

## AIR LIQUIDE LARGE INDUSTRIES, L.P. PIPELINE OPTIMIZATION

Air Liquide Large Industries, L.P., the U.S. subsidiary of global France-based Air Liquide Group and the world's largest producer and distributor of industrial and medical gases, is in one sense an "energy transformation company". In 1999 the company initiated a high-level internal study, known as the Air Liquide Decision Support System (AL-DSS), to identify the technical tools and systems that could help address such complex business issues as deregulation of the energy market; fluctuating energy prices; changing customer demand; production and delivery costs; and, the need for real-time valuation of its supply chain assets.

As a result of the study, Air Liquide embarked on a transformation – from a traditional business model to a scientific approach to optimizing its core assets. The company turned to the scientists at NuTech Solutions to exploit the power of complexity science to improve efficiencies in production, distribution, forecasting and transport. Since then, business, science and technology have merged to give Air Liquide the answers.

Air Liquide completed its first project with NuTech Solutions – advanced production and distribution optimization – in 2004. NuTech applied two scientific techniques, genetic algorithms and ant algorithms to determine the best production schedules and distribution points for Air Liquide's products. This implementation

of ant systems still represents one of the largest and most successful industrial applications of the technology.

Today the company's focus remains on optimization, and once again they turn to science and NuTech Solutions to implement a new corporate initiative – the economic optimization of their Gulf Coast pipelines.

### CHALLENGE

Air Liquide operates a large and complex dual-pipeline system of more than 1,800 miles on the Gulf Coast. These pipelines, the world's largest industrial gas pipeline system, consist of two separate pipes for transporting oxygen and nitrogen, which are produced together at their production facilities. Today, the Gulf Coast pipeline network has a production capacity of 21,000 tons of oxygen per day (15 billion pounds of oxygen per year) and 35,000 tons of nitrogen per day (22 billion pounds of nitrogen per year). Air Liquide also deploys 27 distillation production units at 15 production facilities along this network.

Since the project launch in 2004, the company's primary goal has been the economic optimization of its pipelines. Specifically, Air Liquide wanted more insight into its real time variable costs across the pipeline, and a clear path to the optimal solutions for minimizing costs associated with production, transport to its 200+ clients, energy required to "push" its products through the

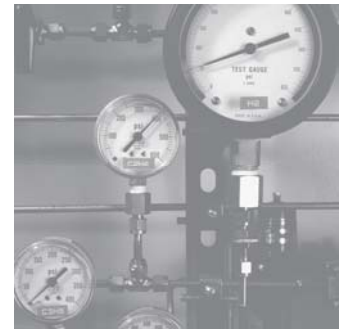
pipeline, and the human resources required to manage it.

To help manage the pipeline, Air Liquide uses a pipeline simulation model that successfully handles hydraulics, such as the volume, pressure and speed. However, the ongoing model did not provide the economic optimization needed to give Air Liquide the valuable data and insight essential to reducing costs.

"Our model is ideally suited for the hydraulics portion of our pipeline, but we could not determine the dollars we were leaving on the table due to inefficiencies across our pipeline," said Charles Harper, Director of National Supply and Pipeline Operations at Air Liquide. "We needed the enhanced robust optimization piece of the puzzle to make critical decisions."

To achieve this level of efficiency, Air Liquide required a pipeline optimization model that could address:

- ▲ a complex, dual-system that transports two gases in two separate pipes, from 15 production facilities
- ▲ fluctuating energy prices
- ▲ changing customer demand and need
- ▲ multiple production plants along the pipeline that cater to a diverse customer base
- ▲ defined efficiency curves for its equipment
- ▲ accurate hydraulic simulations



*"We have the answers to our tough questions – how do we exceed customer expectations efficiently, reliably and cost-effectively. We're doing it, every day."*

*- Charles Harper  
Air Liquide  
Large Industries, L.P.  
Director of National  
Supply and Pipeline  
Operations*



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*“At any moment in time, we know which plant to run at what level, where and how. We get the optimal solution. The power of science has been embraced companywide at Air Liquide, thanks to our partners at NuTech.”*

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In addition to recognizing these challenges, Air Liquide defined specific objectives for this project. The new optimization model must:

