The Whittle Story
A Live Book

Surface Mine Production – Helmut Lerchs & Ingo Grossmann

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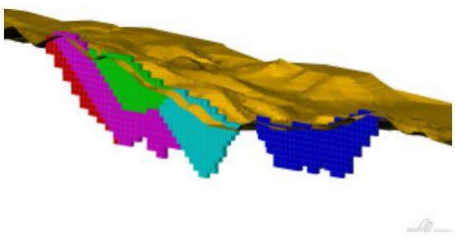
The most popular and well-developed approach to the ultimate pit limit problem is the Lerchs-Grossmann (LG) algorithm, primarily based on Graph Theory. It was 1964 when Helmut Lerchs and Ingo F. Grossmann presented their algorithm to find the optimum design for an open pit mine. In their words at the time, “the objective is to design the contour of a pit so as to maximize the difference between total mine value of the ore extracted and the total extraction cost of ore and waste.”



Maptek Vulcan Pit Optimiser

Ingo F. Grossmann and Helmut Lerchs were both with IBM Canada when they developed the algorithm. They had been working as a team since 1958, with a mission to uncover and exploit new opportunities for computer application of scientific methods to potential business situations that IBM salesmen would bring to them from their territories.

Both Ingo and Helmut had good foundations in applied mathematics: Ingo had a Masters in Mathematics from the University of Munich, Germany, and Helmut had a Diploma in Sciences from the Sorbonne, plus one in Electrical Engineering from the Ecole Superieure d'Electricite in Paris, France. To top their credentials, both had been mathematical "wiz-kids" from schooldays on.

They became active in Operations Research (O.R.), and between 1959 and 1963 executed original projects with a good number of organizations across the industry. These would include oil (refinery scheduling), transportation (allocation models), distribution (warehousing and order processing), education (class scheduling), and mining (plant optimization, and open pit operations).

A number of the applications required new mathematical approaches, and a considerable portion of their effort went into related research. Their findings were then presented to national and international conferences, where they always generated great interest.

The ultimate pit limit problem arose in conjunction with an innovative OR study during the winter of 1960-61, in which Ingo and Helmut were assisting Bill Huston, Superintendent of Concentrators, Steep Rock Iron Mines Limited, to explore the impact of adding a Flotation and Pelletizing Plant to their ore upgrading facilities.

The mine had been in operation since 1945, after the removal of 10 miles of lake out of the Seine River system in Western Ontario, Canada. They had been shipping up to 3.3 million tons annually. Low grade ore had been upgraded in one Screening Plant and two Gravity Concentrators, but now these facilities alone could no longer respond to the demand for higher grade ore required by modern steel production.

A mathematical model was developed to calculate the routing of a quantity of ore with known characteristics, from the mining site, through the upgrading facilities, along the segments of an overall Ore Flow Diagram, to the various delivery sites (railroad cars for the Fines, Coarse and Pellets, and Dump for the rejects), given the settings (within given limits) of operational parameters in each of the upgrading plants. This model was then upgraded to a Linear Programming (LP) model, by adding all cost factors (mining, plant operation, transportation along the segments of the Flow Diagram) and specifications of current demand (minimum grades and maximum ratio of fines), along with the price per ton of iron at the destination. A standard LP computer program (algorithm) could now be run at IBM's 704 Scientific Computing Center in Toronto, to calculate the optimum (most profitable) routing of ore from the mine to the delivery site, given any set of real or hypothetical values for the 50 or so parameters defining the model.

The LP model thus developed was much simpler, but similar to those that oil companies had been using routinely to operate their refineries under variable conditions in the market. Steep Rock Iron Mines Limited was now in a position to quantify their expectations for a higher level of profitability with the augmented facility, and to demonstrate their ability to respond to a wider range of changes. The new plants got installed, and began operating in 1967.

From their discussions with the planners of mining operations, Ingo and Helmut had noticed the absence of any concern for pit optimization. As the topic was not directly related to the project at hand, they decided to take a look at it later, on their own. And so they did. Over the next few years they spent time on the project intermittently. They first translated the optimization problem into a Graph model, and then searched for some iterative process that would converge towards the optimum. By early 1964 such a process had been identified and the mathematics worked out. Realizing that computers were too small and too slow then, to warrant any practical application of their new algorithm, they decided to publish a comprehensive coverage of their findings (The Canadian Mining and Metallurgical Bulletin, January 1965), and revisit implementation at some later time. Twenty five years later, they were delighted to learn that Jeff Whittle, now their colleague in the Hall of Fame, had, with his team, developed the first effective computer implementation of their algorithm, and was successfully pioneering its application in the mining industry.

