

ORMS TODAY

October 2018
Volume 45 • Number 5
ormstoday.informs.org

Also Inside:

- Proper government response to AI issues
- Ethics guidelines for analytics professionals
- The problem with U.S. university rankings
- Thomas Saaty: intellectual giant's final work

Wargaming cybersecurity

How O.R., data science and wargaming empower analysts to do more with less in cyber conflicts.

Biennial survey demonstrates continuous advancement of vital tools for decision-makers, managers and analysts.

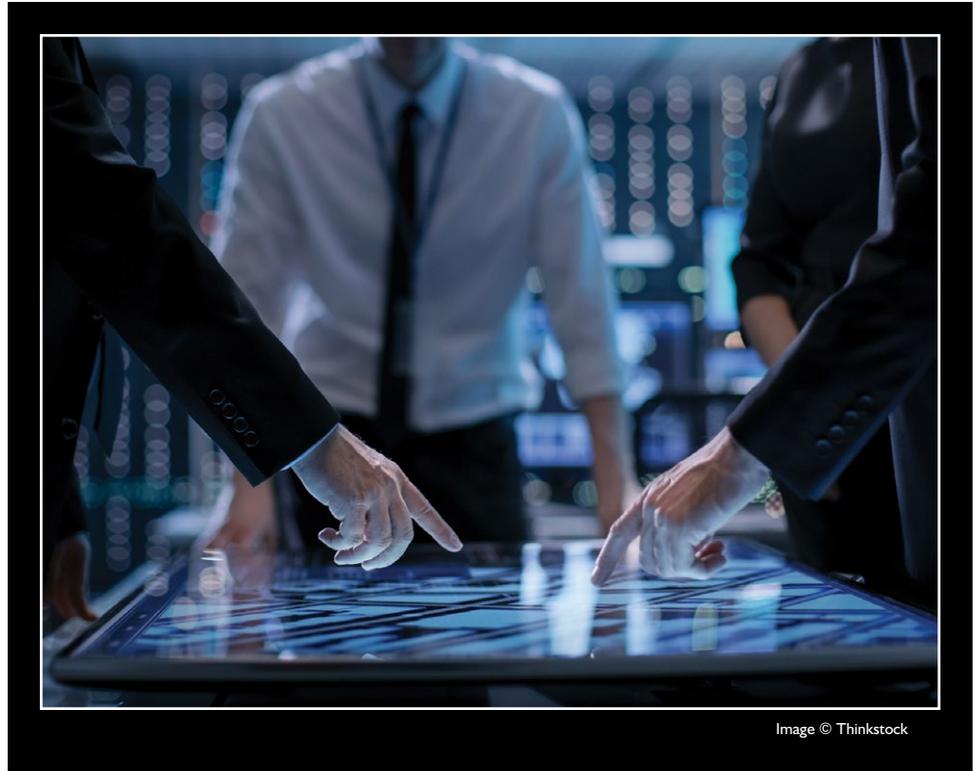


Image © Thinkstock

By Justin Amoyal

Decision analysis

In 2018, the introduction and rapid adoption of once futuristic technologies has become the norm, unfortunately and frequently leaving the numerous hours of design, testing, fabrication and analysis – most importantly decision analysis – without much or any consideration. Prior to becoming realities, these technologies were items of imagination, so much so that they were utilized in movies to add to the “futuristic” element. Going back to “Space

Odyssey” (2001), Facetime-like video and Siri-like artificial intelligence were introduced. Facebook took a page out of “The Minority Report” (2002) by using individual’s interests and history to drive personalized advertisements. Perhaps the most important technological advancement of our time, predicted in “The Net” (1995), was online pizza ordering and delivery [1].

