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# Draglines - The Same "Old" Stuff?

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ABSTRACT: Many people have labeled draglines the "Dinosaurs of the Industry". The perception is that they have evolved at a far slower rate than the industry in which they arc deployed, and "is it fair to expect a machine that is already working in excess of it's initially anticipated life of 30 years to adjust to the demands of today's market?"

Much research has been performed on the application of, as well as the technical aspect of draglines, with papers being presented at most Dragline Users forums and Technical Conferences hosted throughout the world. These papers have covered subjects ranging from bench stability, to use of modified motors, to determining the excavatability of draglines. But what is being done now to enhance the productivity of these machines?

This paper takes a brief look at productivity enhancing modifications that can be applied to draglines today. Scheduling packages and other computer generated aids, digital upgrades utilizing the latest digital control technology, and new boom geometry configurations with associated motion control technology are just some of the enhancements that are currently being developed to bring these machines into the 2 l[st] century. Some of these technologies, at time of writing the paper, are still probably considered to be in the development phase, but the magnitude of the initial results justifies sharing with world dragline users.

## 1 INTRODUCTION

Our perceptions of the pre-historic era are generally of large reptiles foraging in the forests and plains of the world. Life was slow - except when under threat by a T-Rex - and Steven Spielberg's Jurassic Park further emphasized that, and the entire world became more aware of the earth's early inhabitants. These predominantly gentle giants just "plodded along" from day to day.....

Draglines have generally been the equipment of choice when it comes to stripping of coal overburden. Yes, there are shovel/truck applications exposing coal around the world, as there are draglines in other applications such as phosphates, bauxite, diamonds and oil sands, but the majority of coal mines have the dragline as the primary mover of overburden. Although they have a considerable capital outlay, they generally are the cheapest method of moving overburden. These monsters of the mining industry just seem to "plod along" from day to day, moving overburden and exposing coal, moving overburden and exposing coal, moving..... Little wonder they get the name of "Dinosaurs of the Industry". The one problem is however, that the reference to "dinosaur" is also used in another connotation - that of being "prehistoric" and therefore "out of date". Is this a justified comment? Is the coal mining industry hanging on to an archaic technology? Or is it really archaic? What's been done to make dragline operations more efficient, productive and cost effective?

## 2 A QUESTION OF POPULATION?

Probably the most visible area the Mining Industry sees improvement is that of Shovels and Trucks. The last 15 years in particular has seen huge growth in sizes of both Shovels and Trucks, and the population of equipment out there certainly has attracted the attention of developers of technology. We see lots of advertisements on Shovels as well as Trucks and the technology to make them more productive and cost effective. Some of the developments the industry has seen are:

- Larger dippers to load the large trucks in 3 passes
- Digital control technology to lower cycle time
- "Throw away" truck bodies to increase payload

- Remote monitoring of vital signs to better identify imminent problems
- Predictive Diagnostics offers proactive rather than reactive maintenance
- Current developments to minimize the repetitive tasks the operator has to perform
- Some truck manufacturers have been looking at "autonomous" trucks

The above is merely a small sample of what has been going on in that area, and we all know about it - why? There is a huge population of shovels out there, and an even greater population of trucks, so they are "getting all of the attention", we see the adverts, we go to mining shows and see these trucks in "real life" - proudly on display for everybody to "kick the tires". So everybody has a heightened awareness of the technological advancements in that area.

There are far fewer draglines than shovels in operation around the world. They are large and therefore we cannot take them to shows. They lack the "action" and excitement" of a highly productive truck and shovel operation. There are not many units sold - probably averaging 1 every 18 months recently, therefore we see fewer press releases and overall they just have a lower profile.

## 3 USER GROUPS

The smaller population has created a smaller support community, but that's about where the use of "small" ends. The regional dragline user groups are extremely active, addressing issues such as:

- Maintenance practices
- Productivity improvements
- System upgrades
- Application concepts
- Parts longevity
- Parts Pools

Most of the development work on Draglines has been initiated through interaction with these user groups, and there has been a lot of development. We work very closely with the user groups around the world to keep pace with their requirements. This close knit community of users has been responsible for initiating many of our R&D initiatives.

