

EFFICIENCY VERSUS FLEXIBILITY
***Port Facility Investment in a Time of
Turbulence in Trade Patterns***

The Wolfson Centre

For Bulk Solids Handling Technology



- ***One of the world's leading centres of excellence in Bulk Materials Handling***

- Providing education for practicing engineers in the field
 - Especially short courses

Who are we?

- Providing technical consultancy on Bulk Handling projects, and troubleshooting services, for 50 years
- Supported by leading edge research
 - Highly ranked academically
 - Orientated towards practical application

Handling system design

From the small to
the very large



Uncertainties

Conflicts

- Trade wars
- Real wars

Societal

- Labour shortage
- Skills shortage

Environment

- Carbon reduction
- Coal
- Rising sea levels

Consider new investments in bulk ports

- All the above factors have caused seismic shifts in cargo flows
- Uncertainty is the “new normal”
- The need for
 - Cargo flexibility
 - Robustness against the effects of climate change
 - Whilst lowering emissions
 - And accelerating productivity

Storage and handling facility options

Fixed conveyors and silo farm

- ✓ Low operating labour
- ✓ Low ground space
- ✓ Safety
- ✓ Dust containment
- ✓ Minimum cargo contamination

- × Flexibility
- × High investment
- × Long build time
- × Piling foundations
- × No good for “class 3” materials
- × Fire fighting



Concrete dome

- ✓ Moderate investment
- ✓ Fast build
- ✓ Low operating labour
- ✓ May avoid piling foundations
- ✓ May be repurposable as flat store

- ✗ Flexibility
- ✗ Segregation between cargo batches
- ✗ Explosion and fire protection
- ✗ No good for “class 3” materials
- ✗ Fire fighting



- ✓ Low operating labour
- ✓ Moderate cost
- ✓ Flexibility
- ✓ No piling

Flat store – automated
May be covered or uncovered

- ✗ Large ground area
- ✗ Dust emission

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Flat store & mobile plant

May be covered or uncovered

- ✓ Low investment
- ✓ Fast build
- ✓ Flexibility
- ✓ No piling
- ✓ Can handle “class 3” materials
- ✓ Fire management

- ✗ Large ground area
- ✗ Labour intensive
- ✗ High maintenance
- ✗ Dust and safety
- ✗ Fire likelihood
- ✗ High emissions
- ✗ Effect on cargo quality
- ✗ Contamination
- ✗ Degradation



Mobile plant:

Shed, payloader, dumpers

- Flexibility for cargo type
- Low CapEx
- High OpEx
- Poor safety
- High emissions

Fixed installation:

Silos, conveyors

- Inflexible to cargo type
- High CapEx
- Low OpEx
- High safety
- Low emissions

Can we blend the advantages of mobile plant, with the advantages of fixed installations?

Considering the options: Where are the major costs?

Flat stores

- The most labour intensive part is building the pile
- Drives the high OpEx

Automated stores (silos, stacker-reclaimers)

- The most capital intensive part is the reclaim system
- Drives the high CapEx

Pile building in flat store

The worst part of flat store operations:

- Consumes much labour, time and fuel
- High exposure of operators to dust



AC Shropshire



Ceres Machinery

Hybrid: flat store with belt transport and bridge stacker

- Fairly flexible regarding commodities
 - As long as it will go on belt and chain conveyors
- Automated stacking
- Labour intensive for discharge by mobile plant

Hybrid: Flat store with tripper conveyor and underground reclaim



~60% automated reclaim

Pushing across floor for final clean-up





Choosing between storage facility options

- Capital cost
- Customer needs
 - Protection of cargo quality
 - Speed of build
 - Need for batch segregation
- Material handling properties
 - Class 1, 2 or 3?
- Safety and environment
 - Dust emission
 - Fire fighting
- Space available
- Ground conditions
- Operating cost
- “Total cost of ownership”
- **Long term future of cargo flow**
 - Investment horizon
 - **Need for cargo flexibility**



Facing up to climate change

- Sea-level rise
 - Increase in mean high water
 - Up to 1m in next century
- More severe storms
 - Increase in severe storm surges
- Uncertainty
 - How much water level rise to plan for?
 - Many predictions based on 1.5C rise – but we've missed that boat!
- Consequences
 - Higher likelihood of flooding
 - Potentially higher costs of protection against damage

Resilience of handling and storage systems against flood

- Shed and mobile plant



- Inevitable cargo damage
- Equipment easily moved when flood warning in place
- Wet cargo easily moved for disposal
- Quick recovery afterwards, little cost
- Floor level could be raised easily for protection

Resilience of handling and storage systems against flood

- Overhead stacking equipment



- Again minimal damage, quick recovery
- As long as electrics and control equipment mounted at high level
- Make sure you do this for new installations

