Some insights from long, heavy, freight trains

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European Rail Research Institute/Spoornet Interactive Seminar

Farm Inn, Pretoria

6-7 September 1999

Structure of this presentation

1 A selected South African heavy haul chronology

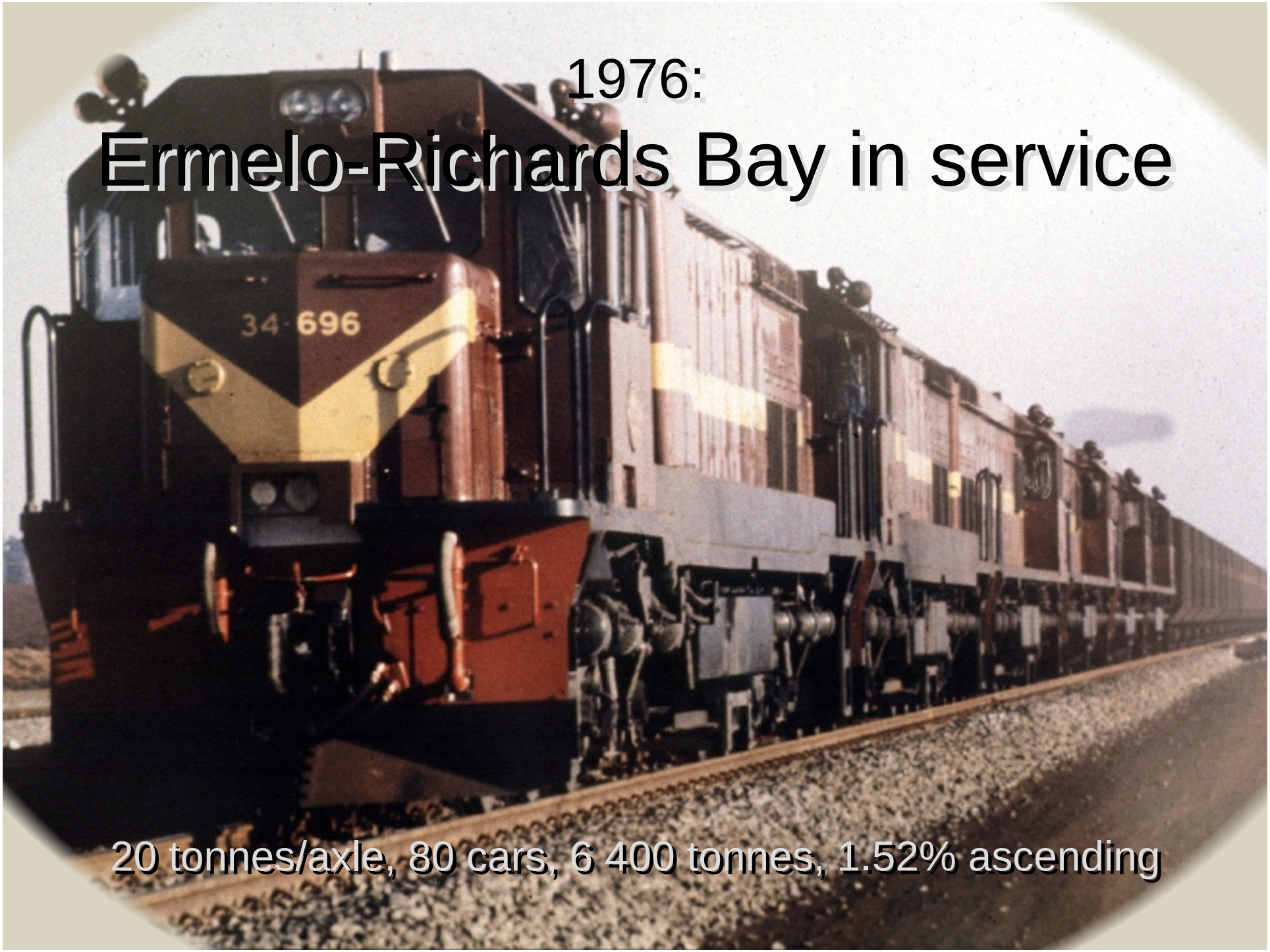
2 A worldview on transport modes

3 Some insights from long, heavy, freight trains

4 Potential for alignment and cooperation

A selected South African heavy haul chronology

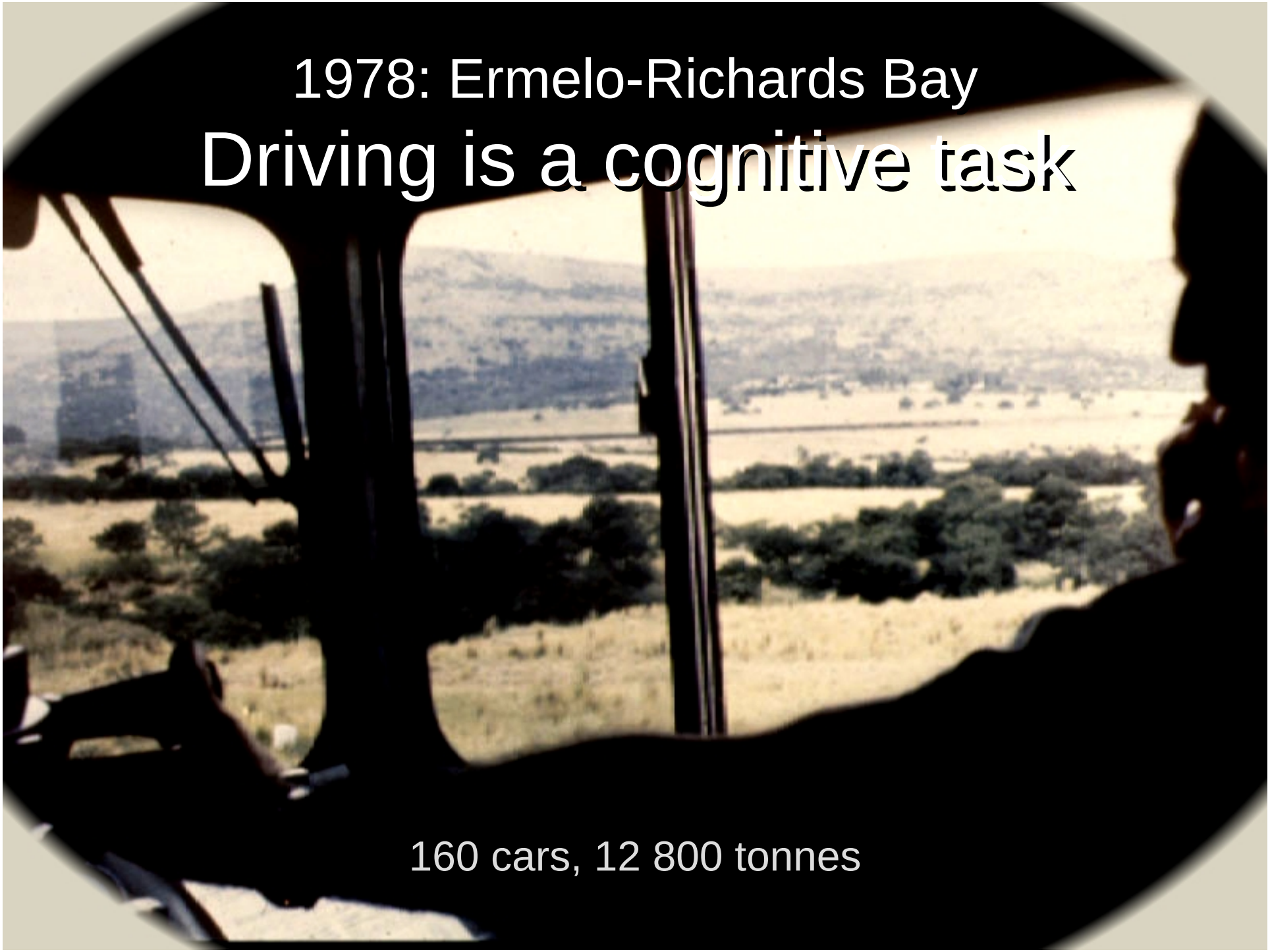