## 4 ARE DRAGLINES OBSOLETE?

Operations are still buying them, they are still investing in development programs, and many projects that are still "on the table" have draglines as the equipment of choice for overburden removal. Dragline user groups still meet with OEM's with a view to improving reliability and productivity and OEM's still invest R&D dollars. Many existing draglines still have many years of operating life ahead and need to be productive and cost effective. So in essence, no, they arc not obsolete.

## 5 ARE DRAGLINES OLD TECHNOLOGY?

The concept of the wheel goes back some time, millennia in fact, and although designs and materials may vary, the concept has remained and has definitely not become outdated. The dragline is probably no different, other than being somewhat "younger", the concept goes back a long way relative to our generation, and this basic concept is still what remains to date. Having said that, does that mean they are "old technology"? On the contrary, the latest technology is applied to new draglines and the developments are conducted so that they can be applied to older machines. What are these developments and technologies?

## 6 DESIGN DEVELOPMENTS

Sophisticated computerized design technology enables designers to build complete machines before s single steel plate is cut for machine production. This ensures that designs are optimized for the payload and geometrical requirements of the specific operation. It is worth mentioning at this stage that although draglines are really individually tailored to the operation into which they are going, designers consider the applications of their work to the existing fleet already in operation as well. The one issue with these design developments is that they manifest themselves in long term benefits, in other words, they don't necessarily display immediate benefits. Long term issues such as reliability and availability are definitely sought after characteristics, but somehow lack the "pizzazz" of something like a reduction in cycle time which can be measured immediately.

## 7 TECHNOLOGICAL DEVELOPMENTS

What has had the most impact in recent years is probably Digital Drive Technology. This has replaced the old analogue with digital technology and has allowed us to stretch the performance of motor characteristics without compromising the reliability of the equipment. We are now able to have motors perform over a wide range of peak power, optimizing the drag, hoist and swing motions, resulting in shorter cycle times, translating to higher productivity. New draglines have the digital control technology as standard, but as mentioned, we develop technology with a view to retrofit existing models in the field. Where we have installed these retrofits, productivity improvements in excess of 10% have been regularly recorded.

As can be seen in Figure 1 below, this example shows the drag motion of a 1570 W dragline prior to a digital drive control upgrade. As can be clearly seen, the drag motion is limited to 700 RPM (at the motor shaft). By utilizing a constantly variable digital control technology, this speed limit can be automatically adjusted to increase overall line speed to 1050 RPM or 150% of 700 RPM (see Figure 2) and keep within the motor commutation limits. Obviously this means a performance increase, and it can be obtained in all dragline motions.

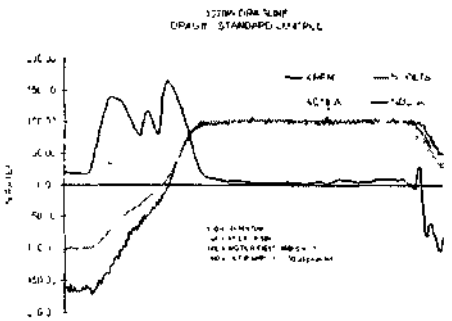


Figure 1 Drag motion of a 1570 W dragline

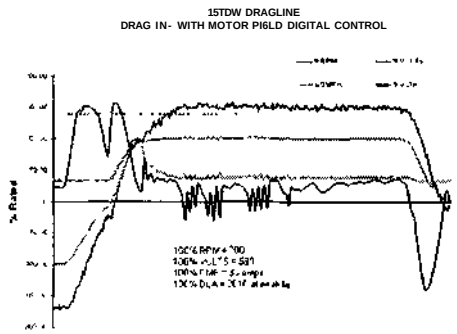



Figure 2 1570 W Dragline with a constantly digital control

There are other technology advancements through the addition of PLC (Programmable Logic Controllers) that are also becoming very popular with dragline owners, they include:

- Boom profiling (anti lightline)
- Propel shoe synchronization

Boom Profiling - this feature simply monitors the position of the bucket relative to the boom based upon the amount of hoist and drag rope paid out and limits operator joystick reference when the bucket approaches the boom. The operator control is limited based upon the speed that the bucket is approaching the boom as well. This simple innovation saves through technology saves many hours of lost production and repairs should the bucket come into contact and inevitably damage the boom structure.

