Truck Haulage System

- Not a stationary system.
- Haul route is dynamic.
- Can haul any type of materials.
- Need engineered haul roads.
- Not able to maneuver through difficult terrain.
- Haulage cycle may not be the shortest possible path - results in higher fuel consumption, exhaust emissions, and dust emissions.
- Not designed for steep haul road grades - less efficient.
- Possible high fuel cost and shortage of supply.
- Parts are not readily available.
- Increasing labor costs - to train, operate and maintain (Mitchell & Albertson, 1985; Metzger, 2007).
- Operating cost estimation is high: $0.87/ton (Metzger, 2007).

Conveyor System

- Stationary system.
- Conveyor path is not dynamic - though it can be shortened or lengthened if needed for mine design.
- Material may need primary and/or secondary crushing (Zaharis, 2011).
- Conveyor path can be through areas where trucks are not able
- Can handle inclines up to 35-degrees.
- Parts are readily available.
- Operating cost is low - reduction in operators, training, and maintenance.
- Particulate matter and noise pollution is significantly lower (Mitchell & Albertson, 1985; Metzger, 2007).
- Cost Estimate: $0.06/ton (Metzger, 2007).

ECONOMIC COMPARISON OF CONVEYOR BELTS AND TRUCK HAULAGE SYSTEM

A key item that needs to be considered in depth is the transportation of materials (e.g. ore and waste) in an open pit mining operation. When considering in what manner the material will be transported the following questions need to be answered; Where is it going? What is the existing topography? What is the initial startup cost? What is the cost to maintain and operate? (Frizzell & Martin, 1992)

In an open pit mine, the cost of transporting materials can be 60% of the operating cost or greater. The method of choice for many years has been a truck hauling system but in more recent years, a conveyor belt system has come into focus due the need to reduce costs. Some of the advantages of having a truck hauling system are low capital cost, ability to adjust and conform in a dynamic mine operation, resale value, and its mobile ability. The haul truck has come a long way from where it started. Current models interact with a dispatch system, have a monitoring system that will result in improved efficiency, are some of the largest trucks ever designed, and use diesel engines and electric wheel drives (Frizzell & Martin, 1992).

Disadvantages of haul truck system range from high fuel consumption (60% fuel energy to move the truck, 40% to transporting payload), possible high fuel costs, inclement weather, requires high manpower, and high operating and maintenance costs. Furthermore, truck haulage system has an operating grade limitation of 10% (Frizzell & Martin, 1992).

A conveyor system is a low cost way to handle material continuously. Some of the advantages are low energy costs, inclement weather does not bring the system to a halt, low operating and maintenance costs, reliable (90-95% availability), and requires low manpower. This system can handle steep grades up to 30% which eliminates the need to remove overburden and implementing a haul road system. Disadvantages of this are high initial capital costs and the inability to be flexible in the loading area. A conveyor system has a life of 25 years where as a truck has a life of six to eight years (Frizzell & Martin, 1992).

Some things to consider when employing a truck system are extra trucks for extreme haulage routes and wear and tear of existing fleet. When comparing a traditional truck hauling system and a conveyor system with in-pit crushing, several mines have concluded that a conveyor system has lower maintenance, operating, and overall unit costs. A conveyor system should be highly sought after in a mining operation for its advantages (Frizzell & Martin, 1992).

SIMULATION AND ANIMATION OF THE SAND AND GRAVEL MINE AND ITS APPLICATIONS

A simulation and animation program of a sand and gravel mine using two separate software packages, GPSS/H® and Proof Professional®, was designed and created to study the mine operation with two possible haulage systems; a truck haulage system or its combination with a conveyor belt.

GPSS/H® (General Purposes Simulation System) has the ability to model and simulate complex mining operations. The Lihir mine in Papua New Guinea was the first mine operation to be completely designed by simulation (Sturgul, 1995). The simulation model includes the mine operation layout with truck movements separately or in combination with a truck and conveyor belt to carry overburden and aggregate to the process and storage area in the site. A few "what-if?" scenarios considering the type of the mine material handling systems were studied using the simulation and animation program. This model assisted the mine engineers to investigate and analyze various material handling systems, either separately or in combination, for the operation according to the short-term and long-term mine planning.

The normal distribution was used in the simulation model for the mine truck travel, load and dump times. However, spot times of trucks were observed to be non-symmetrical, and the exponential distribution was used for the simulation model. In addition to this data, constant travel time for the conveyors belt was considered.

Proof Professional, the animation program, also assisted the modelers with the ability to display the simulation program in progress. The animation of the simulation was necessary to verify a true representation of the actual mining operation. Different screenshots of the sand and gravel simulation are shown in figures 1 and 2. Figure 1 illustrates the model only using haul trucks for the mine haulage system. Figure 2 shows the snapshot of the animation running a combination of trucks and a conveyor belt in the mine.