- ▲ integrate seamlessly with Air Liquide’s back-office systems
- ▲ reproduce the hydraulics portion of its existing model
- ▲ “run” automatically and unconstrained upon data input, giving the best possible solution for any situation or pipeline configuration
- ▲ “close the loop” to recommend optimal solutions without human intervention in field equipment operation

“Again, our goal was simple – to achieve the lowest production costs and maintain system reliability,” said Harper. “NuTech’s optimization model gives us that insight. We now have a clear calculated path to our “ideal world” for any given customer or energy situation. After all, the dollars don’t lie. And that was just the kind of vision we needed to motivate investment, and change our organization and behavior. The scientists at NuTech Solutions delivered that functionality to us before, with the production optimizer, so we knew they could help us again.”

In 2004 Air Liquide and NuTech Solutions got to work on the first pipeline optimization model of its kind.

## SOLUTION

The resulting Pipeline Optimizer, built from NuTech Solutions’ Intelligent Business Engine for Optimization, not only satisfies the objectives outlined by Air Liquide, but it also represents the first optimization model of its kind, developed using the power of

science to improve efficiencies across the pipeline, in both hydraulics and transport. Most importantly, the new optimization model has empowered Air Liquide to lower costs and improve reliability – the company’s primary objectives.

To ensure complete data integration, NuTech Solutions had to rebuild and learn the hydraulics portion of Air Liquide’s existing model, a difficult task because it’s the heart and sole of an optimized solution. The optimizer combines data feeds from Air Liquide’s back office systems with hydraulics statistics and fluctuating power costs to generate the most efficient, lowest cost solution – at every hour. The model also runs unconstrained, enabling Air Liquide to redeploy valuable resources where most needed.

“At any moment in time, we know which plant to run at what level, where and how,” said Harper. “We get the optimal solution. We know exactly when to make changes in hydraulics, for every customer demand. We found the missing piece, that crucial insight into possible inefficiencies. Again the value came in interacting with the scientists, business people and technologists to develop this solution. And again, the power of science has been embraced companywide at Air Liquide, thanks to our partners at NuTech.”

The new pipeline optimization model takes into account the key components that drive efficiency – production, transport speed/pressure/volume, behavior of the products as they move through the pipe, human vs. automated management of the pipeline, fluctuating power costs, diverse customer demand, and a complex system.

## RESULT

With pipeline optimization completed in February 2005, Air Liquide now delivers products along its Gulf Coast pipeline to more than 200 customers from diverse industries, while ensuring the most efficient, lowest cost operation. The company continues to analyze results from the new model, which has to date enabled the company to achieve its objectives.

Using the new pipeline optimization model, Air Liquide identified opportunity savings of \$300 to \$750 every hour, due to inefficiencies and constraints across the pipeline. With this insight, the company can now identify problem areas, and make the necessary adjustments to satisfy customer needs at a lower cost and improved reliability.

“This model is just a powerful tool,” said Harper. “It feels like our pipeline is not so complex. We can successfully tackle the issues that affect our business, like changing customer demand and fluctuating power costs. We get the facts we need to adapt to these daily issues, yet also to remain cost-effective.”

“We look forward to continuing our partnership with NuTech Solutions, and to making the pipeline optimization model a ‘living thing’ with continued improvements and new releases.

“We have the answers to our tough questions – how do we exceed customer expectations efficiently, reliably and cost-effectively. We’re doing it, every day.”





## AGENT-BASED MODELING: A GLIMPSE INTO THE FUTURE

We are all on a quest... a quest for answers. Did I make the best decision? What will happen if I do this? Will I get the results I want?

Imagine that we had the answers. Imagine that we could predict the outcome of a situation before it occurred or the results of our actions before we acted. What powerful insight and knowledge we could use to make the best decisions for ourselves, our family, our workplace, and our future.

Executives search for answers to complex business problems every day – answers that will significantly impact their companies, solutions and marketplace. Progressive companies have used Business Intelligence (BI) applications to leverage their past experiences to improve decision-making, determine new strategies, and drive profits. Unfortunately, these tools are rarely powerful enough to handle the complexities that arise in the real world. Simply stated, conventional BI analysis is more suited to address the “known” than the “unknown”.