These technologies have driven the development of new fields and domains to study, and implicitly with them, experts, models, data and analytics to continuously advance them. Yet, it is rare that a product or system today solely requires the expertise of only one individual or domain. The *Encyclopedia of Information Science and Technology* expands on this by explaining a core problem is bringing multiple professional communities

together: “More specifically, to design effective serious games, the expertise of educators, content experts, and learning experts will need to be utilized on top of all other experts who are typically involved in game design” [2]. The complexity inherent with the desired performance of today’s systems requires the combined expertise of many, thus continuously growing the need for collaboration amongst multiple experts when attempting to make decisions.

Project teams frequently struggle with optimally combining the inputs from stakeholders, experts and models to reach decisions. It is typical for the model builders to side with the model results, the experts to believe in their research, and the stakeholders to strive to advance their portion of the project or their leadership’s interests. What is the remedy to effectively managing these conflicting objectives? In addition to the complexities associated with the problem itself, “an effective decision analyst must understand the challenges of decision-making in organizations, the mathematical foundations of decision analysis, and the soft skills required to work with the decision makers, stakeholders, and experts” [3].

What tools can we use as thought leaders, decision-makers, managers and analysts to define these decision frameworks in our own projects? The results of this year’s biennial decision analysis software package survey are meant to assist in providing the tools and numerous capabilities available to us.

The Survey

In line with previous years, the 2018 survey was made available via an online questionnaire sent to vendors who previously participated or those recommended by staff. Vendors who did not respond by the deadline can still provide their software’s information by submitting a questionnaire (<https://www.surveymonkey.com/r/D6NNZLH>), and it will be added to the online version of the survey. Just as in 2016 and previous years, *OR/MS Today* provides the vendor responses verbatim and does not intend for the results to imply quality or cost effectiveness. Rather, the list serves to raise awareness of the variety of tools available. Approximately 60 multiple choice and short answer questions made up this year’s questionnaire. The primary focus was to define the current capabilities and any updates or advancements associated with each software package, enabling a high-level perspective on decision analysis software capabilities to our audience.

The primary goal of the software survey was to ask questions focused on the decision analysis capabilities of each tool. These include but are not limited to multiple competing objectives, probabilistic dependencies, stakeholder collaboration, value functions, strategy tables, elicitation and decision algorithms. Moving forward, vendors were asked questions to define the usability of their applications. To do so, they provided feedback on their software interfaces, visualization capabilities,

model and data protection, user interfaces, and other usability related features. Types of training offered, as well as the recognized certifications associated with each software tool, were also investigated in the 2018 survey.

2018 Results

This year’s survey includes 28 software packages from 18 different vendors, domestic and international, who responded by the deadline (see page 42). Pricing for licenses varied, ranging from free products to a max of \$100,000, depending on the user/license type and elements of the software package. Specific industries and markets for these software applications are widespread, including defense (military, aerospace and shipbuilding) healthcare (pharma, hospitals and clinics), energy-related domains (petroleum and nuclear energy), as well as many others.

Decision analysis capabilities: Each of the decision analysis-focused capabilities proved to be available by at least one of the software tools reviewed. Uncertainty existed in every tool, yet implementation likely differed within the applications, and it is therefore worth investigating to find the one best fit for an individual project. Unfortunately, there were two minimally available features, an evidential reasoning (e.g., Bayesian belief networks) capability and portfolio decision-making, which do not exist in 79 percent and 48 percent, respectively, of the tools reviewed. Value functions/scores and risk tolerance existed in 75 percent of the tools, while strategy tables were available in 43 percent of them. Seven of the tools offered AHP, while 13 offered MODA/MAUT.

Usability: Usability features were fairly consistent among the vendor responses. XML integration and API (embedded decision support system) proved to be the capabilities most limited. Yet the inclusion of an API has increased since 2016 from 50 percent of the tools to 68 percent this year. Only eight of the tools offered simultaneous data input and viewing.

