BY DAN FYLSTRA

Editor's note: This is another in a series of articles profiling members of the INFORMS Roundtable.

Frontline Systems Inc.

Best-known for developing the Solver in Microsoft Excel, cutting-edge company's mission is to make advanced analytic methods accessible to a wide range of users.

Frontline Systems Inc. (www.solver.com), headquartered in Incline Village, Nev., on the north shore of Lake Tahoe, develops and markets software products for optimization, Monte Carlo simulation and related analytic methods. The firm is best known for having developed the Solver in Microsoft Excel. Its mission is to make advanced analytic methods from operations research and management science more accessible to the wide world of users who don't have degrees or special training in OR/MS and typically aren't members of INFORMS.

Frontline Systems' headquarters in Incline Village, Nev.

History

FRONTLINE WAS FOUNDED by Dan Fylstra in 1988 in Palo Alto, Calif., a few years before the advent of Windows 3.0 and Excel 3.0, when Lotus 1-2-3 was still the leading spreadsheet. Its first products used just-in-time compiling methods to speed up Lotus spreadsheet calculations 10- to 100-fold, nonlinear equation solving methods in a multivariable "goal-seeking" add-in (What-If Analyst) for Lotus 1-2-3, and critical path and resource allocation methods for a spreadsheet-based project management tool.

In 1989, the company developed What-If Solver for Lotus 1-2-3, the first spreadsheet add-in capable of nonlinear constrained optimization, using the GRG2 code licensed from Professor Leon Lasdon at the University of Texas at Austin and Professor Allan Waren of Cleveland State University. A short time later, Lotus Development Corporation released Lotus 1-2-3/G, its first graphical (non-text-based) spreadsheet for IBM's OS/2 operating system, which included an internally developed Solver.

The intense rivalry between Microsoft with Excel, Borland with Quattro Pro, and Lotus with 1-2-3, and in a larger sense between OS/2 and Windows, motivated these firms to quickly match new features, so the Solver in Lotus 1-2-3/G presented a challenge for Microsoft and Borland. In 1990, Frontline Systems won a worldwide competition to supply a Solver for the next version of Microsoft Excel (3.0), and in 1992 it won a competition to supply a Solver for Quattro Pro, replacing Borland's own internally developed linear programming code. In 1996, at Lotus Development's invitation, Frontline began supplying a Solver for new versions of Lotus 1-2-3, replacing the Lotus-developed Solver.

Technology

MOTIVATED BY BOTH its OEM and end user businesses, Frontline has focused heavily on technology and innovation in both computational and OR/MS methods.

• In 1999, responding to the need to solve more general problems than could be addressed by classical nonlinear optimization methods, Frontline released the first version of its popular Evolutionary Solver in Premium Solver V3.5; this genetic algorithm-based approach is now included in the standard Solver in Excel 2010.

• In 2000, responding to the need to solve large-scale optimization problems in Excel, Frontline introduced Premium Solver Platform and its first family of "plug-in" Solver Engines. There are now eight large-scale Solver Engines, based on leading codes from Gurobi, FICO, MOSEK, Ziena and others, that can be used within Microsoft Excel. Users have solved LP/MIP problems of over 1.5 million decision variables in Excel, using these Solver Engines.

• In 2002, Frontline introduced two major innovations: its Polymorphic Spreadsheet Interpreter (PSI) which enabled Frontline to treat Excel models in much the same way as an algebraic modeling language like GAMS or AMPL, with capabilities like automatic dif-

All About the Roundtable

INFORMS has two types of members: individual and institutional. The latter (usually a company) joins by joining the INFORMS Roundtable and appointing as its representative the person in overall charge of O.R.

The Roundtable has been very active since its founding in 1982, with three meetings each year and much communication in between. It, its member institutions and its member representatives take a strong interest in how INFORMS serves the needs of practitioners, and have undertaken many initiatives and provided many services toward this end. These involve, for example, public awareness of O.R., both of the annual INFORMS conferences, continuing professional education, one of the prizes and various committees.

In addition, the Roundtable has an advisory responsibility to INFORMS. One bylaw states that it "... shall regularly share with INFORMS leadership its views, its suggested initiatives and its implementation plans on the important problems and opportunities facing operations research and the management sciences as a profession and on the ways in which INFORMS can deal proactively with those problems and opportunities ..." By tradition, it meets with the newly elected INFORMS president-elect each spring to discuss practice-related topics of interest to him or her, and with the entire INFORMS Board each fall to discuss topics of mutual concern.

The Roundtable membership comprises about 50 organizations. Further information is available at http://roundtable.informs.org.

This series of articles aims to share with the INFORMS membership at large some information and insights into how O.R. is carried on in practice today.

Frontline tracks about 25 areas from capacity planning and portfolio optimization to scheduling and supply chain management.

ferentiation, and an Interval Global Solver that finds provably optimal solutions for non-convex problems.

• In 2004, Frontline introduced conic optimization to a broad audience along with another innovation: automated convexity testing for general nonlinear models, a capability that is still unique in commercial software. Convexity is a key property that ensures that models can be solved to global optimality and can be scaled up in size.