Resilience of handling and storage systems against flood

- Ground level or underground reclaim equipment



- Once filled with water, recovery will be very long and expensive
- Protection will be expensive
 - Demolition and rebuilding at higher level
- Any new facilities must be built on elevated ground
 - Small cost increase now, insuring against much greater costs in future



Other developments that should affect your thinking

- Vehicle electrification
 - Autonomous vehicles
-
- Both are happening now
 - The future will see much more of them

Vehicle electrification

- Reducing carbon emission
- Reduces fire risk

Battery



Tethered

Self-driving vehicles

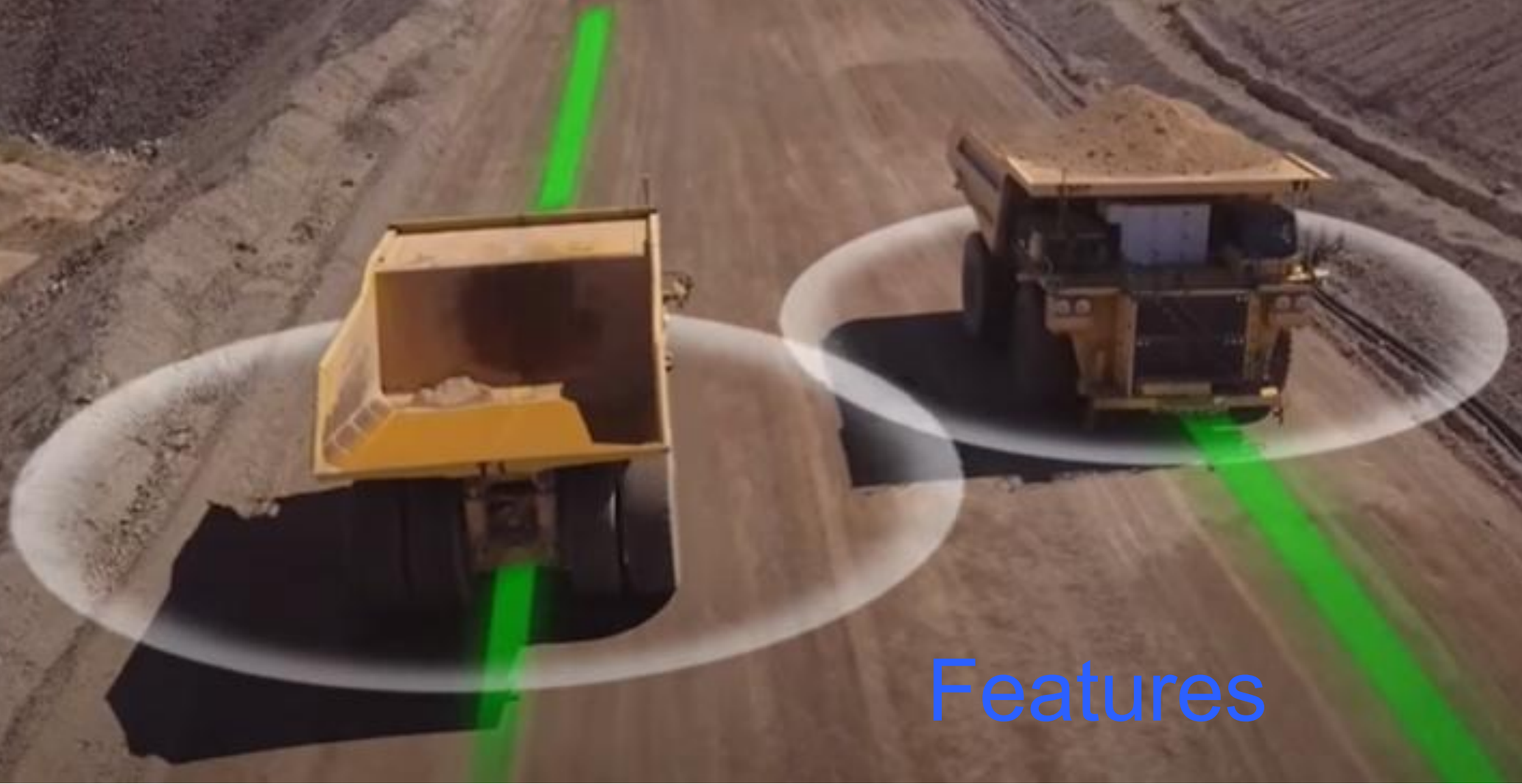
- Mobile plant transport has high flexibility
- But has high maintenance, high labour costs, high accident rates, high maintenance, exposure of operators to dust and hazards
- Mostly it's people that cause the trouble!
- *So if we can take people out of the picture . . .*

Autonomous vehicles on mine sites (oil sands, iron, copper)

