Gurobi® + TOYOTA

CASE STUDY



Maximizing Profitability While Ensuring Environmental Compliance

Toyota generates optimal compliance scenarios in minutes.

Industry	Automotive
Location	Africa, Americas, Asia, Australia/New Zealand, Europe
Use Cases	Automation, Cost Reduction, Production
Website	www.toyota.com

Toyota's passion is about giving people the freedom to explore their world and reach their full potential. Whether physically, through their dependable vehicles and innovative mobility solutions, or emotionally, through inspiring design and intimate experiences— Toyota's ever-evolving desire to help will never end.

Results

- Generates **optimal compliance scenarios in minutes**
- **Automatically generates solutions** of the highest quality and accuracy

Performing environmental compliance simulations requires complete and up-todate knowledge of all relevant regulations.

In the past, the managers at Toyota in charge of global environmental compliance would review the regulations in their assigned country or region, and then use Excel to manually run multiple simulations. These manual simulations would show how many of each model should be produced in order to maximize profit while adhering to all relevant environmental requirements.

This process was difficult and timeconsuming as these simulations had to be run multiple times and checked each time by those responsible for environmental regulations in the various countries and regions. Also, automakers typically make more profit when they manufacturer and sell large, high-end vehicles – and, in Toyota's case, these would be the Land Cruiser and Crown.

In order to determine the right product mix, Toyota needed to be able answer questions like: "If we produce 1,000 hybrid Priuses, 200 Lexus LS, and 50 Land Cruisers, would we meet US CAFE (Corporate Average Fuel Economy) standards? How much annual profit would this generate?"

Answering these types of questions involves analyzing a large number of scenarios and adjusting various constraints to determine the optimal product mix that maximizes profits while meeting environmental requirements. Toyota decided to use mathematical optimization to address this problem and figure the optimal product mix – as this AI technology is capable of automatically generating high-quality solutions in a short amount of time.

After evaluating various mathematical optimization solvers, they chose the Gurobi Optimizer – the fastest solver on the market. The Gurobi Optimizer is used in Toyota's AKARI ("Advanced Knowledge and Real-time Intelligence") Environmental Regulations Module to rapidly perform simulations that take into account the environmental regulations in each region and country. These simulation results are then fed into the AKARI Profit Planning Module, which runs additional simulations to calculate things like the projected profit for the next fiscal year.

Before the implementation of the mathematical optimization solution, it used to take an immense amount of time and effort to conduct such financial simulations and calculate profitability based on production volume and product mix. But now, with this automated system powered by the Gurobi Optimizer, anyone can instantly perform these complex calculations with the simple click of a button.

Rapidly Generating High- Quality Solutions

Prior to the implementation of the automated planning system powered by the Gurobi Optimizer, it was labor intensive and time consuming to create sales plans that effectively balanced the two objectives of profit maximization and environmental compliance.

Using manual planning tools and techniques and relying on their experience and intuition, Toyota's management team used to spend days conducting simulations and evaluating different scenarios – as each simulation had to be performed separately.

Now, with the Gurobi Optimizer, the speed of calculation has dramatically improved and it takes only a few minutes to conduct each simulation. More important than speed, however, is the new system's ability to automatically generate solutions of the highest quality and accuracy – which was simply not possible with manual planning tools and techniques.

Toyota aims to implement and launch other AKARI modules – including Development Planning and Product Planning – by the end of the company's 2020 fiscal year, and will also explore possible ways to integrate and link the various modules. Additionally, the automaker will look for opportunities to expand its use of mathematical optimization across its enterprisewide operations. With mathematical optimization, Toyota has been able to significantly improve the speed and quality of its decision making.

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The automaker believes that, with technologies like the Gurobi Optimizer, it is possible to achieve automation (either fully or at least to some extent) and optimization of the decisionmaking process.

About the AKARI Profit Strategy System Project

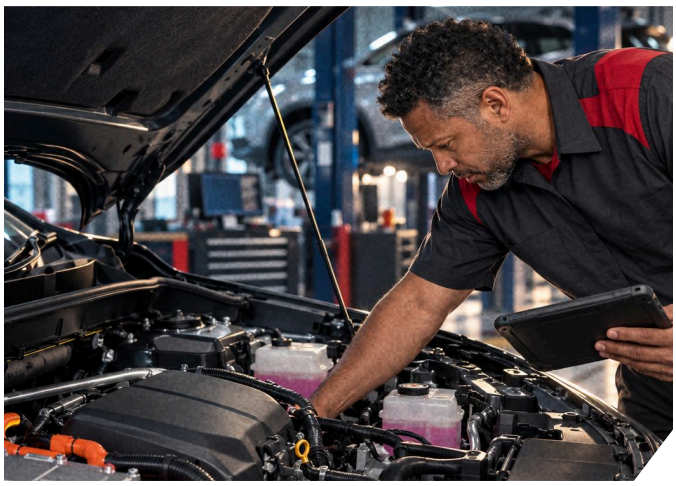
Toyota's Corporate IT Division launched the AKARI ("Advanced Knowledge and Real-time Intelligence") Profit Strategy System project to improve the company's process of formulating profit strategy.

The first step of the project was to develop a Profit Planning Module, which is used to generate the company's medium-term profit plan.

In the second phase of the project, the Corporate IT Division created the Environmental Regulations Module, which uses the Gurobi Optimizer.

The TOBIRA ("Toyota Business Insights for Rapid Action") Management Dashboard is a system that provides Toyota's management with the information and insights they need to make the best possible business decisions in a timely manner. AKARI is integrated with TOBIRA – AKARI automatically processes data from each of its modules, and then feeds this data to the TOBIRA dashboard.

The AKARI Project has two modules (the Profit Planning Module and the Environmental Compliance Module) that are currently operational, and numerous other modules that are under development – with three new modules slated to be launched during the company's 2020 fiscal year.



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>
> Daisuke Furutsu,
> Project Manager, Corporate IT Division, Toyota Motor Corporation

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