

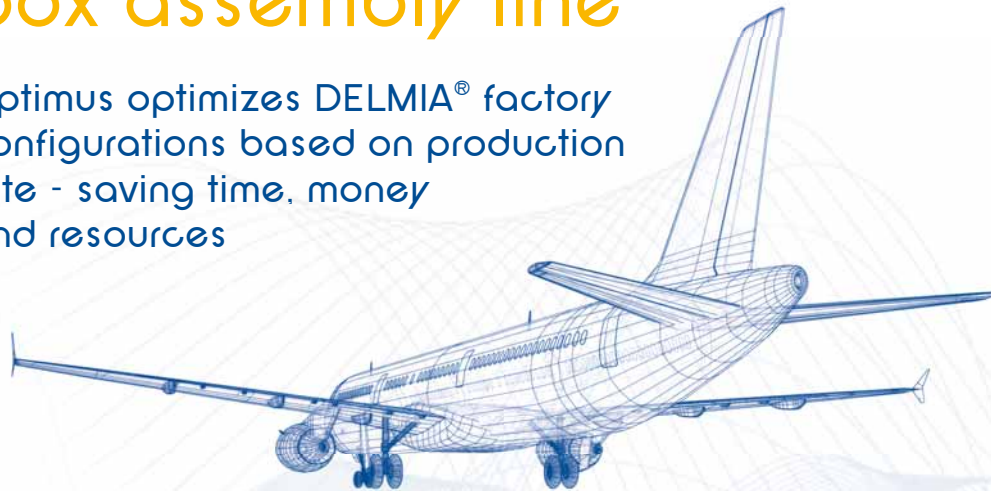
Design for real

Optimus[®]

Case Study

Sogeti High Tech runs Optimus to maximize output of center wing box assembly line

Optimus optimizes DELMIA[®] factory configurations based on production rate - saving time, money and resources



Following the depicted process flow, Optimus intelligently alters manufacturing configurations during simulation to meet the targeted production output most efficiently.

Engineers at Sogeti High Tech are charged with streamlining the production process of a center wing box (CWB) factory in function of production rate variations. After creating a digital CWB factory model with DELMIA[®] with the support of an expert in industrial organization, they use Optimus to trace the ideal assembly line configurations for any production rate between 13 and 20 units per month. Through intelligent automated exploration, Optimus identifies those factory configurations that yield maximum CWB production output using a minimum number of production machines. Production managers can directly read the optimum factory configuration from a diagram, to realize next month's projected production rate as economically as possible. The process eliminates weeks of manual trial and error, saving considerably on personnel and production resources.

From product to manufacturing optimization

“For more than 10 years, Sogeti High Tech is active in development projects for leading aviation and other manufacturing companies,” says Nicolas Kawski, Business Group Manager Studies & Simulations for Sogeti High Tech in France. “We first started with structural finite element analysis (FEA), and soon evolved to a multi-physics approach. We often use Optimus to drive structural/aerodynamic simulation in search of designs exhibiting optimized performance and robustness.”

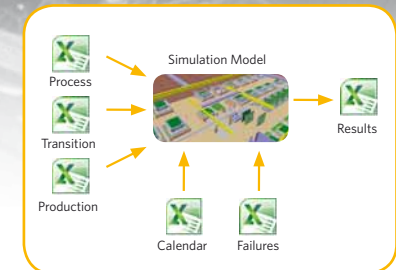
Over the past decade major development programs made aircraft safer and greener, and reduced their operational costs. Important in this regard is the increased use of lightweight composite materials in primary load-carrying aircraft structures. As the integration of associated

production technologies potentially delay aircraft delivery times, aircraft manufacturers are challenged to step up manufacturing efficiency. Recently, Sogeti High Tech was asked to investigate how simulation could further optimize the productivity of a center wing box (CWB) factory in France. A CWB unit is an ultra-strong, rigid assembly that attaches both airliner wings to the fuselage, ready to withstand high-amplitude aircraft lift forces.

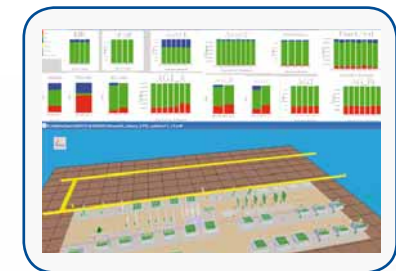
Multi-objective assembly line optimization

A modern production facility should easily absorb additional workload in times when business is picking up. Therefore the plant organization should be adapted flexibly depending on the targeted monthly CWB production rate. “To trace the optimum production configuration,” says Nicolas Kawski, “our consultants perform assembly flow simulations based on a digital factory model defined in DELMIA. To efficiently maximize assembly line output for any production rate between 13 and 20 CWBs per month, they link the digital factory model to Optimus.”