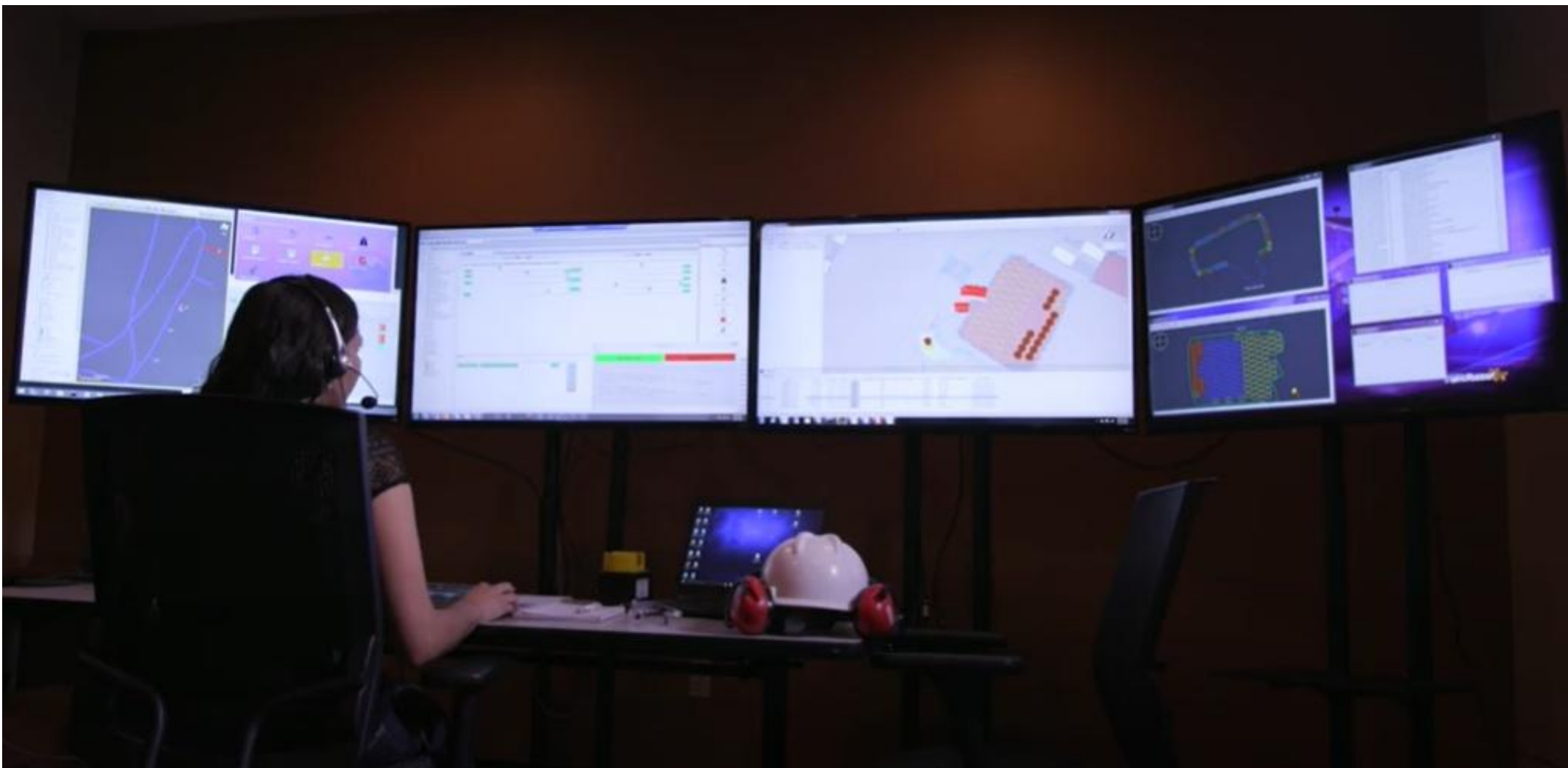


- Self-driving dump trucks
- 10 years experience

- Route programmed by computer
- Location by GPS
- Surround sensing for collision avoidance



Features



Routes programmed from control
room

Manufacturer's claims

- 15% productivity increase
- 13% reduction in maintenance
- 40% improvement in tyre life
- 0 “incidents” in 10 years of operation
- In addition to labour cost savings

Current State of the Art

- Good success with dump trucks on reasonably spacious sites
- Fleet operated by computer
- Vehicles are not collaborative
- Loading shovels still operated manually

A strong future for AVs at bulk terminals

- Closed sites – many fewer hazards than on public road
- Major potential for reducing accidents, collisions, operator exposure to hazards
- Confined sites and routes in bulk terminals facilitate greater safety gains
 - (AVs widely used in factories for component transport)
- Move to electric power will reduce carbon emissions

But:

- Still the compromise of cargo quality that comes with mobile plant ops
- Still particulate emissions from wheel-road interface
- ***How to manage collaboration with payloader operation – currently still manual***
- Especially as stockpile changes shape
- Still research to be done
- Significant potential for payback
- Its time will come, within the time horizon of a new facility investment

CEMENT AND ITS SUBSTITUTES

Cement (“Cem 1” or “OPC” – ordinary Portland cement)

- Cement produces high carbon emissions
- Europe uses a lot of it
- EU producers have to pay carbon penalties
 - Or will have to invest to decarbonise
- Importers do not
- Importation favoured currently
- Will this trend endure?

