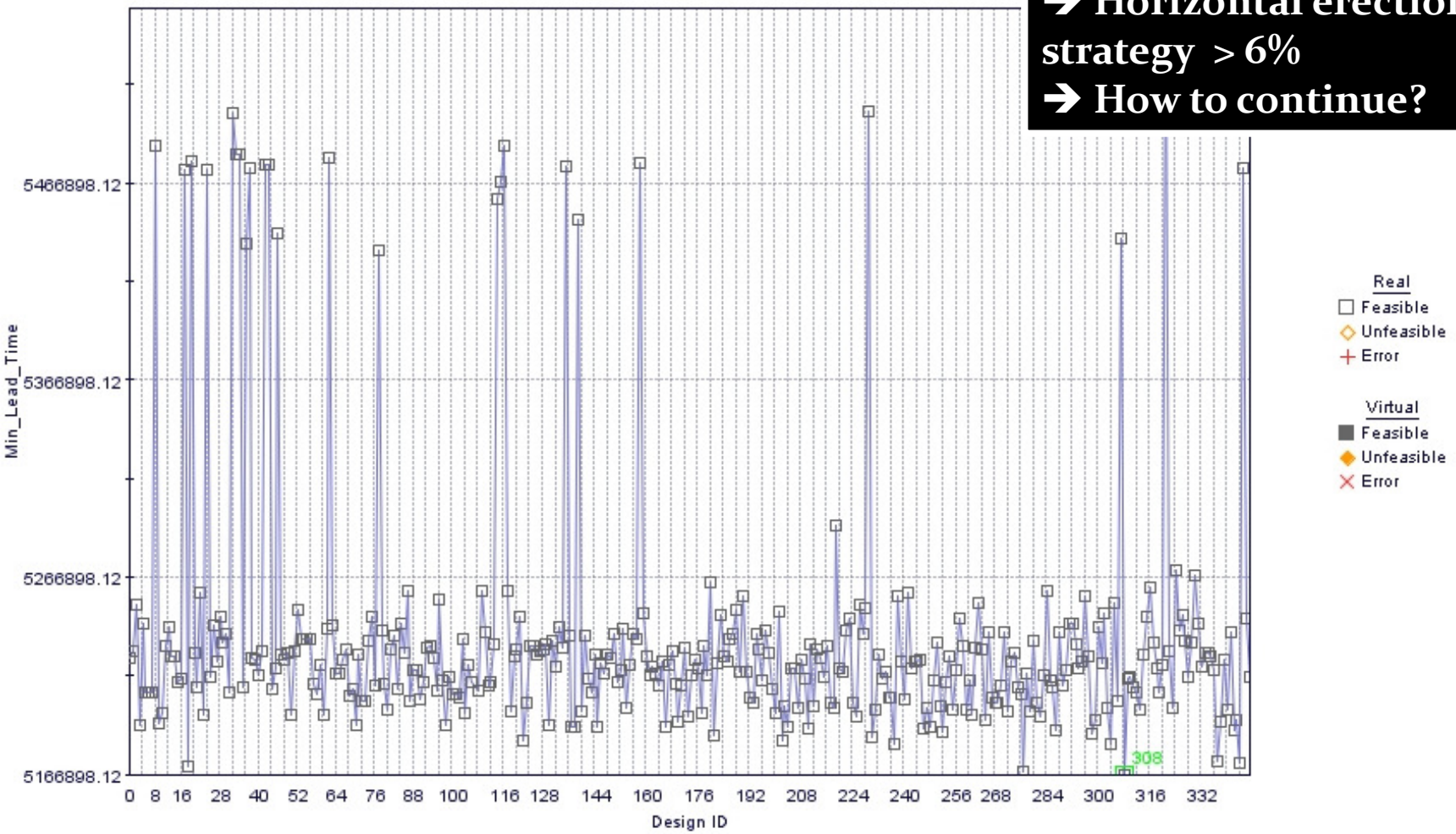
- Objective function
  - Lead time
- Contraints
  - N/A
- Design variables
  - Erection rule
  - First erected block
  - Erection sequence seed
- Simplex & Genetic algorithms



Coupling optimization and DES

First results!

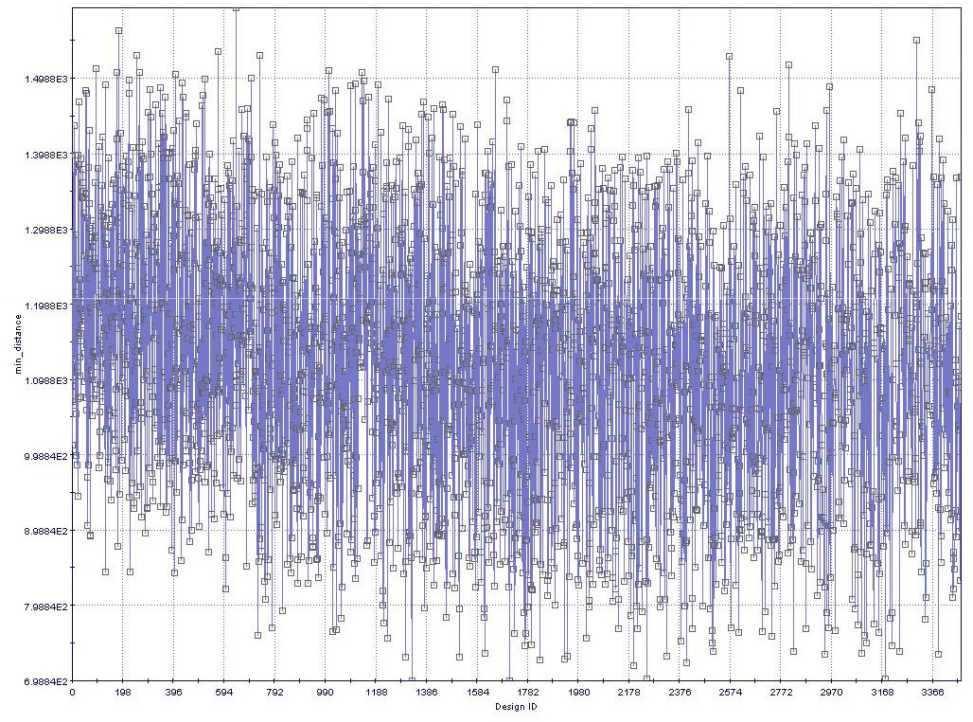
➔ No convergence !
➔ Horizontal erection strategy > 6%
➔ How to continue?



Coupling optimization and DES

Travelling salesman problem

- Given a list of cities and their pairwise distances, the task is to find a shortest possible tour that visits each city exactly once
- Similar problem
  - **NP hard** problem
  - Combinatorial optimization



➔ Again no convergence !
➔ Strong collaboration with ModeFRONTIER to solve this problem

Conclusions

And future work

- A first test of erection sequence optimization have been performed
- Unfortunantly no convergence
- Similar problem (traveling sale man) ➔ Same results
- Two options to continue
  - Improve the optimization software with the developpers
  - Test another alternative to model the problem

Thank you for your attention!