Preface

Zvi Drezner · Frank Plastria

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This volume is dedicated to the memory of Andrew Vazsonyi, also known as E. Weiszfeld, who wrote the seminal paper on location in 1937. He proposed the algorithm which is known as “The Weiszfeld Algorithm” by all. This algorithm was re-discovered independently twice almost 30 years later. Saul Gass wrote a wonderful “In Memoriam” in the *OR/MS Today* issue of February 2004 following Weiszfeld’s death in 2003. Saul knew Andy for many years and his write-up is much better than anything we could write. This article appeared in *OR/MS Today*, February, 2004, and is reprinted with permission from the author Saul Gass and Peter Horner, Editor, *OR/MS Today*.

Z. Drezner (✉)

Steven G. Mihaylo College of Business and Economics, California State University-Fullerton,
Fullerton, CA 92834, USA
e-mail: zdrezner@fullerton.edu

F. Plastria

MOSI (Vakgroep Wiskunde, Operationeel onderzoek, Statistiek en Informatica voor management),
Vrije Universiteit Brussel, Pleinlaan, 2, 1050 Brussel, Belgium

In Memoriam

**Andrew (Andy) Vazsonyi:
1916–2003**

Operations research/management science pioneer, educator, researcher, illustrator and author helped shape profession.

By Saul I. Gass

Dr. Andrew Vazsonyi, a founder of The Institute of Management Sciences and pioneer in the application of OR/MS in industry and business, died Nov. 13, 2003 in Santa Rosa, Calif. Andy, to all who knew him, was a mathematician by training and inclination. But, his curiosity, inquisitiveness and mental abilities made him a concerned scientist with broad interests. His contributions helped shape OR/MS as we know it today.

Andy was the second of three sons born in Budapest to Hermine and Miska Weiszfeld. Miska was a businessman who owned and managed one of the finest handcrafted shoe stores in Budapest. He inherited the store from his father, the most successful shoe manufacturer in Budapest. Early in life, Andy demonstrated an ability to solve intricate math problems. When he was 14, his father arranged for him to meet the 17-year-old math prodigy, Paul Erdős. After exchanging proofs for the Pythagorean theorem, (Andy knew one, Erdős knew 37) they became life-long friends. Andy attended the Pázmány Péter University in Budapest and received his Ph.D. in 1936.

In the 1930s, because of rising fascism and government restrictions against Jews, many Hungarian Jews changed their names. Thus, in 1937, Andy changed his name from Weiszfeld to Vazsonyi, after his cousin, the noted politician and founder of the democratic party, Janos Vazsonyi. (The cousin had earlier changed his name from Weiszfeld.) This brings us to the first Andy tale.

Famous Problem

When Andy was 16, his interest in geometry brought him to the famous problem first posed by Pierre de Fermat in 1643: given n points, find a point such that the sum of its distances to the n points is a minimum (a generalization of Fermat's original 3-point problem). From an OR/MS perspective, the problem is now interpreted as a facility location problem, but to Andy it was just an interesting math problem. Andy's paper on his algorithmic solution method was written in French and published in a Japanese journal: "Sur le point pour lequel la somme des distances de n points donnés est minimum," *Tôhoku Mathematical Journal*, Vol. 34, 355–386, 1937.

The paper describes the now famous and classic Endre Weiszfeld algorithm. When I asked Andy why the paper was written in French and published in an obscure math journal, he answered: "I cannot recall why I sent the location paper to the *Tôhoku Journal*. I must

have had some indication that they would accept it. French was selected because I had a friend who was available and had good French knowledge. (Hungarian was obviously useless.)”

At the time of its publication, there was little interest in the Weiszfeld algorithm. Things changed in the 1960s when facility location became a hot OR topic. The paper kept being “rediscovered” by many researchers who did not know who Weiszfeld really was. This always bothered Andy. As he wrote in his autobiography, “Which Door has the Cadillac: Adventures of a Real-Life Mathematician”: “To my great chagrin, nobody knows that Weiszfeld is around and kicking, or that Vazsonyi = Weiszfeld.”

I was pleased when Andy sent me a copy of the book with the dedication: “To my dear friend and colleague of many years, the only management scientist who is aware of my early math work like the Weiszfeld algorithm.” The Fermat Problem is often called the Weber Problem or the Steiner Problem, but neither Weber nor Steiner contributed much to its solution. It is time to change the name of the general problem to the Vazsonyi (aka Weiszfeld) Problem.

Escape from Hungary

In 1938, with the support of a Hungarian mathematician, Andy was offered a fellowship at the University of Cincinnati. How he escaped from Hungary, and eventually arrived in the United States two years later is a very convoluted story that deals with passports, visas, bureaucracies, a long stay in Paris, and Andy’s chutzpah. You have to read Andy’s autobiography to see how the new emigrant kept afloat in New York City (the University of Cincinnati fellowship was long gone), how he received a master’s degree in mechanical engineering from Harvard, met and married his wife, Laura, and became a U.S. citizen in 1945.

