Remote Laser Welding (RLW) System *Navigator*

Configuration Optimization

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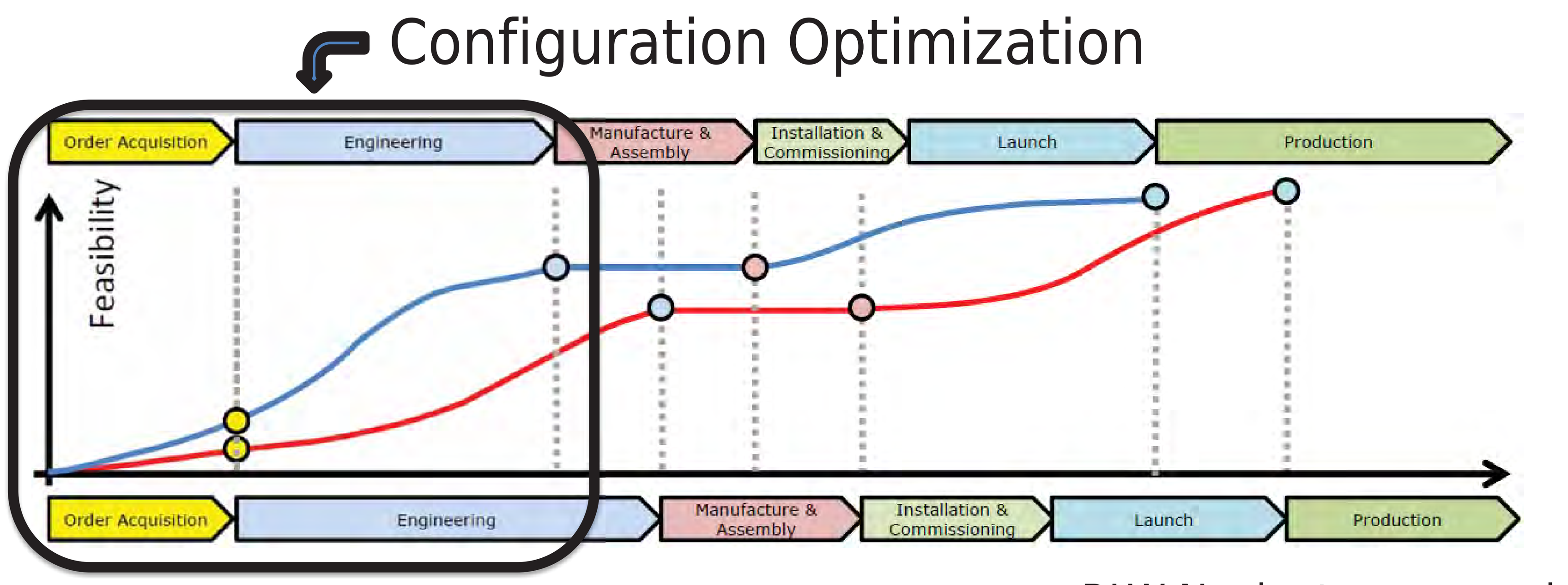
What is it?

System-level configuration optimization integrated with performance evaluation modules within the context of modeFRONTIER software.

Goal:

- ✓ Propose a faster system design procedure, to study more potential configurations in less time.
- ✓ Implement this procedure in an assembly system design platform.