Secondary cementitious materials ("SCMs")

- Additives that replace Cem 1 in concrete, with lower emission footprint
 - Fly ash
 - Blast furnace slag
- Needed in Europe
- But both face low indigenous production
- Currently favours importation
- Will this trend endure long term?

Needs of cement and SCMs

- Specialist conveying systems – pneumatic pipelines
 - Not flexible for other cargoes
- Quality maintenance and efficiency require silo storage
- Sheds can be used but
 - Reclaim is messy and expensive
 - Sheds need to be VERY thoroughly sealed against air leakage and water ingress
- A well designed cement shed can be repurposed for other cargoes
- A general purpose cargo shed cannot be repurposed for cement

Which way is the wind blowing?

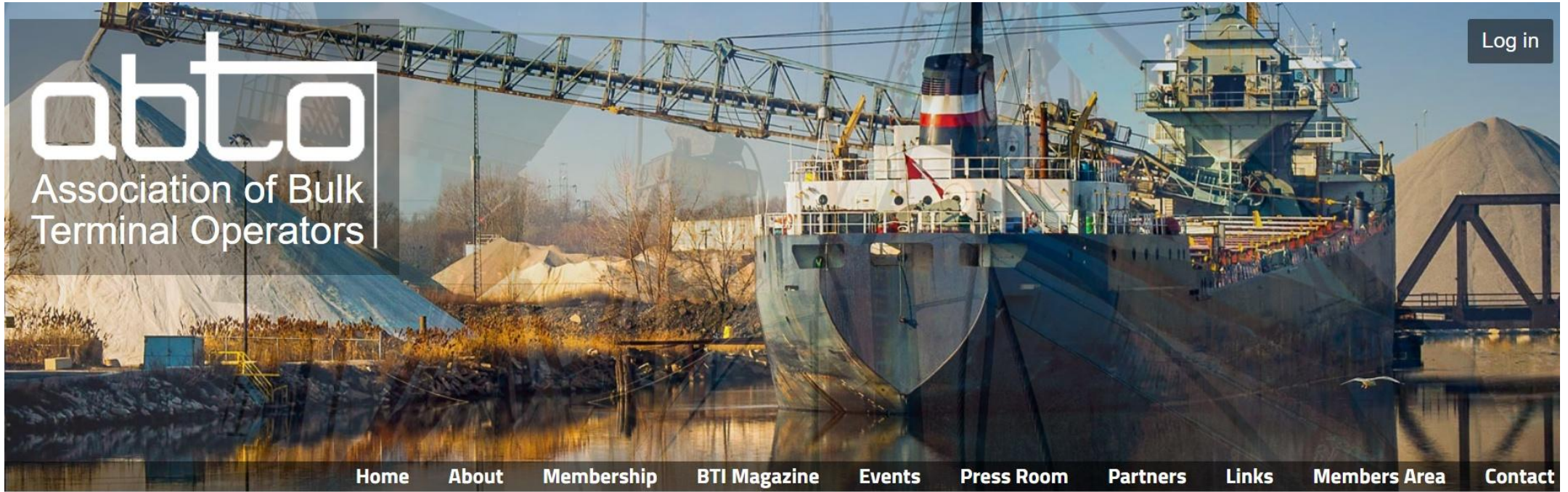
- There will always be a place for fixed installations and silos
 - Efficiency, safety, product quality, low emissions, low OpEx
 - Provided the long term future of the flow is assured
 - Eg grain handling at port-based flour mills
- Where there is less certainty of the future, my bets would be increasingly swayed towards mobile plant
 - Some of the disadvantages are being overcome
 - Except for cargoes with special needs (cement, SCMs)
- Resilience against climate change effects is increasingly important
- Hybrid systems may appear increasingly favourable
 - Sheds with continuous loading but mobile plant reclaim

Return On Investment

R.O.I.

Income a plant generates — *Total cost of owning the plant*

- A new solids handling system will probably last you 30 years
- Over what timespan should ROI be calculated?
- Often 7 years is used for new plants
- For plant improvements, usually 2 or 3 years
- *Chosen timespan depends on many factors*



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