When considering data visualization, it is difficult to rely solely on the decision analysis software tool. Inherent in the name, these are decision analysis tools and therefore they provide the ability to output decision analysis-related visualizations such as graphical sensitivity analysis, expected value tornado diagrams, decision trees and influence diagrams, but stakeholders and decision-makers are usually not decision analysts. Thus, it is important to consider the exporting capabilities of these tools, particularly related to the export of data which existed in 86 percent of the tools. Exporting the data provides the ability to develop advanced visualizations, customizable to the desires and experience of project stakeholders, which may better convey results than the standard visualization existing within the software tools.

Licensing and training: The majority of the vendors (80 percent) reported that a limited use (run-time) or demo version

Software Survey, continued on p40

Software Survey, continued from p39

of the tool is available. Nearly all of the products are available for purchase for educational (96 percent) and/or commercial (100 percent) use. As expected, many of these tools are offered free or at a discounted rate for educational use. The number of tools offering enhanced/high performance capabilities with these software packages showed a significant increase since 2016, from 35 percent to 75 percent this year.

Pricing for these advanced features varies significantly, typically based on the client’s needs and options selected. Multiple options for training were offered in relation to the software tools, mostly offered by the vendors themselves (79 percent). Online resources including training, tutorials and open source collaboration was offered for 75 percent of the tools, a nearly 25 percent increase since 2016.

Conclusion

This year’s decision analysis software survey demonstrates that software capabilities continue to advance, enabling users to conduct decision analysis regardless of industry, interfacing and elicitation needs, and desired visualizations or operating systems. When solving difficult problems, it is important to understand the resources available, interfacing requirements, desired decision analysis techniques to be utilized, required outputs and other problem-specific elements to select the tool that will best fit the analysis.

It is no surprise that every tool reviewed in this survey will not be the “perfect fit” for each decision analysis problem. Thus, the percentages mentioned earlier associated with nonexistent features is not detrimental to a tool’s potential performance for a specific project. A project on a tight timeline may not have the opportunity for iterative analysis; therefore, a tool offering this capability would provide no additional value.

In closing, this year’s software survey includes an impressive list of applications available to decision professionals, and the survey results can assist professionals in selecting the best decision analysis package for their particular needs. **ORMS**

Justin Amoyal (jamoyal@innovatedecisions.com) is an analyst with Innovative Decisions, Inc. (https://www.innovatedecisions.com).

Note: Survey results begin on page 42.

REFERENCES

1. Pahle, Rebecca, 2016, “15 Movies That Predicted the Future,” Mental Floss, Sept. 15, mentalfloss.com/article/86080/15-movies-predicted-future.
2. “Gaming,” 2015, *Encyclopedia of Information Science and Technology, Information Science Reference*, pp. 3,291-3,291.
3. Parnell, Gregory S., and Bresnick, Terry A, 2013, “Introduction to Decision Analytics” in “Handbook of Decision Analysis” (by Parnell, Bresnick, Steven N. Tani and Eric R. Johnson), John Wiley & Sons.

OR What?
INFORMS Student Video Competition

Operations research, management science, and analytics are saving lives, saving money and solving problems. That’s what inspires students like you to pursue careers in these incredible and growing fields.

But too often students don’t learn about operations research, management science, and analytics until they reach graduate school.

We Can Change That!
 The INFORMS Student Affairs Committee is excited to announce a new student video contest to promote OR/MS and analytics to undergraduate students.