NuTech Solutions builds on the basic principles of BI technology by incorporating a new breed of modeling techniques that are ideally suited to address the unknown. One of NuTech’s Intelligent Business Engines™ for Modeling includes a new technique called Agent-Based Modeling (ABM). Agent-based models grow dynamic outcomes through predictive simulations that offer realistic and plausible outcomes to complex business problems. This insight empowers business leaders to learn from and solve such complex issues where conventional BI analysis falls short.

Particularly valuable for complex systems comprised of many interactive components, such as a supply chain, assembly line or a large population of people, an agent-based model is comprised of “agents” that represent any entity in a real-world application. Created with the same characteristics as their real counterparts, these unique agents act, interact and compete in a realistic, dynamic simulation. It is precisely these simulated activities and interactions among agents that produce reliable conclusions to complex business questions – and give users insight into the future not possible with traditional BI techniques.

NuTech Solutions’ customers have deployed ABM for a diverse range of applications, from managing daily operational issues to planning long-term strategies. Together, NuTech and its customers have ideally integrated basic business principles with emerging science and technology, resulting in the transformations of corporate business models, cultures, and profits.

While the applications for ABM are diverse, two distinct advantages have emerged as the most prolific and influential in the marketplace:

### Strategic Prediction of Market Effect

ABM provides predictive insight into the impact of future changes, such as policy changes or market shifts either anticipated or likely. In these scenarios, agent-based models are typically the only simulation technology that can realistically capture the diverse range of probabilities and impacts that the changes might produce. NuTech Solutions helped the NASDAQ exchange using an

agent-based simulation to predict how the market might react to the new regulatory policy of Decimalization. The Joint Chiefs of Staff used ABM to explore robust Force combinations to deal with the new and unconventional threat landscape of the post cold-war era.

Possibly the most prominent application of strategic prediction agent-based models has been in industrial operations, such as supply chain modeling, to determine what small changes might have a profound impact on operations, or how to improve decision-making in such areas as production and distribution.

### Data Farming to “Test” the Market

A company or organization may simply not have the experience or historical data to examine when analyzing complex issues. Using agent-based models, data farming refers to the creation of new source data.

Procter & Gamble and the Department of Defense used NuTech Solution’s data farming technique to explore new methods of influencing human decision-making. Data farming enabled these clients to “test” their markets by generating future outcomes and analyzing their effects on their respective markets. The applications included testing market acceptance of a new product, encouraging alternative tax filing methods and executing more effective peace-keeping missions.

With agent-based modeling, science, business and technology merge. And the result? Well, you might just get a glimpse of the future.



*From managing daily operational issues to planning long-term strategies, NuTech and its customers have ideally integrated basic business principles with emerging science and technology, resulting in the transformations of corporate business models, cultures, and profits.*



## BEIERSDORF A.G. REACHING THE HIGHEST LEVELS OF INNOVATION

*In 2004, Beiersdorf had 16,402 employees worldwide and global revenues of 4.6 Billion € (around 6.0 Billion US \$). The company's drive to develop state-of-the-art technologies to support their intensive research and development work enables Beiersdorf to define their markets and set new trends for products that are highly effective and meet consumers' needs. As a trendsetter, Beiersdorf generates over 30% of their sales with products that were launched within the past five years.*



Beiersdorf AG, based in Hamburg, Germany, is a leading cosmetics and health care company with global brands such as Nivea, Tesa, and Hansaplast. Known for their high standards in all facets of product design and development, and with 120 years of expertise in skin research, 100 years' know-how in emulsion technology and 120 years' experience of plaster development, Beiersdorf prides itself on a culture of constant innovation.

### CHALLENGE

Maintaining a leadership position in the cosmetics industry requires a strategy of quick-to-market products and a strong brand. The market has expanded beyond primarily women, to encompass more men and teens, and reaching those consumers has become increasingly varied, through grocery stores, drugstores, mass merchandisers, warehouse clubs, specialty retailers, and online e-tailers. One significant area of market growth is in natural products.

As an innovation leader, Beiersdorf planned to add their well-known brand to the natural products arena with a body lotion. Their research and development team worked with various natural ingredients for three months to develop a formulation for the body lotion. However, the conventional development approaches used by the formulation experts failed to yield a stable formulation.