In late summer of 1964, Helmut joined the General Motors Research Laboratory in Warren, Michigan, but returned to Canada one year later when the opportunity arose to form, together with Ingo Grossmann and Gerry Wanless of IBM sales, AGT Management Systems, the first independent software house in Canada. Joining them for the start-up, were three younger "tigers", also from IBM: Bill Aitken, Alvis Zuntaks and Aarne Aus. Their combined talent and reputation helped generate business right from the start.

By the fall of 1965 AGT won a landmark project, when The Ontario Government entrusted them with the implementation of Canada's first govenment sponsored medical insurance plan OMSIP (Ontario Medical Services Insurance Plan). They were hired to design, develop and install, from scratch, a universal medical insurance system for the province of Ontario. The computer system had to register and maintain: all Ontario residents (then some 7,000,000) and their medical histories; all medical doctors and their claims histories; all medical procedures, their fee schedules and the complex rules of their adjudication. In addition, a financial system was required for processing of medical claims, and payment to doctors. Timely registration of Ontario residents began 9 months after project start, and first payments to doctors went out 3 months later! It took several more years to streamline the system and to train the personnel of the newly created OMSI

Division (a staff of 600) in registering of Ontario residents and in processing of claims (some 30,000 per day). The project execution was deemed a complete success.

Early 1968, AGT aquired a new partner, Ted White, a sales executive from IBM, and reviewed strategies for expansion. By November AGT went public (the first Software House in Canada to do so). Ingo and Helmut, less ambitious for rapid expansion, sold their shares and each took a few years off to pursue their personal interests.

They reconnected in early 1973, when Helmut joined Versa Management System, a small group of ex-IBM and ex-AGT people that Ingo had assembled the previous year to exploit the potential of minicomputers in business applications. They were inspired by Four-Phase Systems Inc. of Cupertina, California, who had recently developed, and were successfully marketing a Data Entry (key-to-disk) Minicomputer System, that would handle up to 32 video/keyboard terminals concurrently. VERSA decided to turn the Four-Phase minicomputer into a generalized business application processor. They expanded its operating system to include generalized online transaction processing capabilities, built their own Database Management System, as well as facilities for Security, Backup and Recovery . They could now develop business computer systems for the non-DP envirenment, and their clients could operate sophisticated online business applications without computer specialists on their staff – a novelty in the 70s.

The following list illustrates the variety of application systems custom-developed by VERSA over the next 25 years:

- Labour Force Survey System (Unemployment Statistics for the Government of Canada)
- Hospital Administration Package for HBO, a large U.S. health care company (over 30 hospitals installed)
- Distribution/Order Processing for Borden Foods accross the U.S., as well as for Borden Chemicals and Borden Dairy in Canada
- Light Oils Distribution Planning and Scheduling System for AMOCO Oil, Chicago (for their 300 distribution sites in the US)
- Disability Determination System (Over 20 states installed in the U.S.)
- Regulatory Board System Package (about 10 systems installed in the US, covering over 3 million regulated entities)
- Shareholder Accounting System for Mackenzie Financial Corporation and three other financial management companies in Canada.

Ingo eased off his project activities during the 1980s, and retired from VERSA in 1989. His health soon failed him, and he left us in 1995, at age 70.

Helmut took over the direction of VERSA by the late 1970s, but ramained active in the development of innovative application systens until 1998, when the company was sold to KPMG. He then retired, aged 67.

Ingo Grossmann – Personal Interests

Hunting, fishing and all things to do with the natural world were extremely important to Ingo. He developed an outstanding knowledge of plants and animals. He hunted deer every fall in Southern Ontario. Major expeditions further afield included hunting Dall sheep in the Yukon, elk in B.C., caribou in Labrador, moose in Northern Ontario, as well as salmon and char fishing in the Arctic.