1976:
Sishen-Saldanha in service

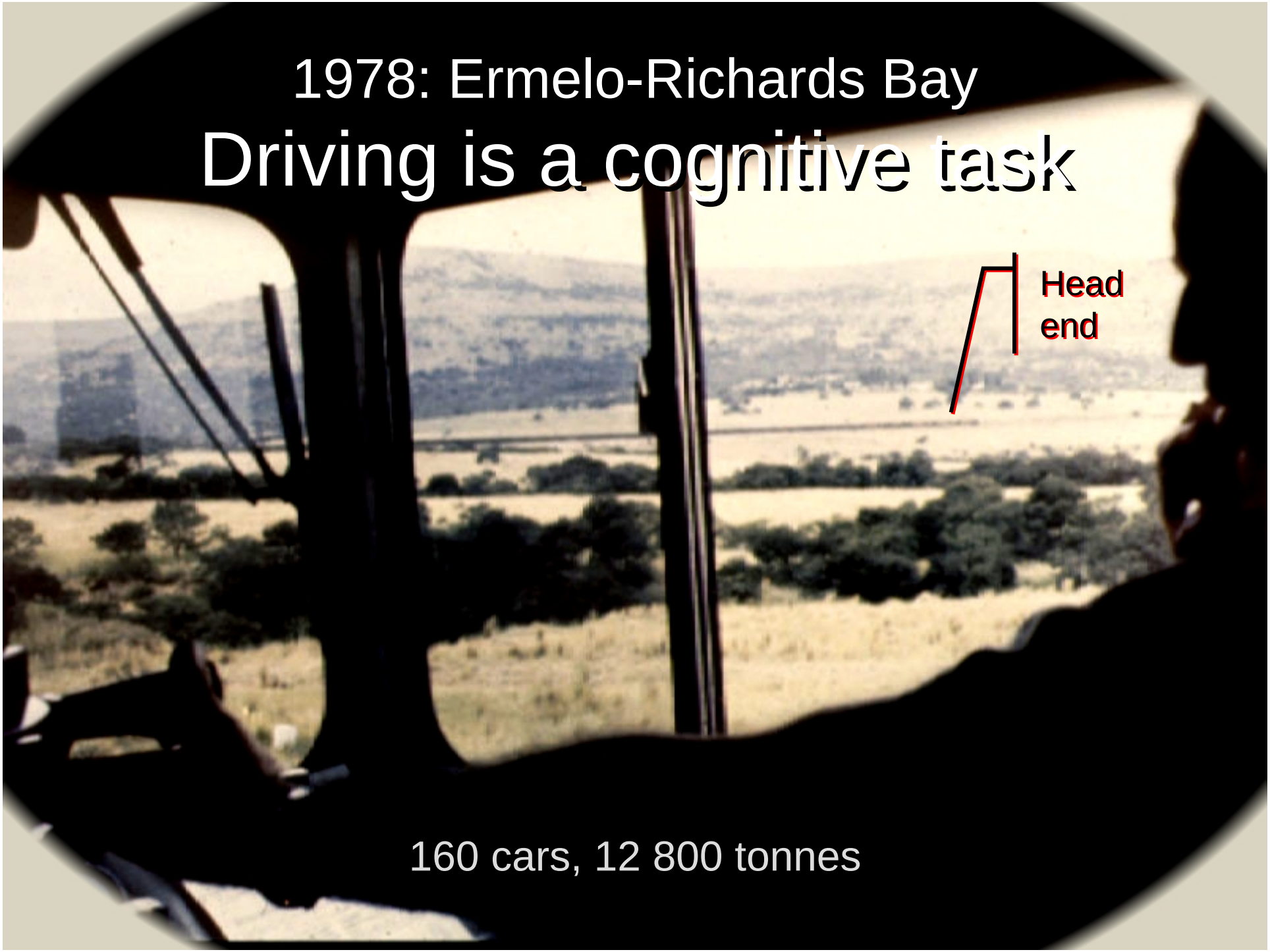


1976:
Ermelo-Richards Bay in service

20 tonnes/axle, 80 cars, 6 400 tonnes, 1.52% ascending


Location of lines
Sishen-Saldanha
Ermelo-Richards Bay


1978: Ermelo-Richards Bay
Driving is a cognitive task
160 cars, 12 800 tonnes


1978: Ermelo-Richards Bay
Driving is a cognitive task
Head end
160 cars, 12 800 tonnes

1985-9: Ermelo-Richards Bay

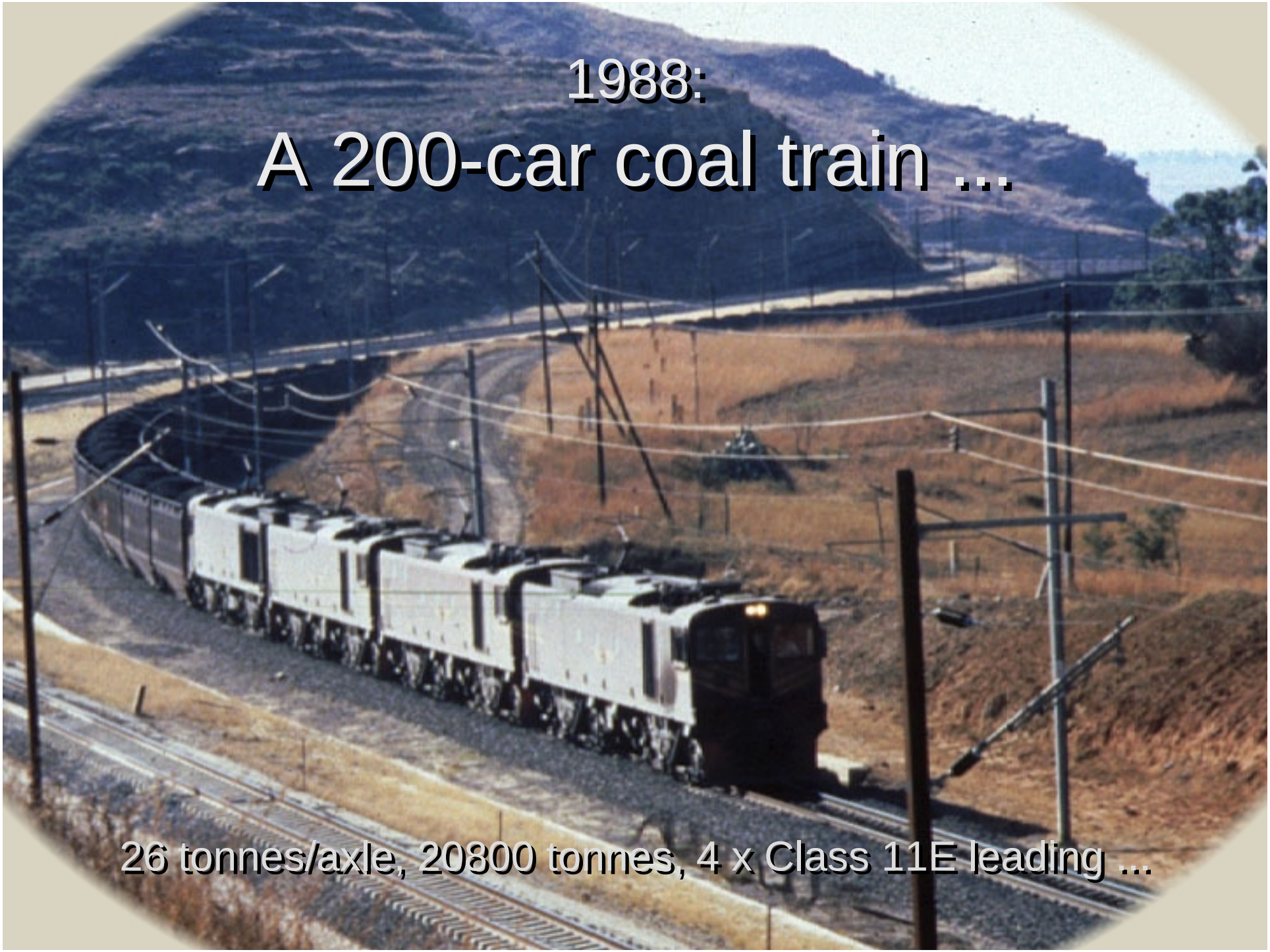
Axle load increased to 26 tonnes ...