<http://info.informs.org/or-what>

Does Product Support the Following Visualization Features and Outputs?				Pricing & Licensing Information				Training Classes Offered				Features not Explicitly Stated Previously which Support DA	Specific Industries or Market Segments in which the Product is More Popular	Specific Applications in which the Product is More Widely Used	Comments					
Graphical Sensitivity Analysis	Graphical Display of Analytical Results	User-customized Graphics	Interactive Graphics, Displays or Analytical Components	Expected Value Tornado Diagrams	Decision Trees	Influence Diagrams	Limited Use (run-time) or Demo Version	Education	Enhanced/High Performance	Commercial	Describe Licensing Options for the Commercial Version (e.g., multi-user, individual, #simultaneous users/tokens)	Vendor	3rd Party	Classroom	Online	Specify Resources Available (training, tutorials, open source collaboration)				
y	y	y	y	y	-	-	y	Various: disc. academic lic.; free for acad. award recipients; Etc.	POA	POA	Annual license or project license	y	y	y	y	Online Tutorials	Integrated individual and group decision-making processes. PAPRIKA method: user-friendly and scientifically valid.	Most industries, including health, academia, government, agribusiness, finance, etc.	Patient prioritization, disease classification, technology selection, social services targeting, business consulting, ...	A suite of online tools for decision-making, prioritization, conjoint analysis and max. value for money, ...
y	y	y	y	-	-	-	y	0 to \$5,000	\$2,000 - \$100,000	\$2,000 - \$100,000	Pricing depends on use & size	-	y	-	y	Online Tutorials	Real-time web collaboration, drag and drop decision Kanbans	Government decisions, infrastructure and construction, aero, defense	Project prioritization and project selection, procurement, strategy development, technology selection	Ease and affordable, full-function AHP software with project prioritization application and stripped down freebie.
y	y	y	y	y	y	-	y	\$25 semester, \$62.50 one year	\$995 one-time + \$1,000 yearly	\$250 yearly	Single/concurrent user licenses, desktop & cloud ver.	y	y	y	y	Online Tutorials	Support for decision automation in business processes; cloud-based decision support models in user's own web, ...	Very broadly used, but energy, pharma, and investment management applications are especially popular.	New drug development, oil & gas exploration, electric power trading, bidding/auctions.	Analytic Solver integrates decision analysis, simulation and risk analysis, mathematical opt., forecasting, ...
y	y	y	y	y	y	y	y	Free up to 100 variables, 50% of commercial prices	Prof. \$995, Enterprise \$2,795, Optimizer \$4,795	Subscriptions 50% of initial price	Contact Vendor	y	y	y	y	Online Tutorials	Hierarchical influence diagrams, Intelligent Arrays, and efficient Monte Carlo methods allow Analytica to work.	Electricity, oil and gas, renewables, environment and climate, health, food safety, high tech, and more.	Risk analysis, R&D management, optimization, public policy, group decision making, decision support tools.	Influence diagrams provide primary user interface. It encourages close engagement between analyst and client.
y	y	y	y	-	-	-	-	Free (contact Britest)	-	Depends on size of company - contact Britest	-	y	-	y	y	-	-	Pharma and speciality chemical	Chemical route selection, chemical storage, equipment selection and sourcing decisions	Contains four software tools, one for structuring a decision problem and three for analysing a dec. problem. ...
-	-	y	y	-	-	y	y	£99 / £295	-	£99 / £495	-	y	-	-	y	Training materials, ebooks, and newsletter	Primarily a cognitive mapping tool, supporting methodologies for strategic planning, ...	Corporate planning; Managing decision making in complex situations.	-	A proven tool for managing "soft" issues - the qual. information that surrounds complex or uncertain situations.
y	y	-	y	y	y	y	y	Public & Private courses; webinars; website videos; Etc.	On-site/remote Coaching	Client Specific	Individual Licenses	y	-	y	y	Phone & email support; website tutorials; Etc.	The components of the Decision Quality DeskTop are aimed at helping build and sustain internal DQ capability.	Energy and other capital intensive industries.	Decision Quality implementations, Decision Framing, value of information analysis, decision tree analysis, ...	DTRio for Decision Framing and high level VOI analysis TreeTop for Tornadoes, Trees and Range of Value Curves, ...
y	y	y	y	-	-	-	y	Free (5 subscriptions available)	\$24,000 yearly for a portfolio manager	\$24,000 yearly for a portfolio manager	Contact Vendor	y	-	y	-	Consulting support	Facilitates group decisions using an 'anytime/anywhere/any device' design, making it easier for telecommuters.	Federal agencies and the financial services, higher education, and corporate headquarter industries.	Budget formulation, IT demand management, merger & acquisition selections, organiz. cost savings, ...	Provides a collaborative process to build consensus and make complex, multi-criteria decisions in a range of scenarios. ...
y	y	y	-	y	-	-	y	\$160 (fully functional, perpetual license)	-	\$995	-	y	-	-	y	Webinar videos	-	Medical devices (validated), communication products, healthcare and cosmetics.	Quality, Design for Six Sigma, Risk and Project Management	Excel Add-In for Monte Carlo Simulation and Global Optimization with MIDACO Solver
y	y	y	y	y	y	y	y	Individual from \$99, Department site \$299	\$1,995 Enterprise Version, \$8,995 Portfolio Version	\$1,495 Professional Version; \$1,995 Enterprise Version	Named user licenses and Group licenses available	y	-	y	y	Various Online Support Options	Real Option Analysis, Policy Tree/Policy Summary, Influence Diagram/Decision tree combination, hybrid models, ...	Oil & Gas, Electric Power, Utilities, Mining, Life Sciences, Financial Services, New Product Develop., Infrastructure.	Capital investment strategy, project valuation, risk management, portfolio prioritization	An intuitive, graphical decision-tree based modeling environment for performing robust decision & risk analyses, ...
-	y	-	-	y	y	-	y	Free	N/A	\$29,000	Single/Multi-user, Subscript., Network, Web	y	-	y	y	Online Videos, and consulting options	-	Pharma, Med Device	Project and Portfolio Planning & Scheduling	Uses modeling technology to predict the performance of project portfolios while identifying schedule, financial, ...

