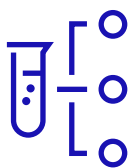


# Cognitive AI for Formulation

A lubricant formulation advisor that intelligently recommends formulations based on human knowledge and AI, improving discovery and optimization.



Beyond Limits' cognitive formulation advisor combines machine learning and artificial intelligence techniques with domain expert knowledge to provide a fast, efficient, and reliable software application to augment and optimize the lubricant formulation process leveraging the client's historical data and expertise.

## Benefits and Value Proposition

- + Accelerated speed to market
- + Reduced program & material cost
- + Integrated user-friendly platform
- + Embedded expertise in the workflow
- + Standardized processes reduce compliance risk

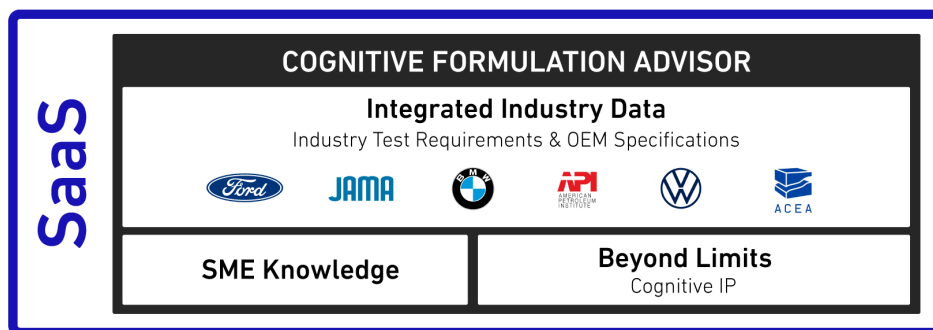
## LUBRICANT FORMULATION CHALLENGES

Historically, the process of creating, optimizing, and testing new engine lubricants has been a long, high-risk, high cost, trial and error process that requires deep domain expertise. In addition, ever-changing regulatory, environmental, and equipment manufacturers' guidelines further complicate the process. Lastly, each candidate formulation is typically validated through a long and expensive series of tests, further increasing the cost, risk of failure, and time-to-market for new products.

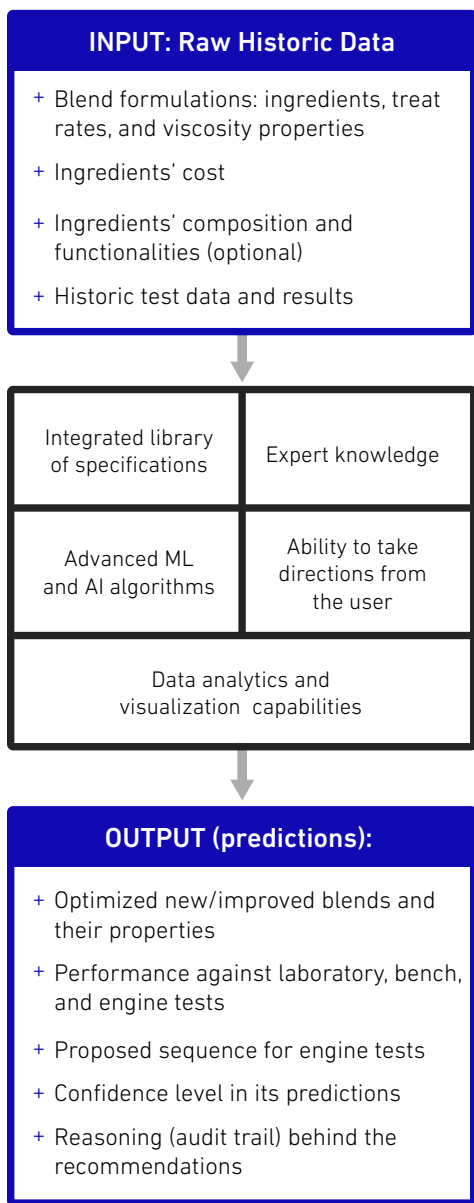
To unlock key competitive advantage, it is imperative for manufacturers to transition from mostly manual, trial and error, high-risk approaches to a fast, efficient, data and knowledge-driven development process powered by the most recent advances in science and technology.

To help overcome these challenges and provide lubricant manufacturers with a crucial competitive advantage, Beyond Limits has developed a cognitive formulation advisor. The advisor is a software product that integrates empirical relations and expert knowledge with advanced artificial intelligence and human-like reasoning to provide a fast, efficient, and reliable software solution to augment and optimize the lubricant formulation process, from discovery to testing.