New CCL^{-5} cars, compared to old CCL^{-3} cars

1985-9: Ermelo-Richards Bay

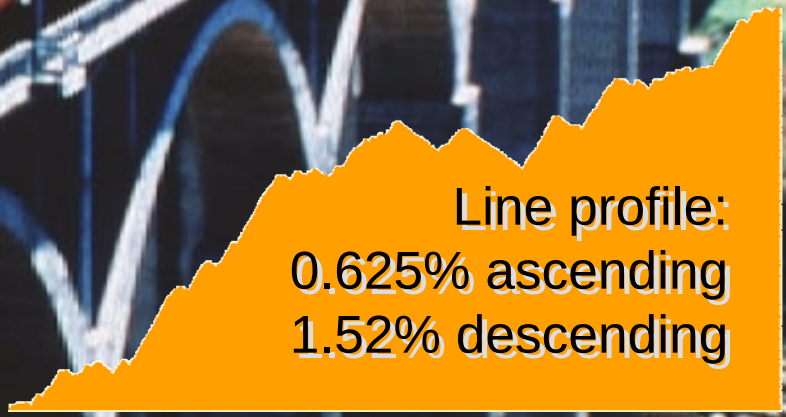
… ascending grades eased to 0.63%

New CCL^{-5} cars, compared to old CCL^{-3} cars


1988:
A 200-car coal train ...
26 tonnes/axle, 20800 tonnes, 4 x Class 11E leading ...


… with manned helper locomotives
… 26 tonnes/axle, 20800 tonnes, 6 x Class 34 helping

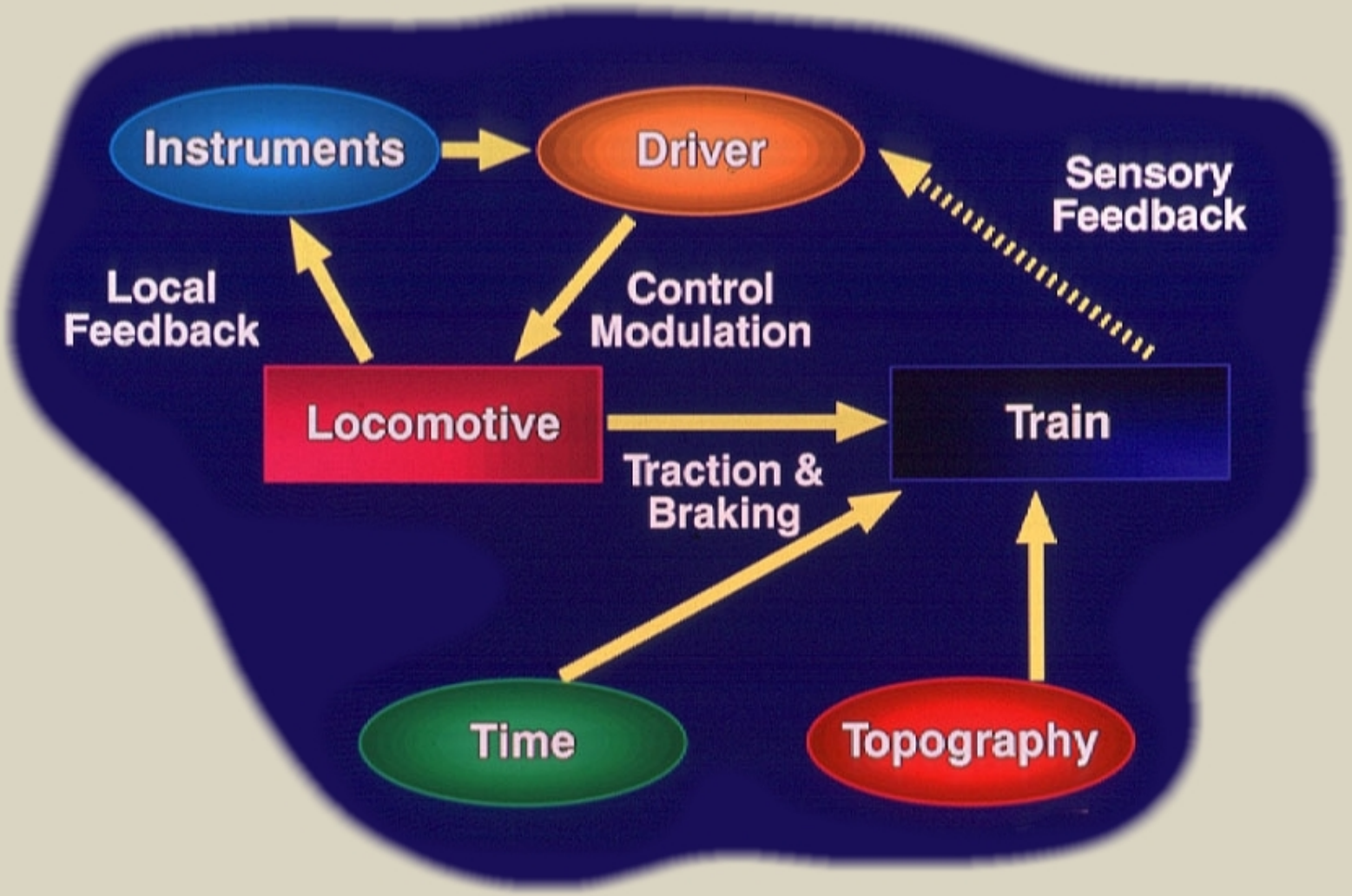
1989:
Ermelo-Richards Bay 200-car trains



