

## **ENHANCING THE PIPELINE ROUTE SELECTION PROCESS**

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### **ABSTRACT**

The pipeline route selection process focuses on achieving the optimal location for a pipeline. Even though this is the desired process outcome, in reality it is counter to data and information collection efforts that are concentrated on identifying and inventorying locations for pipeline avoidance.

Changing and aligning the routing mindset from output (pipeline route) to input (discipline information) is what truly allows for optimization of route selection, reduction in costs and risks, improvement in decision consensus, and reuse of valuable information throughout the pipeline lifecycle. Through discussion of an enhanced pipeline route selection process, this paper will cover a range of benefits including establishing data collection corridor widths, dynamic routing considerations, and methodologies for managing and using multi-purpose and multi-discipline information.

### **INTRODUCTION**

Discussions, documentation, and development of the uses and merits of the least cost path analysis in decision support are readily available (Husdal 2001) within the analytic Geographic Information System (GIS) community. The applicability of this analytical method to the pipeline routing process is somewhat well known and there are cases where this analysis proves to save on overall pipeline construction costs by nearly 30% (Delavar 2003). Yet there remains an obvious reluctance to adopt these techniques as commonplace within the overall pipeline routing process even with such incredible cost savings and cost avoidance opportunities.

### **TRADITIONAL ROUTE SELECTION PROCESS RELUCTANCE**

The traditional pipeline route selection process typically begins with "Point A to Point B" plan. An owner company gathers high-level data, almost overview information, and the feasibility of progressing the plan further is rapidly determined. If the plan is progressed, then the plan becomes a project, contracting companies (Engineering and Environmental) become involved, and the pipeline route becomes the pivot around which personnel begin honing data, information, opinion, and decisions.

In early stages of the route selection process a battle rages between those deeply rooted in field-based approaches (traditional) and those who strongly believe in a desktop approaches (partially traditional and partially enhanced). Most often, the field-based approaches win out over the desktop approaches not based on technical merits but on rather on "project panic". "Project

panic” is an intense fear experienced by personnel involved with projects stemming from process change or any movement away from the status quo. The intensity is due to the pace of the project and the fear manifests itself in a myriad of phrases similar to “it will affect the project schedule and/or budget”.

Heavy reliance on the way things were done (successfully?) in the past is what has caused companies to avoid process or technology enhancements. Even where technologies such as GIS have made it into the routing process it is not utilized to its full potential, for example, use of GIS to make prettier maps is not much higher on the value chain, although it may save some costs, than use of CAD or manual drafting to accomplish the same goal. Another example of technology underutilized occurs when GIS is used to make paper maps for disciplines to mark-up, measure against, take-off quantities, perform *analysis*, or any other manual task that is actually repeatable within a GIS environment.

### **TRANSITIONING TO AN ENHANCED PROCESS**

Personnel and software are key parts of any geographic information system and the critical components of an enhanced pipeline route selection process. The software or technology component of this enhanced process is mature; in fact, little has changed with least-cost-path algorithms in recent times. So what is the holdback on adopting least-cost-path analysis as a fundamental portion of the route selection process?

In a non-technology sense, one reason for avoiding a least-cost-path approach is that there has been little to drive the contracting community to improve upon their processes – the old way remains sufficient. Only with a strong push from owner companies will there exist enough momentum to invoke process change. When owners set and enforce expectations, contracting companies (and the GIS community in general) will begin to explore the technology and educate themselves.

Owner and contracting companies are beginning to realize this very fact and some are taking the correct steps towards technology edification. Others remain, however, with only a general understanding or genuine lack of understanding of the technology or choose to stay with what is familiar especially in project situations.

Changing and aligning the routing mindset from output (pipeline route) to input (discipline information) is what truly allows for optimization of route selection, reduction in costs and risks, improvement in decision consensus, and reuse of valuable information throughout the pipeline lifecycle. Enhancing the route selection process will only come from a concerted effort on behalf of personnel to understand the technology.

### **CAPABILITIES CREATION THROUGH ENHANCED PROCESS**

#### Data Collection Corridor

One the most important aspect of the route selection process is proper identification and inventory of impassible or possible problematic places. A vast majority of sites requiring identification is available from public domain data sources; however, to fill any potential data gaps and to improve data quality the project will undertake a field data collection program.

This approach certainly has its purpose but initial data collection programs performed in early stages of a project can be done in such haste that many crucial items may be overlooked, *minor* items like the data collection corridor width. Regardless of the data collection corridor width, if

not set properly there can be additional costs incurred by the project. A collection width too narrow means revisiting the corridor whereas a corridor set too wide becomes logistically unwieldy and involves many personnel and many chargeable hours.

Using an enhanced route selection process does not eliminate the need for field data collection but it is able to help curb the amount of fieldwork necessary. The least-cost-path analysis can effectively establish an optimal data collection corridor. Defining the corridor with more rigor than just stating "1 mile either side of the alignment" is a different approach but has its advantages in its ability to focus efforts on realistic routing options. Without sensible identification of these options prior to a field program wastes financial, personnel, and time resources. Careful planning of collection corridors allows for better project controls.