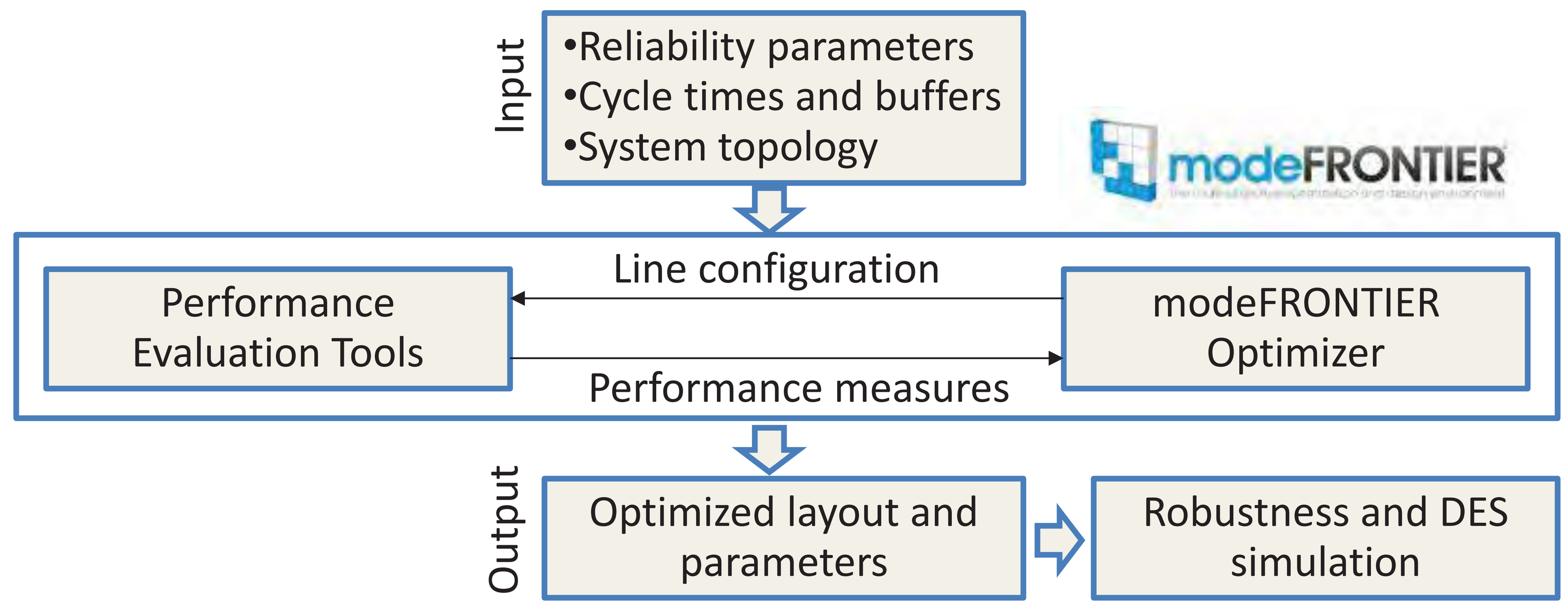
New Product Introduction Process

Key results & Impacts:

- ✓ Shorten time to market of system configurations (from 2-3 months to 1 week).
- ✓ Knowledge re-use – configurations database.
- ✓ First time right designs and fast quoting.
- ✓ Fast quoting.

What does it do?

- ➢ Multi-objective optimization.
- ➢ Generation of optimized candidate solutions (Pareto frontier).
- ➢ Robustness and sensitivity analysis on Pareto solutions.
- ➢ Discrete Event Simulation on Pareto solutions.



Description of software platform and tool interaction

Key design parameters:

- Selection of resources (robots, fixtures, etc).
- Task asisgnment and sequencing.
- Buffer design.

Energy, Cost, N°robots, Floor space, Station cycle time

$$Min\left\{E_{hour}, C_{tot}, R_{tot}, N_{tot}, \frac{1}{\mu_i^{RLW}}\right\}$$ ⟵ Multi-objective optimization.

$st:$

$TH \geq TH^{target}$ ⟵ Throughput constraint

$LB(CT_i) \leq CT_i \leq UB(CT_i) \quad \forall i = 1,.., NS$ ⟵ Processing rate range