Does Product Support the Following Visualization Features and Outputs?										Pricing & Licensing Information				Training Classes Offered			Features not Explicitly Stated Previously which Support DA	Specific Industries or Market Segments in which the Product is More Popular	Specific Applications in which the Product is More Widely Used	Comments
Graphical Sensitivity Analysis	Graphical Display of Analytical Results	User-customized Graphics	Interactive Graphics, Displays or Interfaces that Allow Users to Adjust Analytical Components	Expected Value Tomado Diagrams	Decision Trees	Influence Diagrams	Limited Use (run-time) or Demo Version	Education	Enhanced/High Performance	Commercial	Describe Licensing Options for the Commercial Version (e.g., multi-user, individual, #simultaneous users/tokens)	Vendor	3rd Party	Classroom	Online (training, tutorials, open source collaboration)	Specify Resources Available				
y	y	y	y	y	y	-	y	N/A	N/A	Upon Request	Subscript. based, Multi-User / Enterprise	y	-	y	y	Online Tutorials and Videos	Utilizes Descriptive, Diagnostic, Predictive, Prescriptive Analytics all in one tool.	Healthcare, Hospitals	Patient Flow through the entire hospital as well as department level flow for peri-operative suites, emerg. dept. ...	Contact Vendor
y	y	y	y	y	y	-	y	Student version has no exp. date, up to 50 attr. and is free	Full version/ 1,000 attrbts. for education institutes £600/lic.	Full version can handle up to 1,000 attributes is £1,200 per license	Contact the developer of the software	y	y	y	y	Quick guide, full, operations manual, Etc.	Contact Vendor	Healthcare, Engineering, Finance, Research and Education	Risk and safety assessment and management, performance analysis and improvement, fault diagnosis, ...	Evidential Reasoning (ER) extends Bayesian reasoning for handling imprecise probabilities. ...
y	y	-	-	y	-	-	y	Free for educational use	Free for educational use	Perpetual licenses start at \$495 and vary cap. and opt.	Individual and site license available	y	y	-	-	-	Has state of the art algorithms for stochastic optimization, including chance constraints.	Petroleum and Financial	Multi-period stochastic optimization	Main algorithm is multi-period stochastic optimization.
-	-	-	-	-	-	-	y	Free for educational use	Free for educational use	Perpetual licenses start at \$395 and vary cap. and opt.	Individual and site license available	y	y	-	-	-	-	Petroleum and Financial	Multi-period stochastic optimization	Main algorithm is multi-period stochastic optimization. Computes EVPI, etc.
y	y	y	y	-	-	-	y	Professor \$285, Student \$65	Group \$1,895, Portfolio \$2,895 Group & Port. \$3,895	\$895	Contact Vendor	y	y	y	-	-	-	Military, government, aerospace, automotive, engineering, ...	Multi-objective decision analysis, analysis of alternatives, systems analysis, ...	The most powerful alternatives evaluation software available.
y	y	y	y	-	-	-	-	Free	N/A	\$18,500	Single User, Multi-User, LAN	y	y	y	y	Online Tutorials, Quick Start Videos, Etc.	Dynamic Animation helps visualize your process or system in action.	Hospitals, Clinics, Healthcare Systems	Patient Flow, Emerg. Department, OR Scheduling, Facilities Design and Planning, Process Improvement	Provides administrators and manages the opportunity to test new ideas for system design or improvement in the delivery of care.
-	y	-	-	-	-	-	y	Free	POA	Free for general use	Contact Vendor	-	-	-	y	Integrated help and decision template library.	Many decision templates are provided. User interface streamlined for everyday consumer use.	Individuals and consumers. Available commercially for product promotion and selection.	Individual everyday decision-making, production promotion and selection.	Brings state-of-the-art technology to decision-making problems of everyday life.
-	y	-	-	-	y	-	y	N/A	N/A	Upon Request	Subscription, Multi-User, Enterprise	y	-	y	y	Online Videos and Tutorials	Rule and constraint-based schedules, Provides Online, on-demand access to cap. planning data, machine learning eng.	Shipbuilding	Capacity Planning, Allocate Construction Space over Time, Crane and Transporter Planning, Shop Scheduling, ...	Multi-user, web enabled application. Configurable Roles/ Rights.
y	y	y	y	-	-	-	y	Free	N/A	\$4,500	Single User, Multi-User, LAN	y	y	y	y	Online Learning Mgmt. System, Tutorials, Etc.	UI is Microsoft Visio with Dynamic Animation.	Automotive, Aerospace, DoD, Gov, Healthcare, Med Device, Pharma	Process Modeling, Manufacturing Assembly, Service Processes	Transform Static Value Stream Maps, Flowcharts and Workflow Diagrams into Dynamic Simulation Models.
y	y	y	y	-	-	-	y	Free	N/A	\$18,500	Single User, Multi-User, LAN	y	y	y	y	Online Learning Mgmt. System, Tutorials, Etc.	Dynamic Visualization helps visualize your process or system in action	Automotive, Aerospace, Manufacturing, Supply Chain & Logistics, Medical Device, Pharmaceuticals, Shipbuilding, Gov/DoD	Process Design and Re-design, Process Improvement, Capacity Analysis & Planning, Lean & Six Sigma, ...	A discrete-event simulation technology used to design and improve manufacturing, logistics and operational systems.
-	y	y	-	y	-	-	-	Single license \$17; quantity discounts	-	Single license \$59; quantity discounts	-	-	-	-	-	-	-	Industries and market segments using Excel what-if models	Sensitivity analysis of Excel what-if models using tornado and spider charts	Sensitivity analysis add-in for Mac Excel and Windows Excel.