26 tonnes/axle, 20800 tonnes, 4 x Class 11E at head-end only

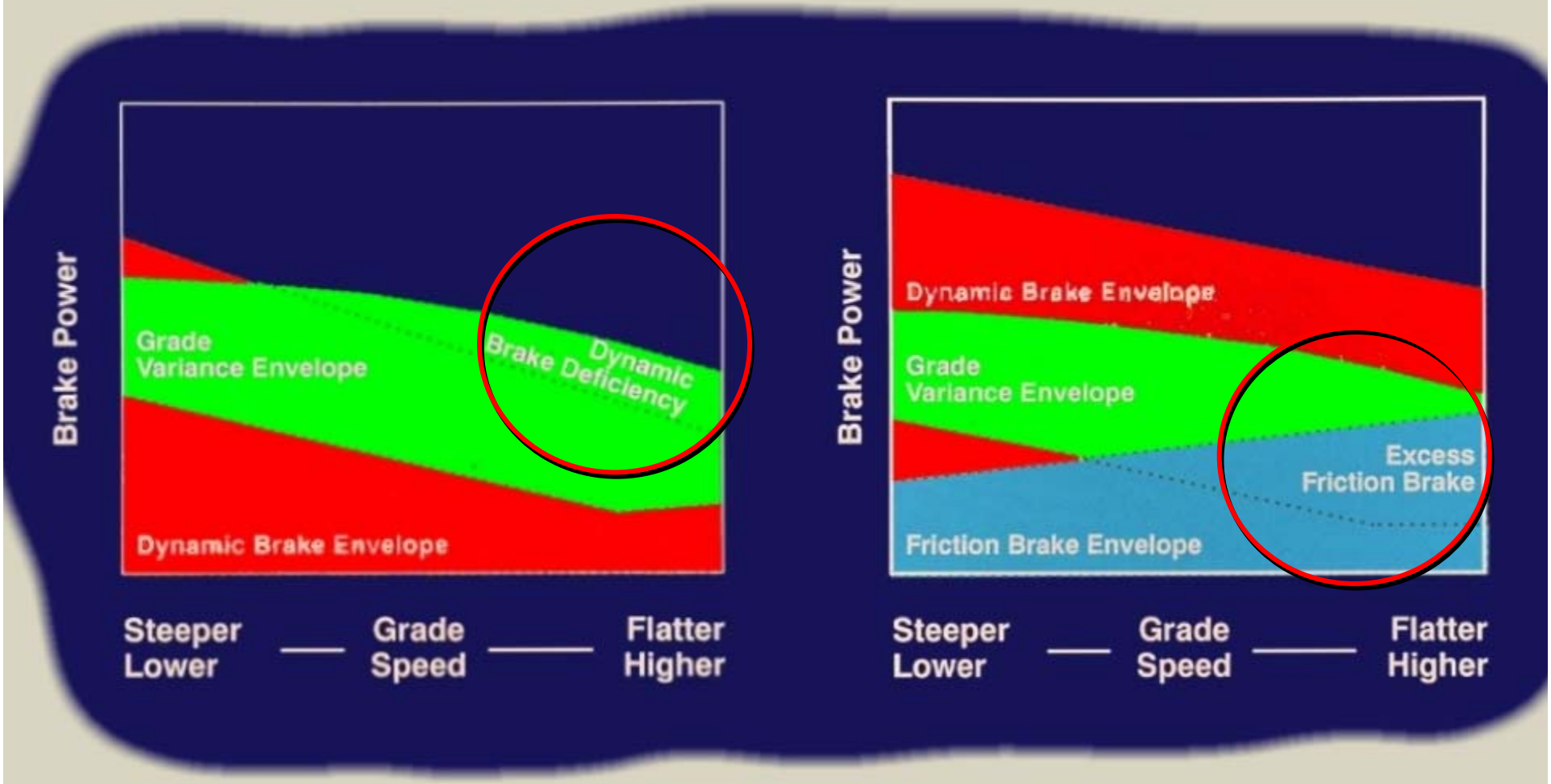
1983-93: Optimized sensory feedback

Systemic relations



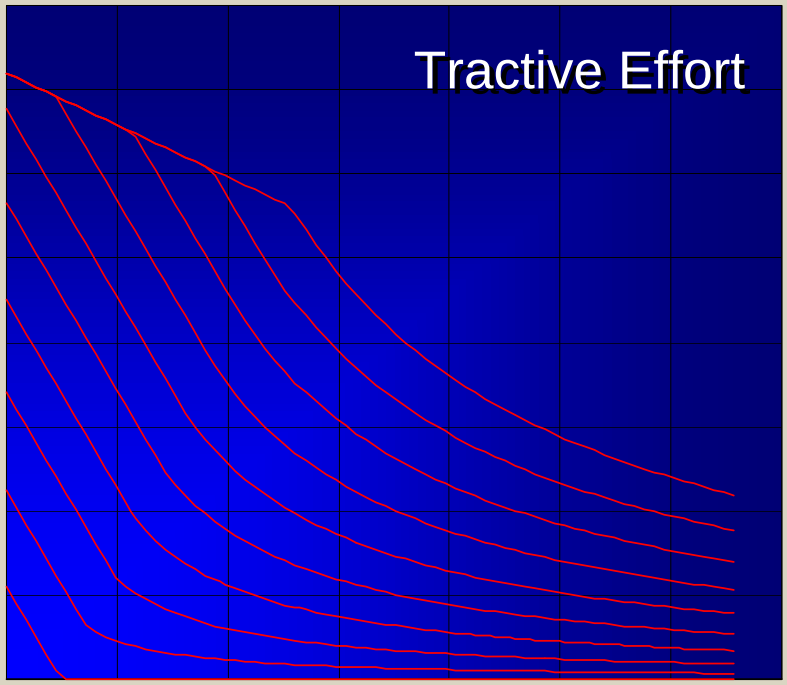
1983-93: Optimized sensory feedback

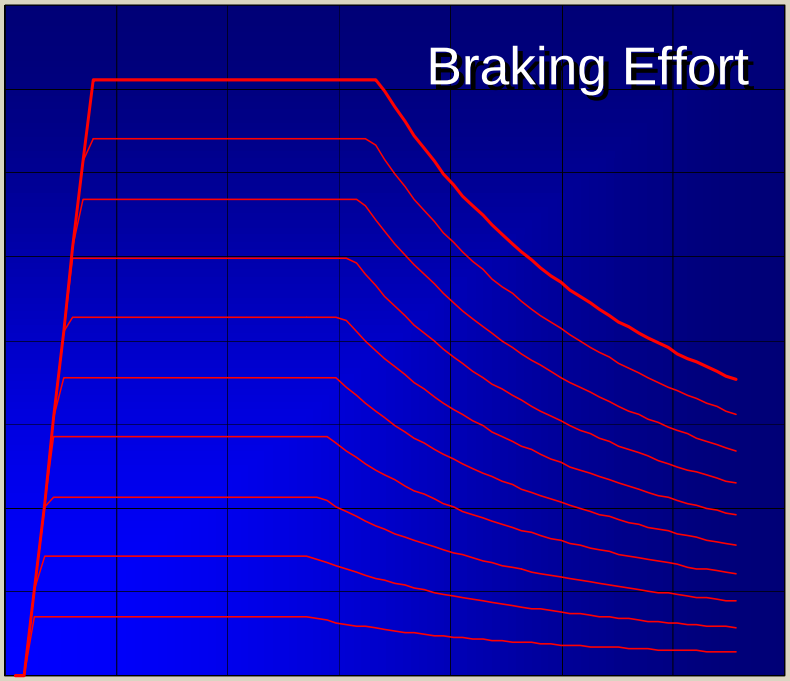
Friction/dynamic braking balance



1983-93: Optimized sensory feedback