The advisor helps organizations shorten the time-to-market for new lubricants, reduce material and operating costs, and lower regulatory and compliance risks.



The advisor is a software application that integrates empirical relations & expert knowledge with AI & human-like reasoning to optimize the formulation process.



## BEYOND LIMITS COGNITIVE FORMULATION ADVISOR

The cognitive formulation advisor is a web-based software application that facilitates discovery, optimization and testing of new blend formulations with desired specifications. The advisor leverages Artificial Intelligence (AI) algorithms that are educated by domain knowledge and trained with historical data.

The advisor ingests historical blend data, including their components (base stocks, viscosity modifiers and additives), treat rates, cost of materials, as well as viscometric properties or other measured properties, such as chemical content of historic blends. It is capable of carrying out similarity matching for additives based on functionalities of the additive components, and their chemical and metallic compositions. It also ingests historic data on laboratory, bench, and engine tests carried out on historic blends, creating a centralized library of information to assist with the generation of optimal blend candidates.

- + Formulate improved or new blends that meet desired viscosity grade, specifications, and OEM requirements
- + Predict viscometric characteristics of each proposed blend and report the confidence level in its predictions
- + Identify the best performing and most economic combinations (multi-variable optimization)
- + Predict the performance of hypothetical blends with respect to required laboratory, bench, and engine tests
- + Recommend an optimized testing schedule by considering cost, time, likelihood of success, and industry rules and standards

As part of its solution architecture, the advisor applies advanced feature engineering techniques to aggregate functionalities, ingredients, and chemical composition of various components including base stocks, viscosity index improvers, and additives.

It offers an intuitive and easy-to-use interface that enables users to interact with raw data and the predictive models, provide relevant inputs, examine underlying data, and evaluate and export outputs. In addition, its powerful visualization and data analytics tools enable users to plot, filter, and sort data in various formats, offering a centralized, all-in-one platform to assist with lubricant formulation discovery and optimization.

## WHY BEYOND LIMITS COGNITIVE FORMULATION ADVISOR

To unlock key competitive advantages, lubricant manufacturers need to accelerate the transition from mostly manual, trial and error, high-risk approaches to a fast, efficient, AI-powered development process fueled by data and knowledge.

Beyond Limits' cognitive advisor incorporates domain knowledge and rules (such as VGRA and BOI) into its process and reflects a formulator's thought process and constraints in its reasoning. It also augments the existing expertise of formulation engineers by providing a fast, easy-to-use, interactive, and intelligent tool, which is capable of ingesting, analyzing, and building on top of large, complex data sets and domain expertise libraries.

Beyond Limits leverages a world-class team of data scientists and AI engineers to develop hybrid numeric/knowledge-based algorithms and deploy software tools to address key challenges for the lubricant formulation industry.

### UNIQUE FEATURES OF THE COGNITIVE FORMULATION ADVISOR TOOL INCLUDE:

- + Ingesting new and historical data from existing databases and historical data from existing databases
- + Using advanced machine learning algorithms to create new blends by exploiting and learning from the client's data and experience and exploring new combinations - a unique exploration/exploitation strategy to push the boundaries of discovery and optimization
- + Integrating expert knowledge and empirical relations into the data-driven predictive models to develop unique hybrid models
- + Taking inputs and directions from the user, from desired specifications to required constraints and desired product and industry considerations
- + Using deep reasoning by understanding the effect of ingredient type and chemical composition (such as key properties of additives and viscosity index improvers) on the estimated performance of blends
- + Characterizing confidence levels in its predictions, supporting critical decision-making with respect to candidate blends

In addition, the advisor incorporates a rich, up-to-date library of industry specifications such as SAE, API, ACEA, and JAMA to help ensure compliance and drive discovery of new marketable products. For automotive lubricants, additional Original Equipment Manufacturers' (OEM) requirements are also integrated into the tool.

These capabilities enable the discovery and development of optimal formulations, adding value, shortening timelines, lowering cost, and reducing risk across all stages of the process: discovery, optimization, and testing.

For more information contact  
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## DATA PRIVACY, SECURITY AND DEPLOYMENT

Beyond Limits understands that inputs to the cognitive formulation advisor (including historical data on blends, costs, test results, and additives) – are amongst its clients' most valuable business assets. Beyond Limits is fully committed to protecting and securing our clients' data against unauthorized or unwanted use, and adheres to state-of-the-art data privacy and security standards across all storage and deployment scenarios.

The cognitive formulation advisor can ingest live or static data and support multiple users across the entire enterprise. Beyond Limits is committed to ensuring scalability across deployment environments of any size across public clouds, on-premises, and hybrid cloud infrastructures.