Propel Shoe Synchronization - this feature saves much potential walking structure damage. The theory of operation has propel shoe synchronization monitoring the position of both walk shoes via positional input devices that are connected to a PLC. The PLC watches for discrepancies during the rotation of each shoe. Should a mismatch in the position of any shoe relative to the position of the other occur, then the PLC send a reference signal to the drive control to either speed it up or slow it down until both shoes are synchronized. Simple, but very effective, and no doubt a great maintenance enhancement.

## 8 PLANNING AND SCHEDULING PACKAGES

There are companies that have made significant investment in developing packages for use in dragline operations, cut diagram generators and scheduling packages enhance the effectiveness of the mine planner. Many more scenarios can be tested "on paper" before making a final decision on a mining technique. The designers of these packages continually improve their offerings to the industry as the available technology allows them to do so. These packages, although they have nothing to do with the design of the dragline, enable the operations to optimize the use of their equipment.

## 9 WHAT'S GOING ON NOW?

We mentioned earlier that the concept of the dragline had really not changed since the "early days". The concept of drag, hoist/swing, dump, lower/swing is still the same. Design technology has enabled us to increase payloads, or change the geometry of the machines, and digital drives have enabled us to speed up that process, but we have been strictly limited by geometrical constraints and the machine and the cycle elements - especially the digging and dumping cycle.

Each dragline has a "digging envelope" in which it operates, and "digging" generally contains the following elements:

- The bucket has been lowered to the point at which you wish to start digging
- Drag the bucket until -
  - it is full, and
  - it is at a stage in the digging envelope that it can be picked up without spilling much of the load as it "nods" on pick up
- Pick up and start swinging

The "'dumping" portion of the cycle is limited geometrically since material can only be dumped at the boom point position of the operating radius. It is possible to dump closer in, but utilizing techniques that are unproductive and inefficient. Draglines have therefore been limited in their ability to choose the dumping position. The result is that much unnecessary time is spent in the dig cycle, and material is generally placed at a point with no alternative option, other than inefficiency.

There has been an alternative to this, a concept that is not necessarily new, but the availability of digital control technology has really given us the ability to implement it - UDS, or Universal Dragline System has arrived!

## 10 UDS (UNIVERSAL DRAGLINE SYSTEM)

What is UDS? - The conventional rigging system of a dragline is represented in the diagram below:

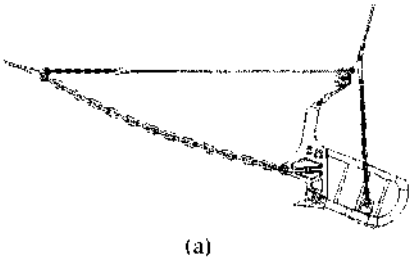
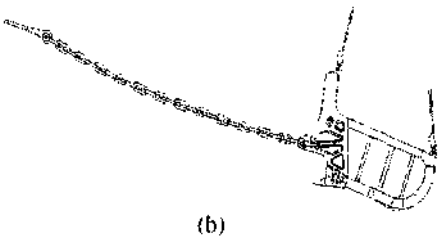



Figure ? Conventional rigging system of a dragline

UDS takes a new approach. The rigging is significantly reduced. Instead of the two hoist ropes attaching to an equalizer - which attaches to the dump block assembly - which in turn is connected via chains to the hoist trunions, the hoist ropes attach directly to the bucket - one on the arch and one at the back of the bucket. The dump block, ropes and chains are eliminated since the hoist ropes operate independent of each other, bucket carry angles can therefore be controlled and set by the operator.




Due to the changes in the hoist rope configuration, the boom of the dragline requires modification to have the sheaves one behind the other versus side-by-side, see diagram below.

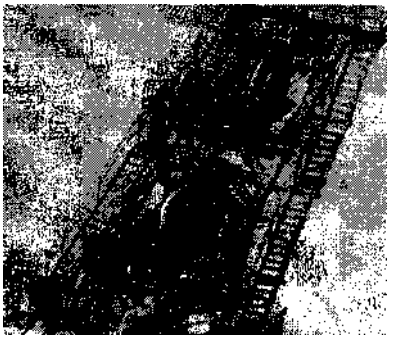


Figure 4 Modified dragline boom to have sheaves one behind the other vs side-by-side

The diagram below gives an indication of the new configuration on a dragline.