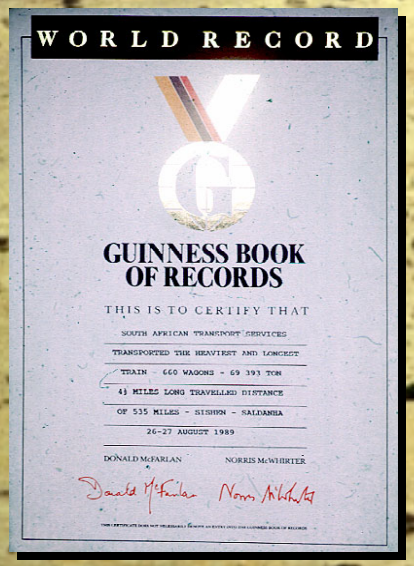
Curves shaped for intuitive feel





< Speed >

1989:
World record freight train

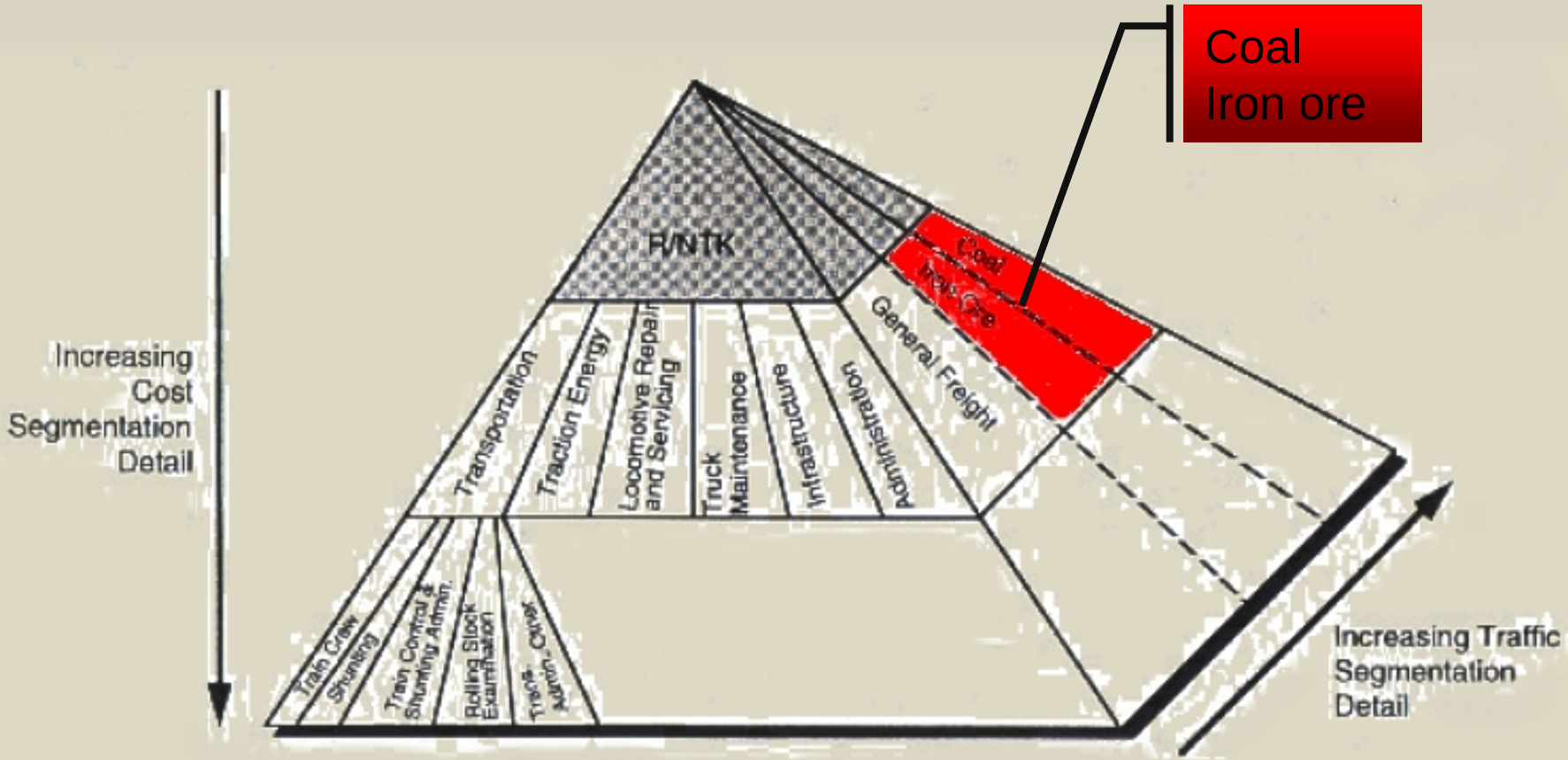


70 000 tonnes, 7300 meters, 660 cars, 861 km


1994:
Full-motion driver training simulator

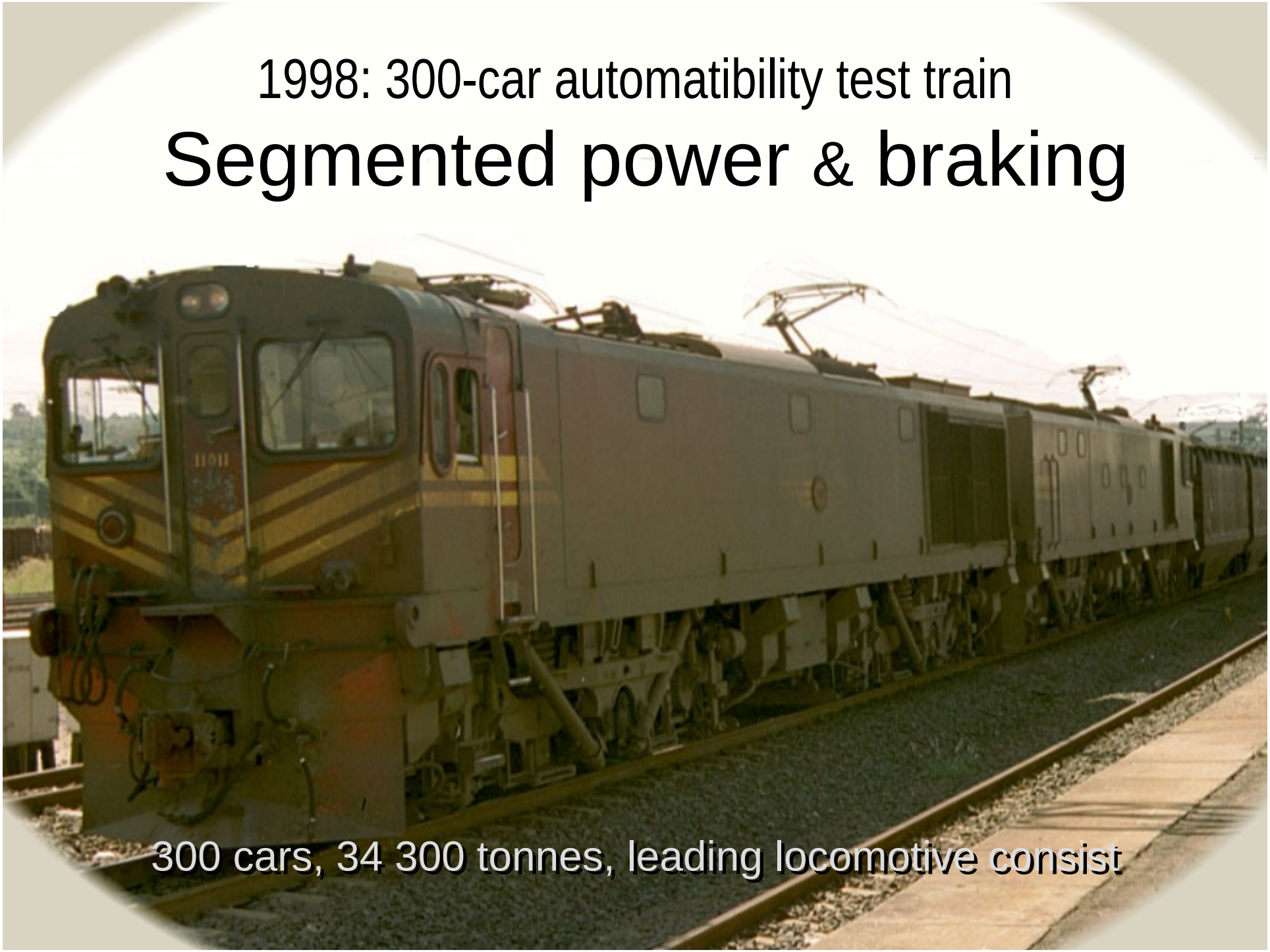
1994: *Mercer Management Consulting* benchmark