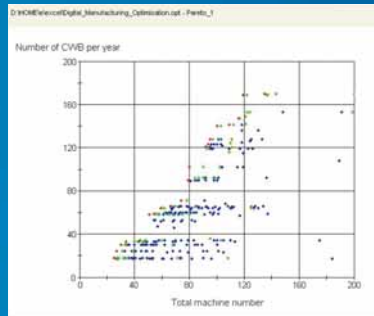
Sogeti High Tech engineers first sketch the design optimization process flow in Optimus’ graphic drag-and-drop process integration editor. The DELMIA factory model takes into account detailed information related to time process,



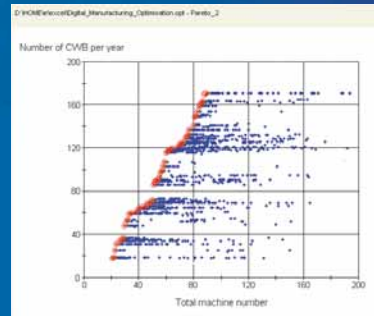
Using Optimus, Sogeti High Tech optimizes factory configurations based on production rate, and imports/exports data directly through Excel®.



The digital DELMIA factory model takes into account detailed information related to time process, plant organization, production failures, working shifts, etc.



100 iterations



500 iterations

Preliminary insight gained into the Pareto front (left) versus a full optimization run that evaluates more production line configurations to reveal all Pareto front details (right).

Extreme productivity gains in a fraction of the time

plant organization, production failures, working shifts, etc. The large number of mostly discrete input data and the non-linear production flow make the simulations fairly complex. No factory management or programming skills are required because Optimus arranges the parametrization and subsequently automates design variable substitutions to extract simulation results. This allows Optimus to orchestrate parametric DELMIA simulations by writing input data, driving simulations and analyzing simulation results – including Microsoft Excel® input/export.

Kawski explains that when driving DELMIA simulations, Optimus intelligently varies the number of machines per manufacturing cell and the positions of the machines in the assembly line.

“The iterative optimization process driven by Optimus’ multi-objective evolutionary algorithms reveals the so-called Pareto front. Points on this line represent those configurations that deliver the most favorable input trade-offs in view of both simulation objectives: maximizing CWB output and minimizing total machine count.” In multi-objective optimization, the Pareto front separates the region of feasible design points, for which all constraints are satisfied, and the region of infeasible design points.

Automatic optimization covering 100 iterations steered by the evolutionary algorithm already provides some preliminary insight into the Pareto front. “A 500-iteration optimization run simulates sufficient assembly line configurations to reveal all Pareto front details, as shown on a diagram.” Kawski clarifies. “From this diagram, CWB factory managers can instantly read the most economic assembly line configuration that turns out the targeted number of units. They consult Excel result files to find out what this configuration entails in terms of manufacturing cell machine count and assembly line layout.”

To respond to changing aircraft demand, Optimus identified the most efficient assembly line configuration for each discrete CWB production rate. Kawski

says that it took Optimus only one day to complete the entire simulation campaign, whereas the manual approach lasted three days. “Manually performing DELMIA simulations led to improved assembly line configurations, but failed to match the optimized assembly line productivity.”

Through Optimus, Sogeti High Tech successfully increased the bottom line of the CWB factory. “Optimization makes the difference by maximizing the economics of flexible manufacturing infrastructure, equipment and teams. Optimus identifies assembly line configurations that realize factory savings beyond what was previously thought feasible.”

“Sogeti High Tech relies on Optimus to optimize CWB factory productivity in function of production rate variations, realizing tremendous economic savings.”

Nicolas Kowski

Business Group Manager Studies & Simulations, Sogeti High Tech in France

Process optimization

- ✔ **Define the optimization process flow on the fly**
 Engineers simply sketch the optimization process flow, using Optimus' graphic drag-and-drop process integration editor.
- ✔ **Drive a wide range of virtual simulations**
 Optimus easily captures any simulation process and orchestrates the simulation software automatically – regardless whether focusing on structural finite element analysis, multi-physics engineering or digital factory simulation.
- ✔ **Get relevant information at minimum cost**
 Optimus defines an intelligent virtual experiment plan to acquire the most relevant design information possible with a minimum simulation effort.

Design optimization

- ✔ **Identify the most economic assembly line configuration that meets production targets**
 Optimus' multi-objective optimization algorithms quickly reveal Pareto front details, empowering factory managers to instantly find out the most economic assembly line configuration for any targeted CWB output, out of all possible combinations.
- ✔ **Quickly respond to changing manufacturing demands**
 Optimus completes a full simulation campaign for a discrete set of production rates in a small fraction of the time needed compared to the manual approach, delivering optimized assembly line productivity whenever required.



Sogeti High Tech

Sogeti High Tech is a leading company offering Engineering and Technology Consulting Services. With over 20 years of expertise, Sogeti High Tech undertakes major technical and engineering innovation projects for R&D departments of global industrial firms. To meet customer requirements, Sogeti High Tech developed five business lines: Consulting, System Engineering, Physics Engineering, Software Engineering and Testing. Sogeti High Tech is a subsidiary of the Capgemini group.

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