• In 2006, Frontline entered the Monte Carlo simulation market with its first product, Risk Solver Engine, and several innovations: Automatic "vectorized evaluation" of Excel models, making simulations up to 100 times faster; Interactive Simulation, which enables users to ask "what-if" with uncertainty; and the first implementation of Professor Sam Savage's ideas for Probability Management in large organizations.

• In 2008, Frontline introduced Risk Solver Platform, integrating optimization and simulation, with another innovation: the first general-purpose facility for robust optimization, capable of solving optimization models with uncertainty, chance constraints, and recourse decisions – about two years ahead of other commercial software.

• In 2009, Frontline was first to offer a wide range of parallelized algorithms in its modeling system and Solvers, exploiting modern multi-core processors in areas ranging from automatic differentiation to its Evolutionary Solver, to solve challenging nonlinear optimization, non-smooth optimization and simulation optimization problems.

OEM Business

ONE KEY ELEMENT of Frontline's business is its work at the OEM (Original Equipment Manufacturer) level, where it supplies fundamental software technology to other software companies for inclusion in their products. In addition to Microsoft, Borland and Lotus, Frontline has supplied the software that forms the basis of the Solver in MathCad, the Optimizers in Analytica and TK!Solver, and the Extreme Speed feature of Oracle's Crystal Ball software for Monte Carlo simulation.

Frontline's most extensive OEM relationship is with Microsoft. Besides developing the Solver in every version of Excel, from Excel 3.0 to Excel 2010 (for Windows) and Excel 2011 (forthcoming for Macintosh), Frontline developed the original Scenario Manager in Excel, major elements of the Excel spreadsheet component for Internet Explorer in Office 2000, and most recently new, more accurate versions of the probability distribution and inverse functions in Excel 2010 and Excel 2011.

Commercial Business

THE MAJORITY of Frontline's revenue comes from sales made directly to end users, typically in large (Fortune 1000 or Global 2000) companies, and to or through consulting firms and other software vendors whose clients are large companies. Frontline licenses its Premium Solver Platform and Risk Solver Platform for Excel, its Solver Platform SDK for optimization and simulation in programming languages outside Excel, and its large-scale Solver Engines to these customers. Only about 10 percent of Frontline's commercial customers are involved in INFORMS; 90 percent have other professional affiliations.

The applications of Frontline's software are truly diverse, with customers in virtually every industry – aerospace, automotive, banking, chemical, consumer goods, defense, financial services, health care and pharmaceuticals, oil and gas, mining, utilities and many types of manufacturing. Frontline tracks about 25 application areas, from capacity planning and portfolio optimization to scheduling and supply chain management, and has licensed software for scores to hundreds of applications in virtually every one of the 25 areas. More than 5,000 companies have licensed Frontline's advanced "Solver Platform" products, and more than 250,000 individuals have used these products. The Solver in Microsoft Excel is available to an estimated 500 million people worldwide.

Higher Education Business

ANOTHER IMPORTANT AREA for Frontline is support for teaching operations research and management science methods in higher education, with a special focus on MBA programs. A large majority of MBA programs use Frontline's software to teach optimization – either the standard Excel Solver or Frontline's Premium Solver for Education, which is bundled in more than 35 textbooks. Although higher education accounts for only a single-digit percentage of Frontline's revenue, the company considers this area strategic, spends a great deal of time listening to its academic customers, and offers great values on its software to this market.

In late 2009, Frontline introduced Risk Solver Platform for Education, which meets most of the needs for software in an introductory management science course – not just for optimization but for Monte Carlo simulation, decision trees and sensitivity analysis. Frontline is currently rolling out Risk Solver Platform V10.0 and its Education counterpart, with support for Excel 2010 (32-bit and 64-bit), for the upcoming academic year. This fall, new editions of at least four textbooks, including the very popular textbooks from Cliff Ragsdale and Steve Powell and Ken Baker, will be available, using Risk Solver Platform throughout. This collaborative effort with the textbook authors will simplify teaching in many courses.

Frontline Systems employees such as Yong Li (China), Skylab Gupta (India), Edwin Straver (Netherlands) and Hristo Konstantinov (Bulgaria) (left to right) hail from around the world, but they all enjoy Lake Tahoe.

Future Prospects

FRONTLINE PLANs to stay on the leading edge of technology. As computing power becomes ever more available and affordable, it's an exciting time. Frontline is aggressively supporting Microsoft's Technical Computing Initiative, which is designed in part to make cluster computing – with hundreds to thousands of processors – accessible to non-experts, not just at university supercomputer centers but at businesses large and small. Closely related is cloud computing (including Microsoft's entry, Windows Azure), which is making powerful computers and even compute clusters available "on demand" through a Web browser or desktop Excel.

Frontline Systems has come a long way from What-If Solver and the earliest Excel Solver, with its capacity to solve problems of a few hundred variables, to an era where solving a million-variable LP/MIP problem on a desktop PC is routine, and using a few hundred computers at once, each one with this desktop's capacity, to solve a truly large problem will soon be straightforward. The future looks bright for firms like Frontline Systems, but it looks even brighter for their customers, who will find it easier than ever to solve their most challenging problems. IORMS

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