Spoornet rated global cost/net tonne-km leader



1998: 300-car automatibility test train

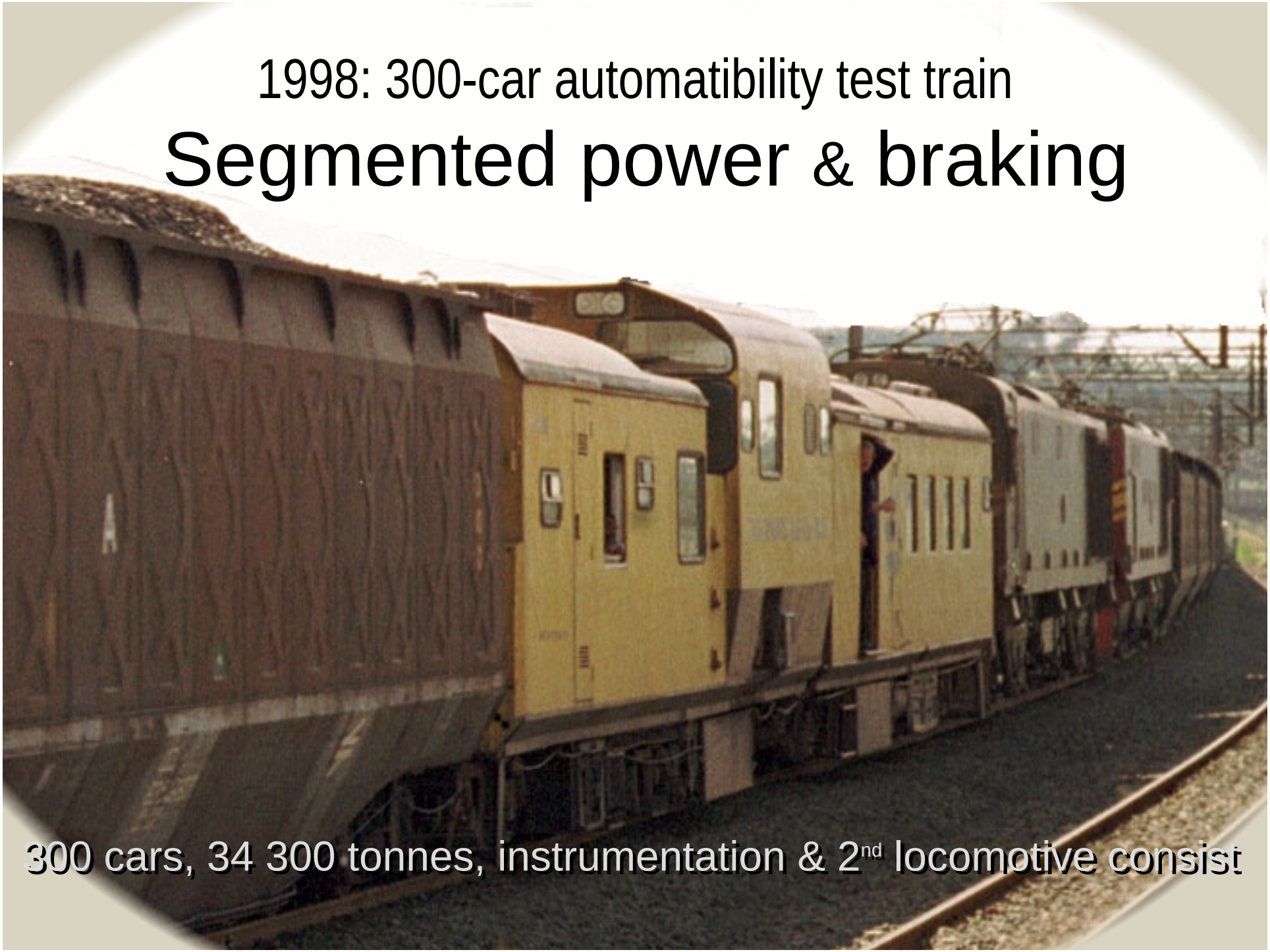
Segmented power & braking



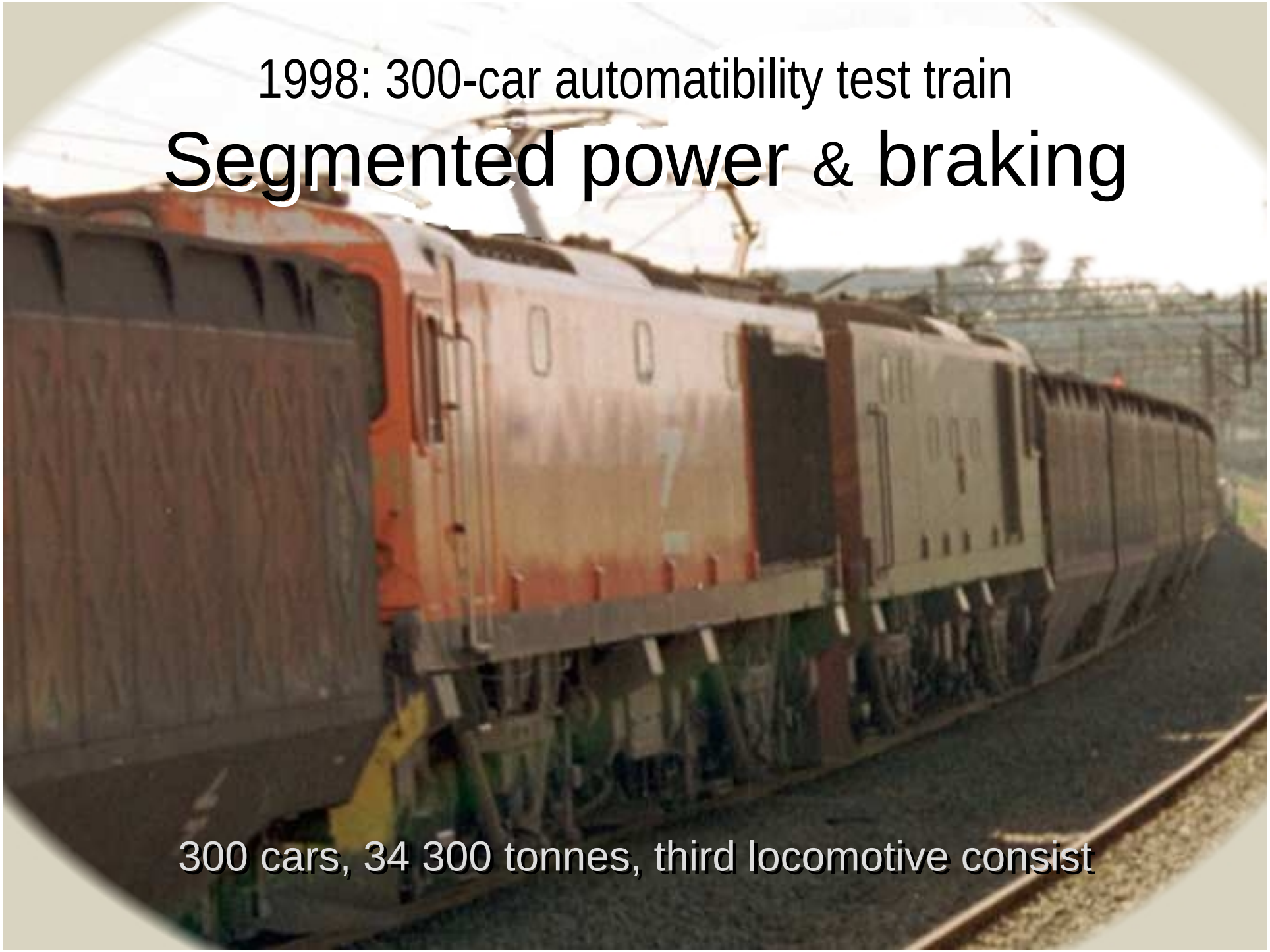
300 cars, 34 300 tonnes, leading locomotive consist

