Constraint-based Computing ENABLES BETTER DECISIONS

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Constraint-based computing is a form of computing intended to help deal with problems that have numerous variables and choices. This technology can deal with situations in which there are many more choices than a human being would want or be able to go through with a pencil and paper. It can make consistent choices, infer their implications, balance priorities and preferences, and help cope with uncertainty and change.

For example, consider the many variables that surround the activity of retail staffing. More staff is needed during the end-of-year holiday season, and there are government regulations placing restrictions on factors such as how many hours people can work consecutively and when employees are eligible for overtime pay. Furthermore, there could be hundreds of thousands of staff dispersed globally with different options of when they can work. The retailer must find a way to take all these constraints into account while satisfying corporate, employee and customer needs.

Similar problems arise across the enterprise and across all sectors of the extended retail industry. Whether an ERI company is involved in manufacturing, workforce management, product configuration, or any other activity that helps move goods through the consumer demand chain, it will face a multitude of constraints and variables that must be fully accounted for in order to perform proper planning.

In the case of product configuration, let's assume that a salesperson pays a visit to a client who is considering the purchase of a complex item. The client wants to look at a customized configuration, which may be something as simple as an alternate color or as involved as a different internal architecture. The salesperson needs to be able to work through the requested configurations and then see if they are viable based on factors such as available resources and staffing levels, in real time.

At the Cork Constraint Computation Centre at University College Cork, with support from Science Foundation Ireland and other sources, we have worked on many real-life implementations of constraint-based systems for better management of inventory, scheduling, and interaction with customers, to name a few specific scenarios. For example, with additional funding from Enterprise Ireland and Bausch & Lomb, we worked with eye health product provider Bausch & Lomb utilizing constraint-based technology to analyze design and manufacturing issues. Bausch & Lomb wanted to understand its inventory holdings, but did not know if any alteration would make a negative impact in terms of the manufacturing schedule and hence achieving its due dates. In addition, the company was interested in the impact of new raw materials to the supply chain and a possible change in future customer demand. Would more or less assembly machines be needed as a result of these alterations? We worked with Bausch & Lomb to build a framework around these issues that measures the implications of all changes against each other, instead of measuring each variable in isolation. The technology provides models and hence schedules based on different process design options.

We are currently participating with the University of Limerick and others in a project funded by the European Union to develop a decision support tool that will take an enterprise model and through analysis and supply chain knowledge, transform it into an optimization model. This project is aimed at small- to medium-sized industries and includes partners such as Tippo International, an Irish specialist door manufacturer, and Blueline, a UK solutions provider for office and residential furniture.

In another project supported by Enterprise Ireland, we are working with a company in the travel industry to improve the quality of its customer interactions. Called "TalkingShop," the project is intended to give the company the opportunity to bring all the different aspects of travel together (hotel, flights, car hire, itinerary), and aided by constraint-based technology to provide a configurable holiday package. This allows the customer to build his or her own configurable holiday package instead ofjust selecting from predefined ones. This, in turn, better qualifies the customer for when he or she talks face-to-face with the travel agent.

Looking ahead, constraint-based technology will likely play a pivotal role in helping the extended retail industry deal with one of its biggest problems: uncertainty in inventory control. In the US alone, retail sales total $3 trillion a year. US retailers support those sales by holding more than $1 trillion worth of inventory. Of that inventory, manufacturers keep $450 billion, wholesalers and distributors keep another $350 billion, and $400 billion is kept at retail locations.

Yet with this huge capital, stockouts still result in one of 12 shoppers not finding what they want on the shelf. ERI companies can't manage this inventory simultaneously, so there are a lot of stockouts. We are currently building prototype decision-making tools that will allow ERI companies to consider all available inventories at various locations when making stocking decisions, which will hopefully lead to fewer stockouts and more satisfied customers.

Ultimately, constraint-based computing technology offers proven decision tools that can go beyond the traditional spreadsheet that may be "state of the art" in business decision-making. It allows qualitative and quantitative decision-making. For the first time, ERI companies can truly consider all the possible implications of every decision they make, before actually making them.

Editor's Note: Professor Freuder is the Director of the Cork Constraint Computation Centre at University College Cork and the leader of the Value Chain Optimisation Strand of the Centre for Telecommunications Value-chain-driven Research. He received his B.A. from Harvard and his Ph.D. from M.I.T. He was elected a Fellow of the American Association for the Advancement of Science, and of the American and European Artificial Intelligence societies. He served as the founding Editor-in-Chief of the *Constraints Journal*, and as Executive Chair of the Organizing Committee of the Constraint Programming conferences. His work has received extensive support from industry including Bausch & Lomb, British Telecommunications, Lucent, Nokia, Oracle, and Xerox. Professor Freuder will lead a discussion panel on constraint-based computing at the Global Retail Technology Forum 2006, 13-14 February, Diisseldorf, Germany (visit www.retailsystems.com/grtf for more information). **ERI**