Does Product Support the Following Visualization Features and Outputs?										Pricing & Licensing Information				Training Classes Offered				Features not Explicitly Stated Previously which Support DA	Specific Industries or Market Segments in which the Product is More Popular	Specific Applications in which the Product is More Widely Used	Comments		
Graphical Sensitivity Analysis	Graphical Display of Analytical Results	User-customized Graphics	Interactive Graphics, Displays or Interfaces that Allow Users to Adjust Analytical Components	Expected Value Tomado Diagrams	Decision Trees	Influence Diagrams	Limited Use (run-time) or Demo Version	Education	Enhanced/High Performance	Commercial	Describe Licensing Options for the Commercial Version (e.g., multi-user, individual, #simultaneous users/tokens)				Vendor	3rd Party	Classroom	Online	Specify Resources Available				
y	y	y	y	y	y	-	y	Free open source, GPL license	Free open source, GPL license	Free open source, GPL license	Free open source, GPL license	y	y	y	y	-	-	-	-	Public policy making, health technology assessment, classroom education, legal	General support of decision making process	Free Open Source product for building and analysis of decision trees available with complete source code free for any com. app.	
-	y	y	-	-	-	-	-	Single license \$23; quantity discounts	-	Single license \$79; quantity discounts	-	-	-	-	-	-	-	-	Automated value of information for model input variables	Finance, energy, pharma, legal	Monte Carlo simulation for Excel models	Monte Carlo simulation add-in for Mac Excel and Windows Excel	
y	y	y	y	-	y	-	-	N/A	N/A	POA	-	y	-	y	-	-	-	-	-	-	-	-	
y	y	-	-	-	-	y	y	-	-	\$550	Individual licenses	y	-	-	y	-	-	-	Problem Definition Tools, Idea Generation Tools, MCDA Tools	Areas with multiple stakeholder involv. in decision making - nuclear energy, nuclear clean up, oil & gas, ...	Used for the evaluation of technologies, project prioritization, problem structuring and ideas generation.	Provides robust and transparent analysis with unprecedented sensitivity analysis.	
-	y	y	-	-	y	-	-	Single license \$17; quantity discounts	-	Single license \$59; quantity discounts	Single license; quantity discounts	-	-	-	-	-	-	-	-	Finance, energy, pharma, legal	Analysis of sequential decision problems under uncertainty	Decision tree add-in for Mac Excel and Windows Excel	
-	-	-	-	-	-	-	-	Free for educational use	Free for educational use	Perpetual licenses start at \$495 and vary cap. and opt.	Perpetual licenses start at \$495 and vary cap. and opt.	y	y	-	-	-	-	Has state of the art algorithms for stochastic optimization, including chance constraints.	Petroleum and Financial	Multi-period stochastic optimization	Main algorithm is multi-period stochastic optimization. Computes EVPI and Expected Value of Modeling Uncertainty.		