Getting to market first with a product that meets constantly shifting consumer tastes is critical. Beiersdorf needed a creative way to discover new product formulations, while at the same time decreasing product development time. Beiersdorf engaged NuTech

Solutions to apply data mining and optimization engines, known as ClearVu Formulations, to these challenges in new product development.

### SOLUTION

With the help of NuTech Solutions' ClearVu Formulations, a model was generated from existing formulation data at Beiersdorf. This model was then used to predict stability of new formulations, resulting from modifications of existing formulations. Those modifications to existing formulations included both substitutions of components, as well as changes of the amounts of those components within the formulation. Each formulation that was predicted to be stable served as a starting point for the next round of further modification.

This "virtual formulation development process" allows models to predict characteristics of suggested combinations of ingredients and quantities, improving the resulting recipe by reincorporating the desirable attributes with each subsequent model. As a result, new ingredients, which Beiersdorf experts did not expect to deliver stable formulations, were suggested by ClearVu Formulations.

"Our past experience limited our trials to include only familiar ingredients, and the lengthy process of attempting each combination had led us to declare the desired product infeasible after three months of research," said Thomas Hillemann, Ph.D., from Beiersdorf. "However, with NuTech's ClearVu Formulations, we satisfied all the technical requirements faster

than with traditional processes, and now have a new product we will bring to the market."

### RESULTS

Using NuTech's ClearVu Formulations solution, which is integrated into Beiersdorf's research and development process and customized to their needs, Beiersdorf developed a stable formulation recipe satisfying all technical requirements, such as stability and viscosity, in a surprisingly short amount of time.

Additionally, Beiersdorf formulation experts gained new insight into the formulation process and revised their assumptions about the stability impact of some ingredients. Finally, product development time, based on the number of real experiments in the laboratory, was significantly reduced with ClearVu Formulations because the model's predictions automatically rule out unrealistic experiments, allowing scientists to conduct only those tests with potentially positive outcomes.

"NuTech's solution helped Beiersdorf learn more about their formulations and minimize investment in time and testing by targeting their efforts on relevant experiments," said Thomas Bäck, Ph.D., President of NuTech Solutions, Germany.

With this rapid entry into the natural products segment, Beiersdorf maintains its reputation as an innovator and market leader. ClearVu Formulations from NuTech Solutions will continue to support Beiersdorf in bringing innovative products to market faster and upholding their position as a leading brand of personal care products.

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*- Thomas Bäck, Ph.D.  
President of NuTech  
Solutions Germany*



## BNSF BOOSTS SERVICE PLANNING EFFICIENCY

NuTech Solutions has helped improve service planning efficiency for one of the largest railroad networks in North America, operated by BNSF Railway Company (BNSF).

BNSF's Design Managers required service planning functionality with speed and flexibility not found in legacy applications. Partnering with NuTech Solutions to build a system based on one of NuTech's Intelligent Business Engines™ for Simulation delivered the desired results – fast run-times, what-if scenarios and detailed diagnostics that radically shorten BNSF's design cycle.

"It used to take an overnight run to assess the impact of a proposed service plan change," said Rick Margl, Assistant Vice President of Service Performance for BNSF. "Today, using NuTech's Engines, we can simulate the operation of our entire network in just three minutes, ask unlimited 'what-if' questions, and ultimately leverage all our options to provide the service plan that best meets our customers' requirements. Our shippers' product quality will be enhanced as BNSF's service plan becomes more adaptive to ongoing fluctuations in lane mix and network volumes."

With the Simulation Engine supporting BNSF's Carload operation, BNSF and NuTech

Solutions continue to collaborate on advanced service planning solutions. Future phases of development include incorporating the Simulation Engine into BNSF's real-time tactical planning application and overall network plan optimization.

BNSF maintains high standards for application development, and they relied on NuTech Solutions to add leading-edge scientific knowledge and tools to their robust strategic planning systems. NuTech's Intelligent Business Engines are a critical component of BNSF's simulation and optimization processes today and tomorrow.

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*- Rick Margl  
Assistant VP  
of Service Performance  
BNSF*

## RECENT SCIENTIFIC APPEARANCES

NuTech Solutions' scientific team features several of the world's most prominent Ph.D.'s from the fields of evolutionary computation, data mining and complexity science. These scientists are frequently asked to share their expertise. So far this year they have participated in various workshops, conferences and meetings many of which are international events.