In the simplest context of a least-cost-path analysis, a data collection corridor begins with two cost accumulation surfaces: one surface running from "Point A to Point B" and the other from "Point B to Point A". Adding these two surfaces together generates a new surface that indicates the total cost of positioning a pipeline alignment through any given location. The values generated in the output surface are most useful for establishing data collection corridors when the values at or near the minimum of the surface are extracted.

For example, Figure 1 was generated by first constraining movement between "Point A and Point B" to occur only where the longitudinal slope is less than seven percent. The two output surfaces (cost accumulation surface from "Point A to Point B" and vice versa) were then added together and the minimum value of this grid determined. To derive the data collection corridor shown, the minimum value (representing a least cost) was increased slightly by a factor and then used to extract the potential data collect corridor shown.

One key observation is that the data collection corridor is no longer a constant value but instead is quite variable. This variability in width can be interpreted as "collecting more information where there are more routing options".

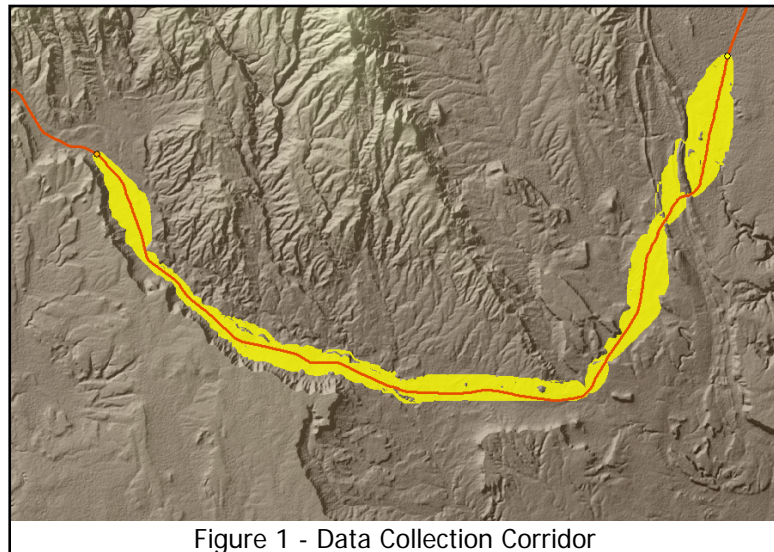


Figure 1 - Data Collection Corridor

### Dynamic Routing Variables

In pipeline applications, the amount of terrain undulation along the pipeline is a measure of several costs throughout the pipeline lifecycle; costs that are evidenced in terms of "cut and fill" operations, the type of equipment usable in clearing and construction, potential geotechnical issues, or site remediation. Remember, the aim of enhancing the routing process is to reduce the overall costs of the pipeline and not just the front-end phases (i.e. field data collection).

In a traditional routing process, the longitudinal slope, or slope along the pipeline alignment, is not derivable until a preliminary alignment exists. The reason for this is that longitudinal slope is measurable only in a frame of reference that is relative to the pipeline alignment. Once the longitudinal slope is determined, segments of the pipeline alignment with slopes exceeding a

predetermined threshold undergo an assessment and then tweaks made to the pipeline alignment. The longitudinal slope is then derived again and the iterative process continues until the alignment meets the project requirements.

In the enhanced routing process, the predetermined threshold for longitudinal slope becomes part of the routing criteria and is used to establish (not post-appraise) the alignment location. This is accomplished by setting up a least-cost-path type analysis that is capable of calculating costs over an elevation surface while restricting movement over the surface to areas under the slope criteria (Tomlin 1990). Important to note that the slope criteria is not evaluated prior to the least-cost-path analysis but rather it is calculated during the analysis thus making the slope a dynamic property of the alignment location.

#### Multi-Use and Multi-Discipline

The pipeline routing process is a multi-discipline process involving such disciplines as engineering, environmental, regulatory, commercial, and more. Each discipline has its own needs in terms of data inputs and, as is often the case, this results in data sets having multiple uses. Data management is as much (if not more) a part of an enhanced routing process as the software required to run a least-cost-path analysis.

In working across multiple disciplines, it is quite important to establish boundaries with respect to data ownership and data usage constraints. The boundaries help in managing change across the disciplines especially in the case of multi-use data. As an example of multi-use data, a digital elevation model suitable for pipeline hydraulics will likely not have an adequate extent for air and/or noise modeling. Similarly, a digital elevation model suitable for air and/or noise modeling will not likely have adequate resolution for pipeline hydraulics.

In this case, what discipline owns the digital elevation model? There is no correct answer just a business decision to be made by the owner company with input from the disciplines. The point of setting and enforcing these controls is for the project to benefit from reduced data expenditures through better data management and data acquisition approaches.

Another awareness issue in working in a multi-discipline environment is that there are now more personnel available "touching" the same datasets. This can positively affect data quality since more personnel using data will lead to more opportunities to identify any potential data issues or gaps. In addition, integration of datasets across disciplines presents itself as another means of data validation.

### **SUMMARY**

The software or technology behind the least-cost-path analysis routing is very mature yet it remains underutilized within the pipeline routing industry. People and software are key parts of any geographic information system and are just as important to a successful enhanced routing process.

Enhancing the route selection process will only come about from efforts of personnel to enhance their understanding of GIS fundamentals. The fundamentals are not that difficult but without self-edification then the potential process improvements and possible cost savings will remain unrealized.

## REFERENCES

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