MJC2

33 Wellington Business Park
Crowthorne, United Kingdom RG45 6LS
info@mjc2.com
www.mjc2.com/strategic-planning-logistics.htm

ProModel Corporation

7540 Windsor Dr., Ste. 300
Allentown, PA 18195-1036
610-628-6842
shaekler@promodel.com
https://www.promodel.com/
https://www.promodel.com/products/
MedModel
https://www.promodel.com/products/
ProcessSimulator
https://www.promodel.com/products/
ProModel

SGH Warsaw School of Economics

Al. Niepodleglosci 162
Warsaw, Mazowiecki 02-656
Poland
+48 22 5646000
silverdecisions@sgh.waw.pl
http://silverdecisions.pl/

SigmaXL, Inc.

305 King St. West, Suite 503
KITCHENER, ON N2H 6T7 Canada
888-744-6295
information@sigmaxl.com
www.SigmaXL.com

Syncopation Software

336 Baker Ave, Suite 1-11
Concord, MA 01742
866-796-2375
sales@syncopation.com

TransparentChoice, Limited

ideaSpace West
3 Charles Babbage Road, Cambridge
Cambridgeshire CB3 0GT
United Kingdom
4.47404E+11
Contact@transparentchoice.com
www.transparentchoice.com

TreePlan Software

2105 Buchanan St.
San Francisco, CA 94115
415-310-7190
mike@treeplan.com
www.treeplan.com