1998: 300-car automatibility test train

Segmented power & braking



300 cars, 34 300 tonnes, instrumentation & 2nd locomotive consist



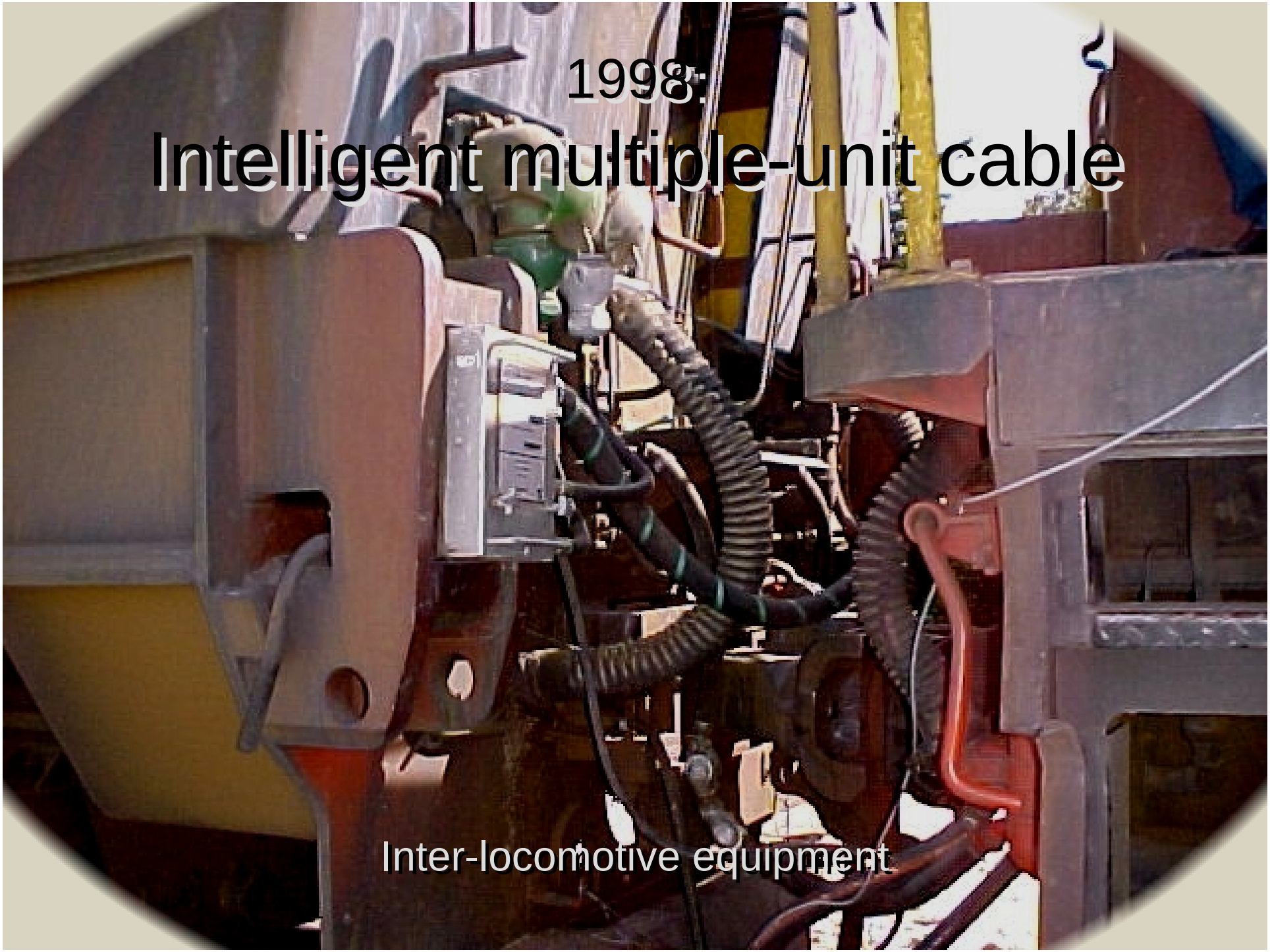
1998: 300-car automatibility test train

Segmented power & braking

300 cars, 34 300 tonnes, third locomotive consist

1998:
Intelligent multiple-unit cable

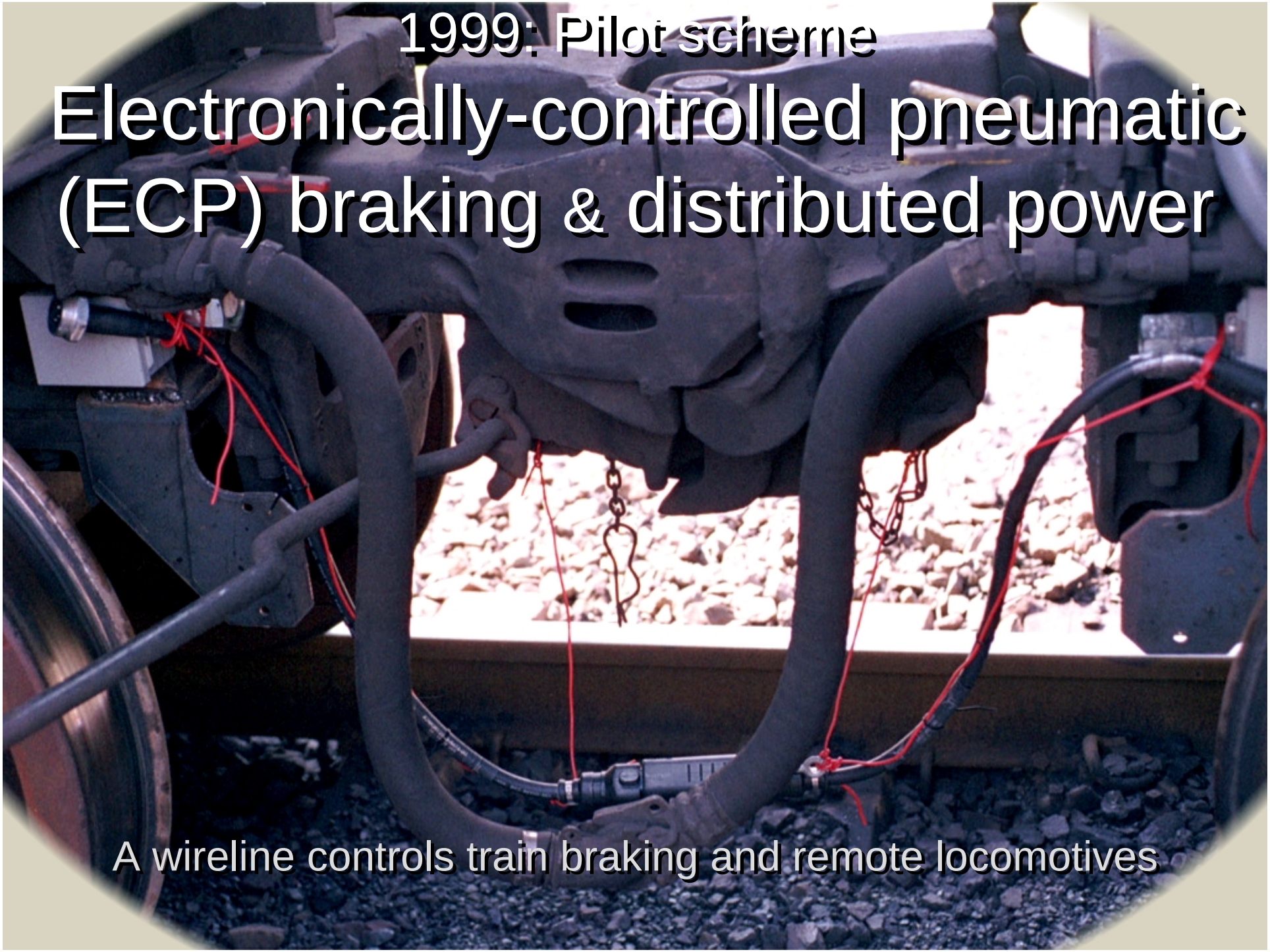
Enhanced flexibility: Electric & diesel locomotives in multiple


1998:
Intelligent multiple-unit cable
Inter-locomotive equipment

1998:

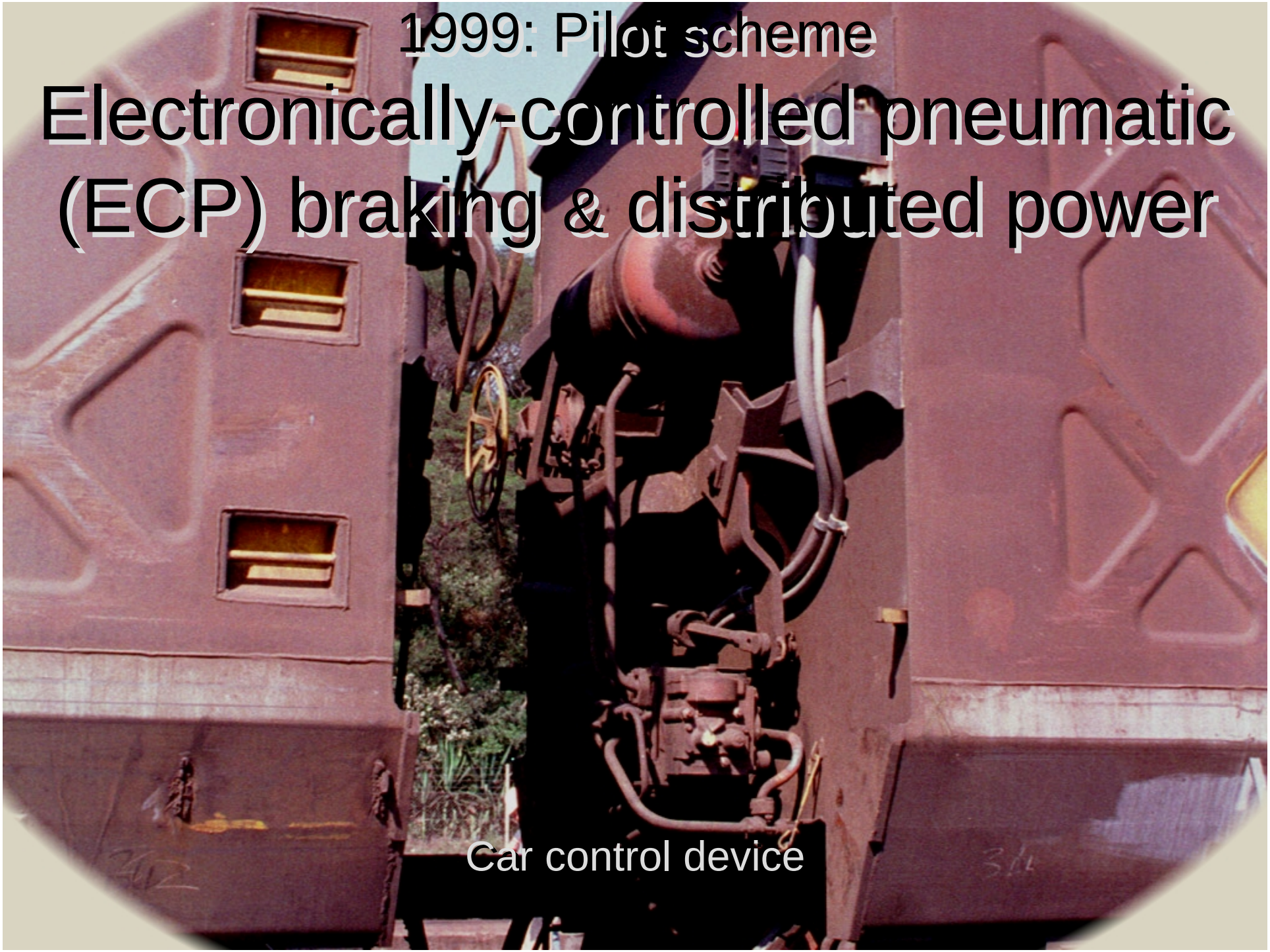
Intelligent multiple-unit cable

Driver's controls


1999: Pilot scheme
Electronically-controlled pneumatic (ECP) braking & distributed power
A wireline controls train braking and remote locomotives