Dave Davis, Ph.D., Vice President and Chief Consulting Scientist is an organizer of many Genetic and Evolutionary Computation Conference (GECCO) events.

Leading up to this year's June 25 - 29 conference in Washington D.C., Dr. Davis helped organize the "Ask the Consultant" workshop. At the workshop, industry leaders described business challenges to a panel of five experts in Evolutionary Computation to gain feedback on evolutionary techniques most suited to those business problems.

At the GECCO conference Dr. Davis organized and chaired a session entitled "Technology Transfer from Academia to Industry". The session is part of a GECCO track co-created by Davis called "Evolutionary Computation in Practice", which focuses on real-world applications of Evolutionary Computation for solving tangible business and societal problems.

Earlier this year, Dr. Davis personified this "science for business" approach by co-authoring a paper titled "Optimizing Cyclic Steam Oil Production with Genetic Algorithms", which was presented at the Western Regional Meeting for the Society of Petroleum Engineers.

In addition, NuTech's scientist outreach extends beyond the corporate world into the public sector. Mario Inchiosa, Senior Scientist at NuTech Solutions, was an invited attendee at an ARDA (Advanced Research and Development Activity) challenge

workshop on knowledge representation for the NIMD (Novel Intelligence from Massive Data) Program in April.

NuTech Solutions' scientific leadership is recognized internationally. Thomas Bäck, Ph.D., President of NuTech Solutions Germany was one of the experts invited for the workshop on Computational Problems in Physics, an event organized by Helsinki University of Technology in Helsinki Finland, May 23 - 27, 2005. Dr. Thomas Bäck's presentation was titled "Evolutionary Algorithms for Solving Real-World Problems".

The common theme of "Science for Business" is echoed around the world, as NuTech's scientists join colleagues and industry and government leaders to discover innovative solutions for today's challenges. Through this ongoing growth and development, NuTech Solutions will continue to offer the best solutions to our clients.





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## EXCAVIO™ EXPOSES DOCUMENT DETAILS

Can you imagine what your life would be like without the use of a computer? Consider your daily routine using the internet and email today compared to just ten years ago. The last few decades have seen an explosion in the amount of information being generated and stored in computer systems. Information resides in many different formats, from word processing documents and emails, to electronic spreadsheets and database systems.

Companies have begun to realize that the information they've been collecting contains important pieces of business knowledge, which can be exploited to make better strategic decisions. By leveraging this information, businesses are able to gain deeper insight into customer acquisition and retention, operational improvements and strategic direction.

Of course, some forms of information are easier to leverage than others. Structured data, like that in spreadsheets and databases, is virtually organized in uniform rows and

columns, and typically easy to navigate. Contrast that with unstructured data, such as the collection of free-form sentences and paragraphs in a word processing document.

Software applications commonly search through structured data sources using a process called data mining, and as a result companies are able to discover valuable business knowledge from patterns in their data.

However, the challenge of using a computer to sift through unstructured data like emails, meeting minutes, marketing documents or web pages is quite difficult. NuTech Solutions has developed Intelligent Business Engines™ that enable a computer to perform this type of intelligent search. The technology is known as text mining. NuTech Solutions' advanced text mining solution is called Excavio.

Let's say you want to find information on a recent client. Excavio Spiders are able to automatically search and gather documents located in various locations, including the internet,

networked servers, and local disk drives. Need additional detail to understand all the documents that are available to you? Excavio includes classification tools that produce content summaries of the documents.

Excavio also makes the process of monitoring constantly changing external information easier using vertical industry specializations, such as Offer Seeker or Brand Monitoring, to scan the internet and report updated information about specified jobs or product brands.

Because Excavio's text mining encompasses a number of smart techniques capable of "reading" documents, understanding their content and comparing them to other documents, there are many possible applications. Using NuTech Solutions' Intelligent Business Engines, companies are now able to leverage decades of accumulated "unstructured" data to benefit their business by quickly accessing details that support both tactical and strategic decisions.



## NUTECH HEADQUARTERS MOVES UPTOWN

Visit our new headquarters location in the Interstate Tower building (effective June 27, 2005).

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