Starting in the early ’70s Ingo put together a large forested property on the southern Canadian Shield to be used for hunting and fishing. By the mid ’80s he had assembled 750 acres (300 ha). He called the property Sans Souci. The nearest public road was 5 km from the property through rough and forested terrain. A private road suitable for heavy equipment was designed and built. A major project at Sans Souci, very difficult and time-consuming, was his creation of a lake from marsh land by building a number of dams. The consensus among the locals was that this couldn’t be done, given, among other things, the lack of suitable foundations for the control dam in the spongy soil. Through the use of heavy equipment the control dam was successfully built and a lake of 45 acres (18 ha) created. Ingo stocked the lake with large mouth bass and pickerel.

In 1981, at the time he was winding down his responsibilities at Versa, Ingo semi-retired to the country with his second wife ‘Gitta. The 20 acre (8 ha) treed property is near the town of Uxbridge, on the Oak Ridges Moraine, roughly 50 km north-east of Toronto. Both the house and land needed a great deal of work. The land, originally forested with hardwoods, primarily maple, ash and beech, had been cleared by early settlers for farming. The poor, sandy soils eroded badly, with some tracts on the Moraine being reduced to blow sand deserts. Many of these eroded tracts were later reforested with Scots pines. This dense, non-native monoculture suffered serious and often fatal infection by pine blight. One of Ingo’s many projects was to replace these dead and dying pines with a variety of native hardwoods and more suitable native pines. One example: he planted more than 3000 red and white oak seedlings.

In his later years, Ingo spent a great deal of time on a project to translate from the German and adapt for the North American reader his father’s work, “The Grossmann Method”, a pioneering

personal work methodology that had, over the years, gained a wide following in Europe. The method involves a disciplined development and execution of time and self-management strategies to optimize one's life goals and achieve personal and professional success. Unfortunately, time did not permit completion of this project. Ingo died in 1995.

Helmut Lerchs – Personal Interests

When freed from his commitment with AGT, Helmut, in the fall of 1969, began a PhD program in Computer Science at the University of Toronto. Within one year he completed the course requirements as well as the comprehensive written and oral exams. For thesis subject he had intended to address the problem of methodology in information systems development. Having experienced the lack of standards in current practices, he was going to explore ways to express the functional requirements of an application system, together with those of performance and control, in a comprehensive, formal, system specification procedure, as is done in traditional engineering disciplines. Among the faculty, Helmut found little enthusiasm for his concerns. Academia felt more at home in the hard sciences of mathematics and computer technology. He then opted for mathematics and spent two more years on a narrow subject in Graph Theory. While he uncovered a good number of amazing properties in the family of graphs under scrutiny, he did not come to terms with the ”hard” problem he set out to solve. He wrote a number of technical papers but did not submit a thesis.

rom the early 1990s, Helmut and his wife Ieva (nee Grodnis), a retired High School teacher of English and Drama, have spent much time in their native country Latvia since it regained its independence. As members of Latvian choirs in Toronto, they both participated in Riga's first free Song Festival of 1990. In the years following, much of Helmut's energy was spent in recovering and managing the family property left by his maternal grandparents, Mikelis and Ella Bruzis. Mikelis, among many other professional and cultural activities, became one of the Founding Fathers of Latvia, back in 1918. But he and Ella were both deported to separate camps in Siberia in 1941, when the Soviets had reoccupied the country. Mikelis died that same year, aged 73, Ella took her own life two years later when she learned about her husband's fate.

In 2001, on the occasion of the 60th anniversary of their deportation, Helmut, in the name of the ten grandchildren, organized a reprinting of M. Bruzis' book of 1937: “Worldview, or Man in Nature, Society and Eternity”. This new edition includes a foreword from Janis Stradins, then

President of the Latvian Academy of Sciences, and an adjoining biography of the author, prepared by historians of the Latvian National Archive.

Back in Toronto, Helmut spends a reclusive life in his ”Ivory Tower” (2d floor library), reads some, writes some, sorts his unpublished research work and the mounds of old pictures and films, vestiges of his photo-lab that succombed to the invasion of digital photography. On Tuesdays and Fridays he plays bridge at the Cultural Centers of Japan and Latvia, respectively. Off and on he picks one of his collected accordeons, dusts it off, and squeezes out a few nostalgic lamentationa. When the snow is gone, he walks with Ieva in the nearby park and plans their next travel destination.

At least once every year he meets with his two brothers, Erik, his identical twin, and Armin, the elder, who both live in Brussels, Belgium. They compare their adventures and philosophize. It is a good life.