$LB(N_{i,j}) \leq N_{i,j} \leq UB(N_{i,j}) \quad \forall (i,j) \in \Gamma$ ⟵ Buffer size range

$$N_{tot} = \sum_{(i,j)\in\Gamma} N_{i,j}, R_{tot} = \sum_{i=1}^{NS} R_i$$

Input and layout

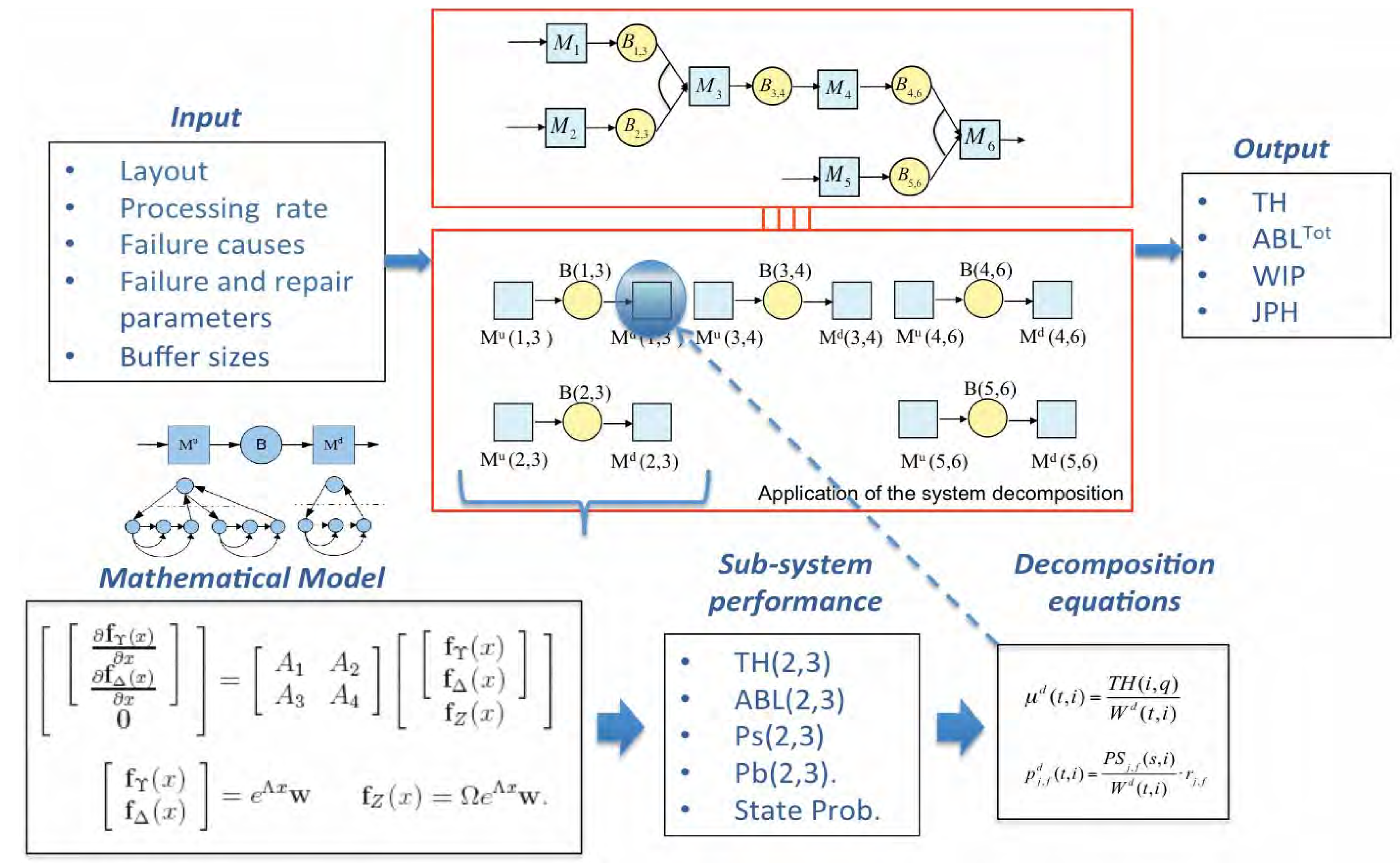
The starting information needed by the optimization is:

- Topology of the system.
- Reliability database.
- Stations cycle times.
- Buffer ranges.

Performance evaluation

The optimization is based on a mathematical model, based on Markov chains that works as evaluation kernel, providing:

- Fast configuration evaluation.
- Actual and detailed line KPIs estimation, like OEE, Jobs per hour (JPH), Work in progress, etc.