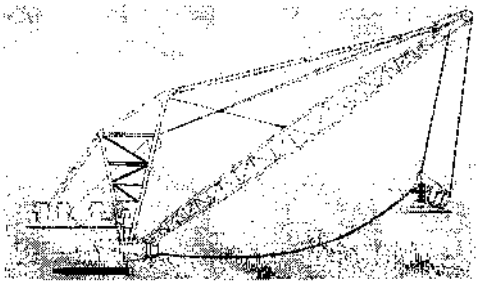
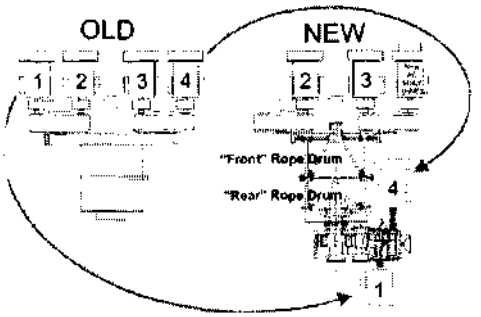
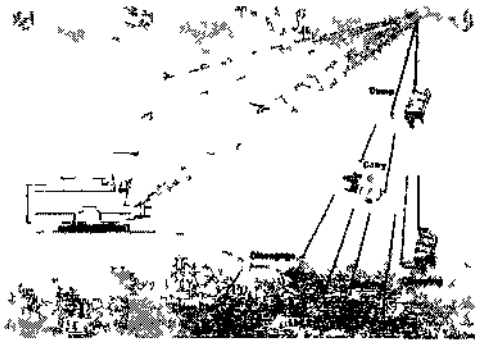


Figure 5 New configuration on a dragline

The controls of the hoist have to be changed in order to go over to the new configuration, in this instance the hoist drum is also split giving the ability to control the ropes independently. There is some deck layout modification required for this.



Since this paper is directed more at the application ot the UDS rather than exactly the setting up or it, we will leave the technical description tor another torum The result ot the above modifications is that the dragline operator is now able to dig and dump in positions that are most convenient



UDS has a number ot benefits

- It ıeduces the number (and therefore mass) of rigging components - the weight savings can be converted to payload
- Reduction in cycle time - less time spent digging
- Absence ot dump block and spreadei bar gives extra dump height - which equates to less rehandle due to lower bench height
- Less down time due to rigging maintenance - especially dump ıope change out
- Bucket can be picked up from digging mode as soon as it is full
- Dumping can take place up to 40m inside of boom point - without use of "special" techniques - much quicker and more efficient pad prepaıatıon and bridge building
- Faster hoisting speeds due to improved geometry - due to the hoist controlling the angle ot cany, the use ot drag in no longei required to keep bucket at carry angle
- Cany angle can be automated by use ot PLC

The bottom line is that trom the results ot the pilot pioject and field installation, production benefits ot well in excess ot 20% seem to be attainable It is perhaps a little early to fully justify the benefits, but numbers ot this magnitude justily a little more attention, and we will be seeing moie measuiable benefits in the not too distant future

## 11 TRAINING

All ot the productivity improvement tools carry a price, but there is one tool that has not been mentioned thus far, which also carnes a puce but which really has an influence ovei the effectiveness ot any ot the other tools - TRAINING - of opeiators as well as maintenance crew This is an element that has historically been the most neglected by many operations around the globe, but really has the most impact Training is not an event - it is a process, and we should be striving to ensuie that bad habits do not creep into opeıatıons These habits impact not only productivity, but also more importantly - SAFETY'

One of the moie recent developments in the training field is that ot "virtual reality training Here the opeiator is been put behind the controls ot a shovel or behind the wheel of a truck and exposed to just about every possible scenario they could encountei in the field - WITHOUT LEAVING THE TRAINING FACILITY' At this stage, true to the trend outlined eaılıer about shovels and trucks getting the high profile, this has indeed happened Diaglines are definitely on the radar screen foi these companies and the Industry should see something soon

## 12 CONCLUSION

So, are draglines "Dinosaurs ot the Industry"' My contention is that their size may cause them to be viewed as such, but that's where the analogy should end Much has been invested in productivity improvement tools and it's really up to us to capitalize on them and put them to use

## ACKNOWLEDGEMENTS

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