The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

The future of mining machines

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Ugo Bardi produced a rather grim look into the future with his recent piece on the Universal Mining Machine, and the various considerations of what we are going to do as the major mining sources of the different ores that are required start to run out.

I would rather like to take another tack, and comment instead on the need that the mining industry will face, at some point soon, in having to significantly change the way in which it mines and processes ore. Whether it is in the mining of the large volumes of rock that yield the coal and oil from tar sands for the fuels industry, or the deeply won gold, from narrow veins found miles underground, the current energy cost of those operations is starting to come into conflict already with other needs, in a time of shorter energy supply. One has only to look at the stories that Leanan has been catching that have reported on the energy shortage in South Africa, to begin to see the start of the conflict. And although the current mine problems may have been overcome in South Africa itself, the "knock-on" effect in countries such as Botswana continues, with doubts as to where they will now get power.

There has been much discussion in the press and here, among other places, on the growing conflict between the growth of crops for food, and those for fuel. One now is starting to enter a time, when the energy cost of mining production may well fall under the same sort of scrutiny.

Charlie Hall has started a praiseworthy effort to look at the energy costs of various methods for producing fossil fuels, and I have, in the past, tried to explain that there are ways to look at getting rock out of the ground that change the energy cost depending on the way in which you actually mine the rock – mining it in very small pieces, for example, costs more energy than pulling it out of the ground in big bits.

But I think we have to go beyond that and look at the overall process, and consider that there might be alternate ways of mining that change the overall balance of the energy costs. Mining operations must consider many factors in choosing the equipment, and the mining methods that they use since they must plan on getting the most value from the operation, with a minimal cost. And in that regard, one might note, in passing, that when I visited the oil sand mining operations at Fort McMurray I stood beside the museum piece that was the bucket-wheel excavator (BWE) similar to the one that Ugo featured in the photo at the top of the page (and which was also featured in the picture of the Cat on the Catwalk , that occasionally crops up on the Internet). It is a museum piece up there (and its sisters have been sold) because when all your production is tied to one machine, when it goes down, then so does the mine (a point that Alistair McLean used in his book Athabasca which is based on mining up there).

Running the machines and keeping them going was a tough and expensive business, and in the end it proved more productive to break the mining operation into about a dozen large electric shovels , with truck haulage , rather than using the BWE and conveyors. Not that the shovels and trucks are that small. When the shovel takes a 100-ton bite out of the working face, and then loads three or four such scoops into a truck before it takes off for the pit floor crusher, we are not talking of stuff you can park in your garage. The middle of the tires is about head height, and, as has been noted, demand being up, it has been hard to get mining tires for over a year.

For large mining operations, shovel and truck operations will continue to dominate in the short term, since the process is very simple, and the large volumes of material that must be moved make the system practical, and it has the flexibility of operation that a BWE does not in terms of being able to do some selective mining (if the rock is barren it can be removed but not taken out of the mine). In the longer haul, however, technologies will need to change as the surface deposits start to diminish and more oil must be recovered from underground. It still may make economic sense to mine all the rock, however, since in this way all the oil can be stripped from the sand, rather than just a fraction.

In the more near term, the first victim to higher energy costs, and lower availability may be the valuable mineral and diamond operations, among the mines now being hit in South Africa. In these mines the ore is often found in narrower veins, that are more often at a steep angle to the horizontal, and where mining must, therefore, proceed in a different way. Depending on how valuable the mineral is that is being mined, and how widely it is disseminated through the host rock, different approaches can be undertaken. The fundamentals of the process, however remain the same regardless as to whether one is using vertical crater retreat or a room and pillar operation,
VCR is a method of blasting down successive layers of a thick deposit, into specially shaped underlying holes from which it can be fed into mine cars, or a conveyor that carries the ore to a mine shaft. (Slides 12 and 13 of this pdf Here it is raised to the surface, crushed down to the point where it is as fine as flour, and then the valuable minerals separated from the waste. And with the ore generally being relatively low in volumetric percentage terms in valuable mineral, that leaves the problem of disposal of this fine material at the surface, which can have environmental consequences.

There was a very interesting program on this topic on "The Daily Planet" a TV show on the Canadian Discovery channel, about eighteen months ago, that unfortunately I couldn't find when I went back to look. It featured Lee Saperstein and he talked about the idea that he had been following, under Department of Energy funding, to look at the process with a new eye.

In essence his idea was that if the rock could be mined so that the different constituents were liberated into their separate grains, as part of the excavation process, then they could be separated at the mining machine, and, as a result, only the valuable mineral need be transported out of the mine, while the waste rock could be left near the excavation site, filling the holes that had been left, and not requiring the intense crushing, transport and surface disposal costs of current methods.

The idea of separating the rock into its mineral component grains was one of the advantages of early hydraulic mining in California, though that benefit turned rapidly into a disadvantage, when the water was not properly processed. In essence gold in the area around the Malakoff is found in a relatively soft sandstone. By using large monitors (water cannon) to wash out the rock, it was disintegrated so that the gold particles could be separated out and collected in the flumes into which the flow was directed. However, while the sand grains also settled out on the mine

property, the rock also contained fine clay, and this was held in suspension until the water reached the Yuba, and other rivers, that carried it west to the sea. As the water speed slowed in the river, the clay settled out, and gradually filled the river bed. Thus when the rains came, or the snow melted, the river could no longer carry the volumes of water and the river overflowed its banks and flooded the farms and villages. This led to a legal battle, which the farmers won, and hydraulic mining has been a historical curiosity since. And I make no comment on that issue, but rather only point out that it illustrates that methods exist for breaking the rock into individual mineral grains, and it was the very efficiency of that process that led to its demise.

More recently, and as mentioned in the broadcast, it has been possible to use much smaller jets of water, at much higher pressures (waterjet cutting is one of the quiet revolutions going on in industry) in order to similarly break harder rock types. Because of the way that the water cuts into the rock, it penetrates along the individual grain boundaries of the individual rock components, breaking them out at the grain size scale, and eliminating the need to break the rock down to much smaller sizes to achieve liberation. The use of intensified cavitation as a secondary breakage tool for the particles not separated in the initial process, can also be provided in a very small envelope that can be included within the body of the machine. This rapidly disintegrates the rock particles into a smaller size, but again breaking along the boundaries of the rock particles that are weakest, to separate out the constituents. It thus provides, in combination, the means to locate both mining and separation equipment at the mining face, so that the ore can be separated there, and only the valuable mineral moved out of the mine. In doing so, and depending on the type of ore and method of mining, up to 50% of the energy used in moving and processing the unwanted waste rock can be saved.

I use this short example as an illustration of the ways that will have to be developed if the energy costs of mining are to be reduced. There are likely others, but in this particular case, the problems that I have cited previously about the future difficulty in developing new answers is illustrated by the fact that since the story came out Dr Saperstein has retired, and the office of DoE through which the project was funded has had its mission changed, and is no longer funding work of this type. (Which also makes it hard to find the reports on the research that was done).

Ah, well!