Description of the developed analytical method.

Configuration optimization

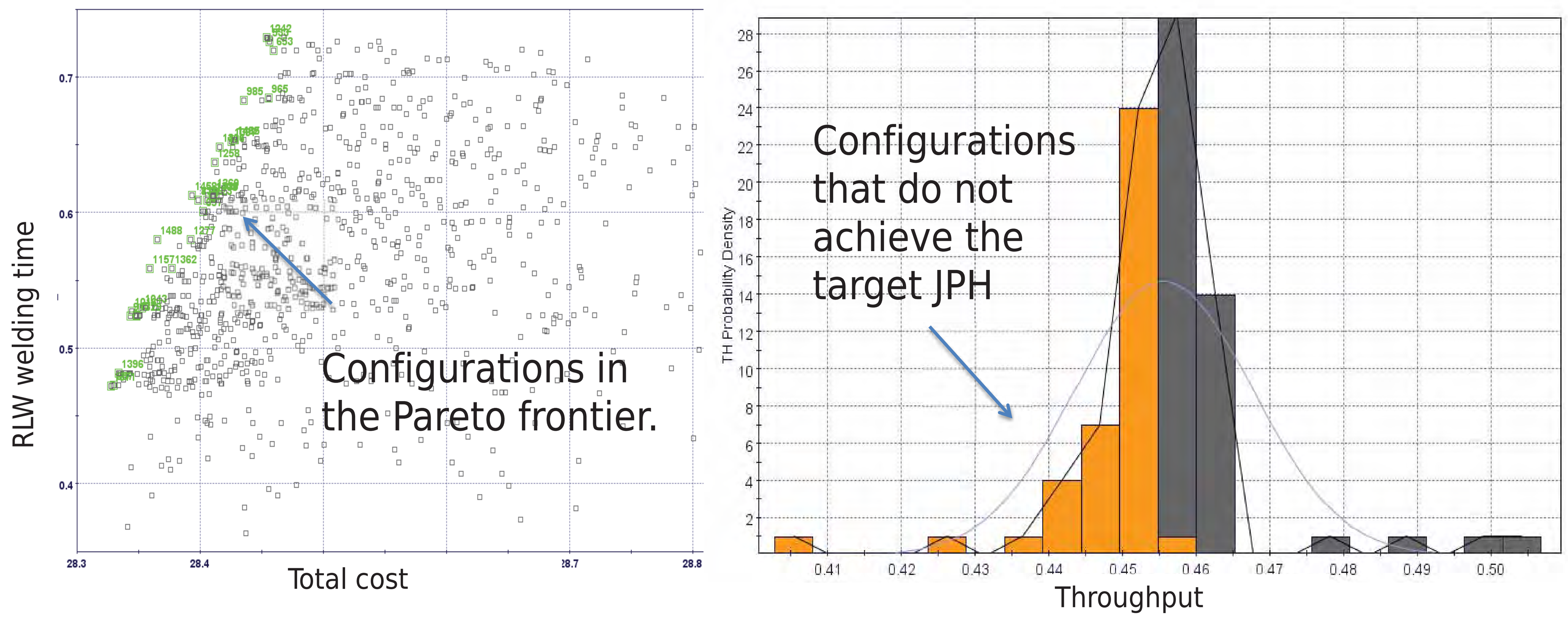
The modeFRONTIER optimizer determines the values of:

- Optimal number of robots.
- Optimal processing time.
- Optimal buffer sizes.

These values are calculated considering the performance constraints in terms of JPH.