Although always a mathematician, Andy started his industrial work in 1945 as an engineer, and later as a manager, working for a small pump manufacturing company in Pennsylvania. Then he was off to California with North American Aviation (where he corrected a serious design problem in the P-51 fighter aircraft), the U.S. Navy Guided Missile Division, Hughes Aircraft, Roe Alderson (a marketing firm), Ramo-Wooldridge, and back to North American Aviation (1958). At Hughes, he became interested in computers and such new concepts as information management. It was then that he first heard of the Operations Research Society of America (ORSA) and started to attend its meetings. Andy became a bit disillusioned with ORSA; to his mind, the members at that time were far removed from the business world. This caused him to be a prime mover, along with Bill Cooper and Mel Salvesson, in the founding of The Institute of Management Sciences (TIMS). At TIMS’ inaugural meeting, Cooper was elected president, and, because the constitution required one, Andy was elected to be the first past president, the only past-president who never served as president! He was proud of that honor. Andy was a founding member and Fellow of the Decision Sciences Institute and served on its Council.

Andy joined academia in 1970. He took a three-year appointment as an untenured professor with the University of California School of Management. Besides teaching statistics, he was responsible for installing the School’s first large-scale digital computer. The installation was successful, but Andy’s teaching evaluations and strained relationships with the faculty (he was one of the highest paid professors in the School) added up to a no vote on tenure. He then accepted a position with the University of Rochester’s Graduate School of Business. He later became a chaired professor at St. Mary’s University in San Antonio, staying there

until he retired in 1987. (He did continue teaching at the University of San Francisco with the title professor emeritus.) When he retired, Andy awarded himself a “McAndrew Grant” so he could “... become an activist who could extend math and the scientific method to all areas of ordinary life; at the same time, I wanted to fight against the nonsense of alchemists, witches, astrologers and others.”

Multiple Identities

Besides having the twin identities of Vazsonyi and Weiszfeld, Andy is also identified with the Italian mathematician Z. Gozinto. In a lecture at the RAND Corporation in 1956, Andy was explaining a complex problem of production control. There were assemblies and sub-assemblies, each requiring parts to arrive on schedule. One of his diagrams, the Gozinto Diagram, illustrated how one part “goes into” another. After the talk, George Dantzig said he never heard of the mathematician Gozinto and wondered what university he was at. Andy thought he was kidding and replied, “You’ve never heard of the celebrated Italian mathematician Z. Gozinto?” Dantzig wondered what Gozinto’s first name was. Andy realized he was serious and was stumped as what to reply. Later, in recounting his encounter with Dantzig to Abe Charnes and Bill Cooper, Cooper suggested the first name, Zepartzatt. From then on, Zepartzatt Gozinto took on a life of his own. Rumor has it that Gozinto perished in an earthquake in the Chilean Andes, but many of us know that he lives on.

Andy authored more than 70 technical papers and seven textbooks, the first of which was an early OR/MS text, “Scientific Programming in Business and Industry,” John Wiley & Sons, 1958. His most recent textbook was “Operations Analysis Using Excel” (joint with Nancy C. Weida and Ronny Richardson), Thomson Learning, 2000. Comparing the scope of these two books shows how far OR/MS has progressed and how Andy made sure he kept up with the times.

His book, “Which Door has the Cadillac: Adventures of a Real-Life Mathematician,” Writer’s Club Press, 2002, is an autobiographical account of both Andy’s life and his passionate love of mathematics. Andy’s autobiography is a must read, and his Web site, www.reallifemath.com¹ a must see for all who are interested in how a concerned member of our profession, citizen of the world and real-world mathematician contributed greatly to the advancement of human endeavors.

A personal note. Although I was friend of Andy’s for many years, we became close only in the past few years due to our joint interest in improving the status of OR/MS in business schools and in higher education in general. Andy had a column, “The Specialist with the Universal Mind,” in *Decision Line*, the newsletter of the Decision Sciences Institute. Five times a year, Andy would expound on his views and concerns, often accompanied by his on-target funny drawings.

I would read the columns, agree or disagree with his comments, and, by a steady flow of e-mails, augmented by telephone conversations, resolve and improve upon the discussions. Our last go-around dealt with the latest AACSB curriculum statement that (re)included management science as something that should be in business school curricula. How to make that happen?

Andy e-mailed: “I look at the new AACSB Standards as an indication that they may be willing to buy management science stuff. ... Our current strategy is not good enough. ... We need more ‘real-life math;’ math phobia is still rampant!”

¹Weiszfeld’s original web site no longer exists: the url now is a real estate site (the editors).

Making it happen would certainly serve as a most fitting testimonial to the vision and memory of Andy Vazsonyi.

*A former president of the Operations Research Society of America, **Saul I. Gass** is professor emeritus at the Robert H. Smith School of Business, University of Maryland.*

In this volume we start with Weiszfeld's seminal paper, translated by Frank Plastria, who also added several comments and annotations.

In the next paper "Efficiency for continuous facility location problems with attraction and repulsion," A. Jourani, C. Michelot, and M. Ndiaye study a very general, but hard question about the location of a semi-obnoxious facility in the plane. This facility is simultaneously attractive to some points, and repulsive to other points, and one wants to determine which sites are Pareto optimal with respect to minimizing their individual distances to the attracted points but maximizing their individual distances to the repulsed points. The analysis includes general norm distances and locational constraints. The most precise results are obtained in the case of Euclidean-like distance.