Sensitivity and robustness

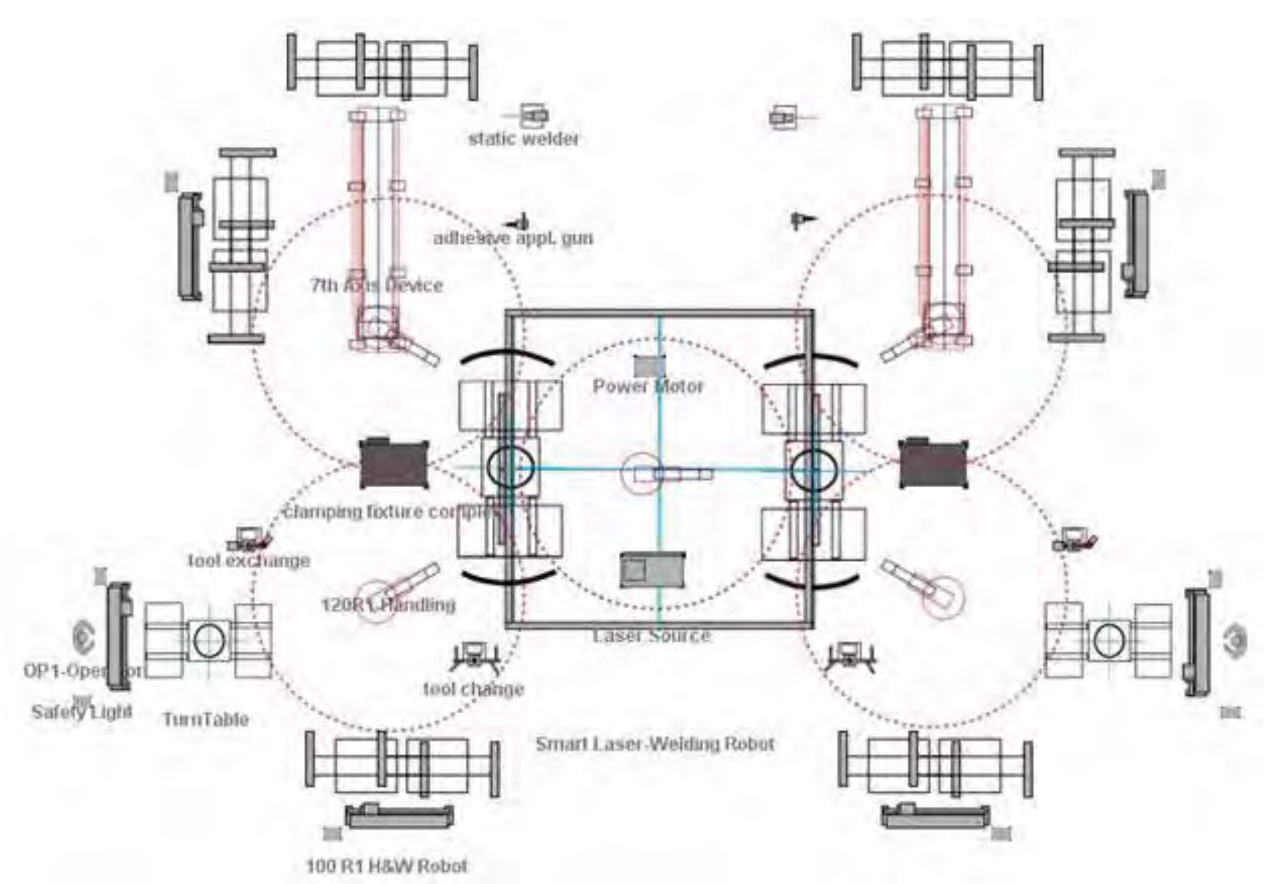
The robustness of the configurations on the Pareto frontier is determined using the modeFRONTIER MORDO functionalities. On these configurations, a detailed simulation is performed, using a dedicated DES simulation software.



Examples of output visualization from modeFRONTIER.

Application to JLR industry case

The methodology has been successfully used in the reconfiguration of the automotive assembly line of Jaguar Land Rover Evoque, involving the introduction of RLW technology.



KPI	Current configuration	Hybrid RLW configuration	Δ%
Throughput [part/t.u.]	0.455	0.46	+1%
Total cost [€/t.u.]	0.55	0.38	-30%
N° robots	28	17	-39%
Energy [kJ/t.u.]	194.5	83.2	-57%

Results from the application to JLR industry case.

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