Equity, or its inverse inequality, is becoming an important criterion in many decision problems, particularly in the public sector. However, it has often been observed that the minimization of many inequality measures in location problems pushes the optimal sites very far from the demand points, something that is clearly unwanted. In the next paper, "Inequality measures and equitable locations," W. Ogryczak shows and compares several ways to combine the classical mean distance criterion with inequality measures so as to avoid this adverse effect, while keeping account of the equity aspect.

Then, in the paper "A robust and efficient algorithm for planar competitive location problems," J.L. Redondo, J. Fernández, I. García, and P.M. Ortigosa study and compare two heuristic approaches for determining an optimal location and design for a facility in the plane in competition with several existing facilities. Both methods rely on a simple local search similar to the classical iterative method of Weiszfeld, but are quite different in their global strategy: the first is a random multi-start, the second is an advanced evolutionary method. This second method turns out to yield excellent, and often globally optimal results (though without this guarantee) in much less time than a numerically intensive global optimization method.

T. Drezner is concerned with the uncertainties connected with future demand when locating a retail facility. In her paper "Location of retail facilities under conditions of uncertainty," she proposes a scenario based approach, considering a representative set of possible future market situations, and uses a minimum regret criterion to select a site for her facility that yields a market share that is the closest possible to the maximal possible scenario in any of these possible futures. The setting is in the plane, and the proposed algorithm is a variant of the popular classical big-square-small-square method based on triangular pieces.

In his paper "Asymmetric distances, semidirected networks and majority in Fermat-Weber problems", F. Plastria surveys many ways to model the general and frequent phenomenon of asymmetry in distance, be it axiomatically, on networks or in planar setting. Particular emphasis is given to a measure of the amount of asymmetry, and how this allows to generalize Witzgall's well known majority theorem.

In their paper "Simultaneous siting and sizing of distribution centers on a plane," S. Huang, R. Batta, and R. Nagi propose a model to simultaneously consider both siting and sizing of distribution centers rather than assuming that one (either location or size) is known and optimizing just the second objective.

R.L. Francis, T.J. Lowe, B. Rayco, and A. Tamir provide a comprehensive review of aggregation models in their paper "Aggregation error for location models: survey and analysis".

In their paper “A computational evaluation of a general branch-and-price framework for capacitated network location problems,” A. Ceselli, F. Libertore, and G. Righini propose a general framework for network location problems, based on column generation and branch-and-price. In particular they consider capacitated network location problems with single-source constraints.

M. Schwardt and K. Fischer propose in “Combined location-routing problems—a neural network approach,” a neural network approach based on a self-organizing map for solving single-depot location-routing problems in the plane. They combine locating a depot and planning tours in one problem formulation.

In their paper “A hierarchical location-allocation model with travel based on expected referral distances,” M.J. Hodgson and S.K. Jacobsen propose a new model for the hierarchical p -median problem. A customer may by-pass a closer facility to get the services of a higher hierarchy facility. The authors introduce the concept of “expected distance under referral” to deal with such irrationality and incorporate it into a location-allocation model that minimizes the negative effects of such irrational behavior.

S. Salhi and G. Nagy present in their paper “Local improvement in planar facility location using vehicle routing” an iterative heuristic for the location-routing problem on the plane. For each depot the Weber problem is solved using the end-points of the routes found previously as input nodes to the Weiszfeld procedure.

In their paper “Efficient solution approaches for a discrete multi-facility competitive interaction model,” R. Aboulian, O. Berman, and D. Krass present efficient solution approaches for discrete multi-facility competitive interaction model. Applying the concept of Tangent Line Approximation presented by the authors in previous work, they develop efficient computational approaches—both exact and approximate (with controllable error bound).

In their paper “Optimal location with equitable loads” O. Berman, Z. Drezner, G.O. Wesolowsky, and A. Tamir find p locations on the nodes of a network for p facilities such that the weights attracted to each facility will be as close as possible to one another. They model this problem as minimizing the maximum among all the total weights attracted to the various facilities.

In his paper “On the convergence of the generalized Weiszfeld algorithm” Z. Drezner considers Weber-like location problems. The objective function is a sum of terms, each a function of the Euclidean distance from a demand point. He proves that a Weiszfeld-like iterative procedure for the solution of such problems converges to a local minimum (or a saddle point) when three common conditions are met.

R. Aboulian, O. Berman, and Z. Drezner introduce a new location problem in their paper “The multiple server center location problem.” A given number of servers are to be located at nodes of a network. Demand for services of these servers is located at each node, and a subset of nodes are to be chosen to locate one or more servers in each. Each customer selects the closest server. The objective is to minimize the maximum travel time plus the average waiting time spent at the server, for all customers.

In their paper “Single facility location and relocation problem with time dependent weights and discrete planning horizon” R.Z. Farahani, Z. Drezner, and N. Asgari investigate the dynamic location problem where the weight associated with each demand point is a known function of time. Relocations can take place at pre-determined times. The objective function is to minimize the total location and relocation costs.

Editors