1999: Pilot scheme

Electronically-controlled pneumatic (ECP) braking & distributed power



Car control device

1999: Pilot scheme

Electronically-controlled pneumatic (ECP) braking & distributed power

Overlay electronic equipment

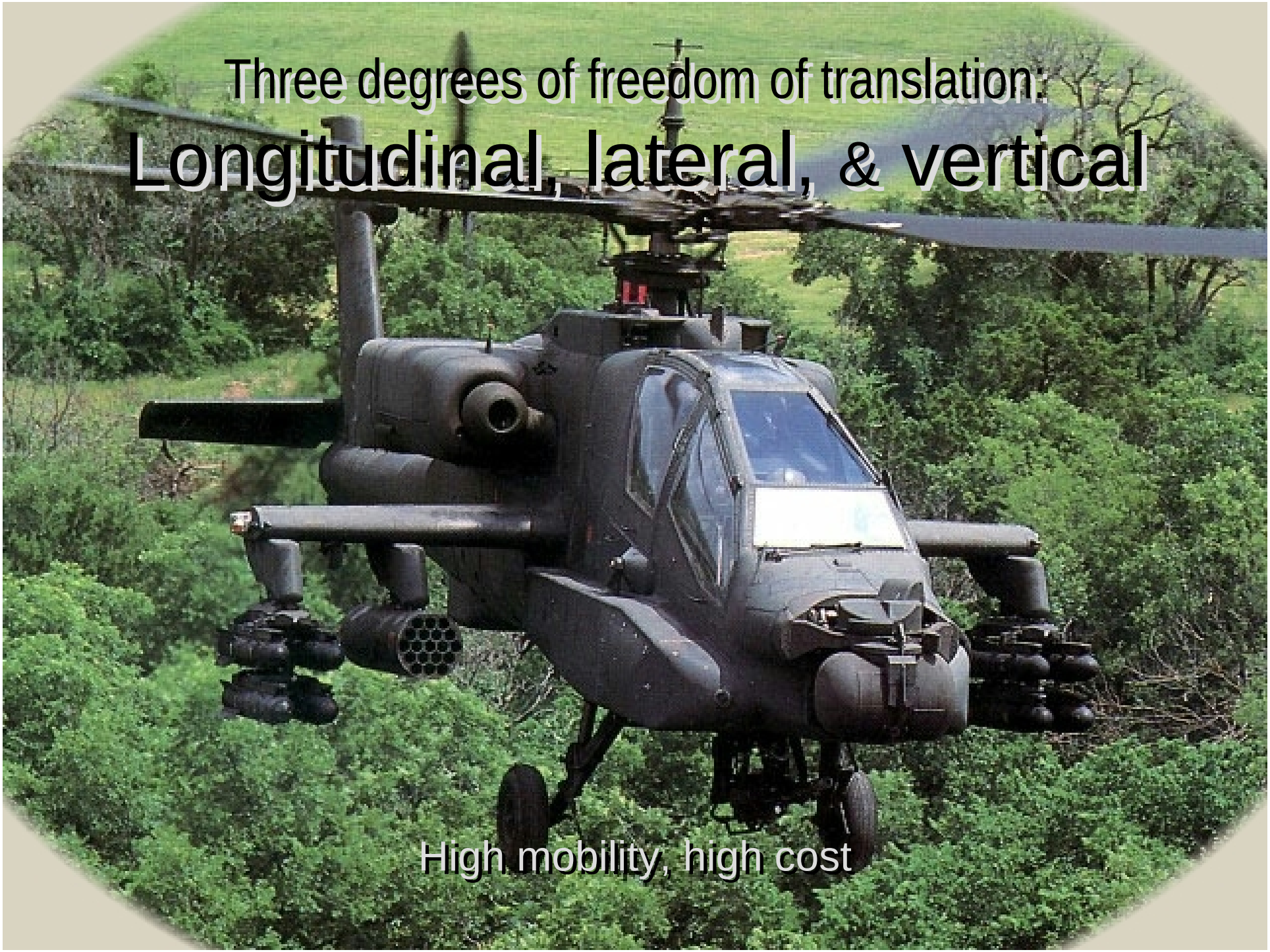
1999:
New 30 tonne/axle car for Orex

Self-steering bogies

Where next?

- Several slides have presented incremental advances in recent years
- One can continue extending limits, but is that all there is?
- Same for high-speed intercity passenger?
- Where can railways find a quantum advance, a competitive breakthrough?

A worldview on transport modes ...


Three degrees of freedom of translation:
Longitudinal, lateral, & vertical
High mobility, high cost


Three degrees of freedom of translation:
Longitudinal, lateral, & vertical
High mobility, high cost

Two degrees of freedom of translation:

Longitudinal & lateral

Less mobility, surface loading is an issue


Single degree of freedom of translation:
Longitudinal only ...


... constrains
origin-destination versatility
Offers precise application of load, plus secure guidance


Single degree of freedom of translation:
Longitudinal only ...


... constrains
origin-destination versatility
Offers precise application of load, plus secure guidance

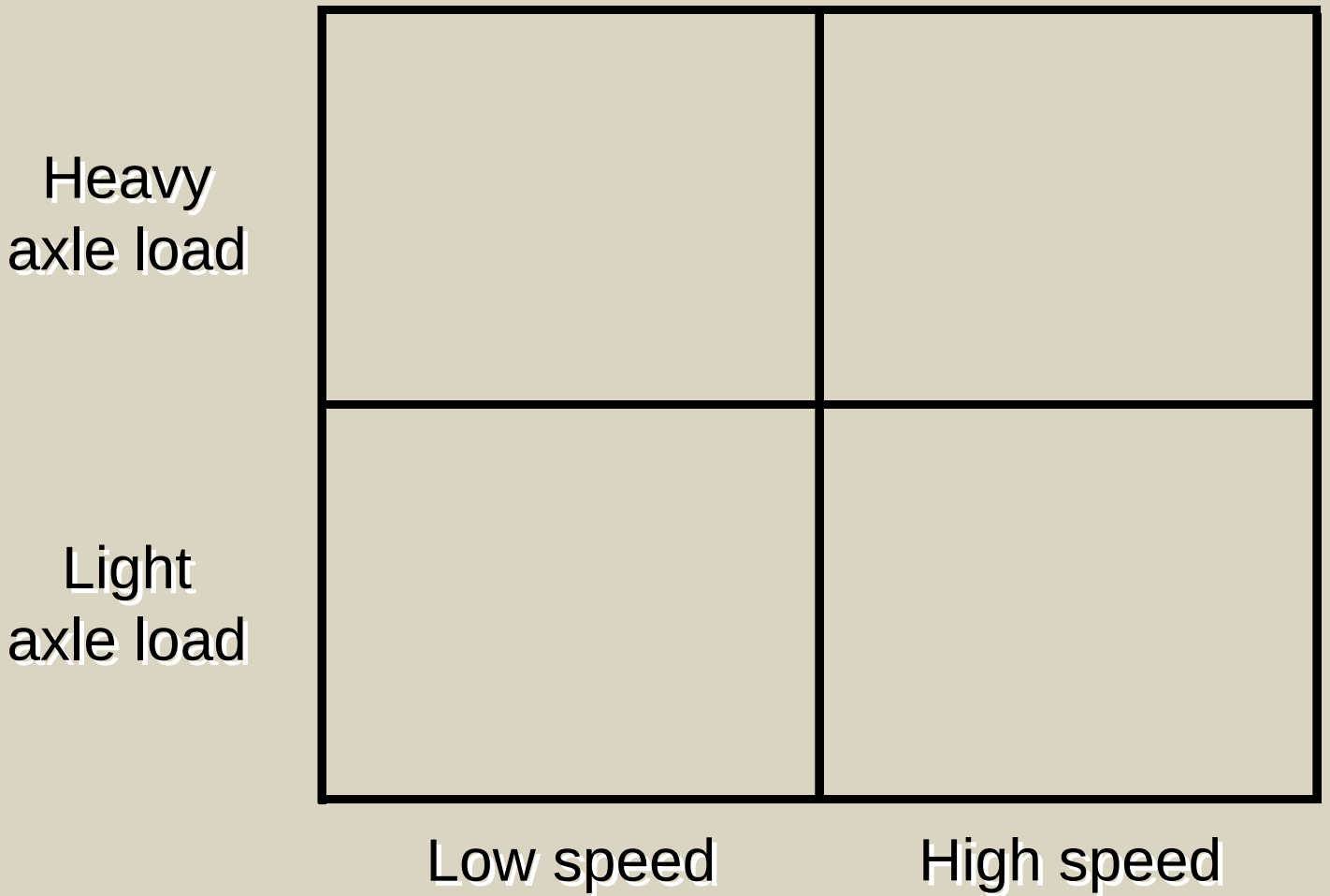
What compensatory trade-offs …

What compensatory trade-offs ...

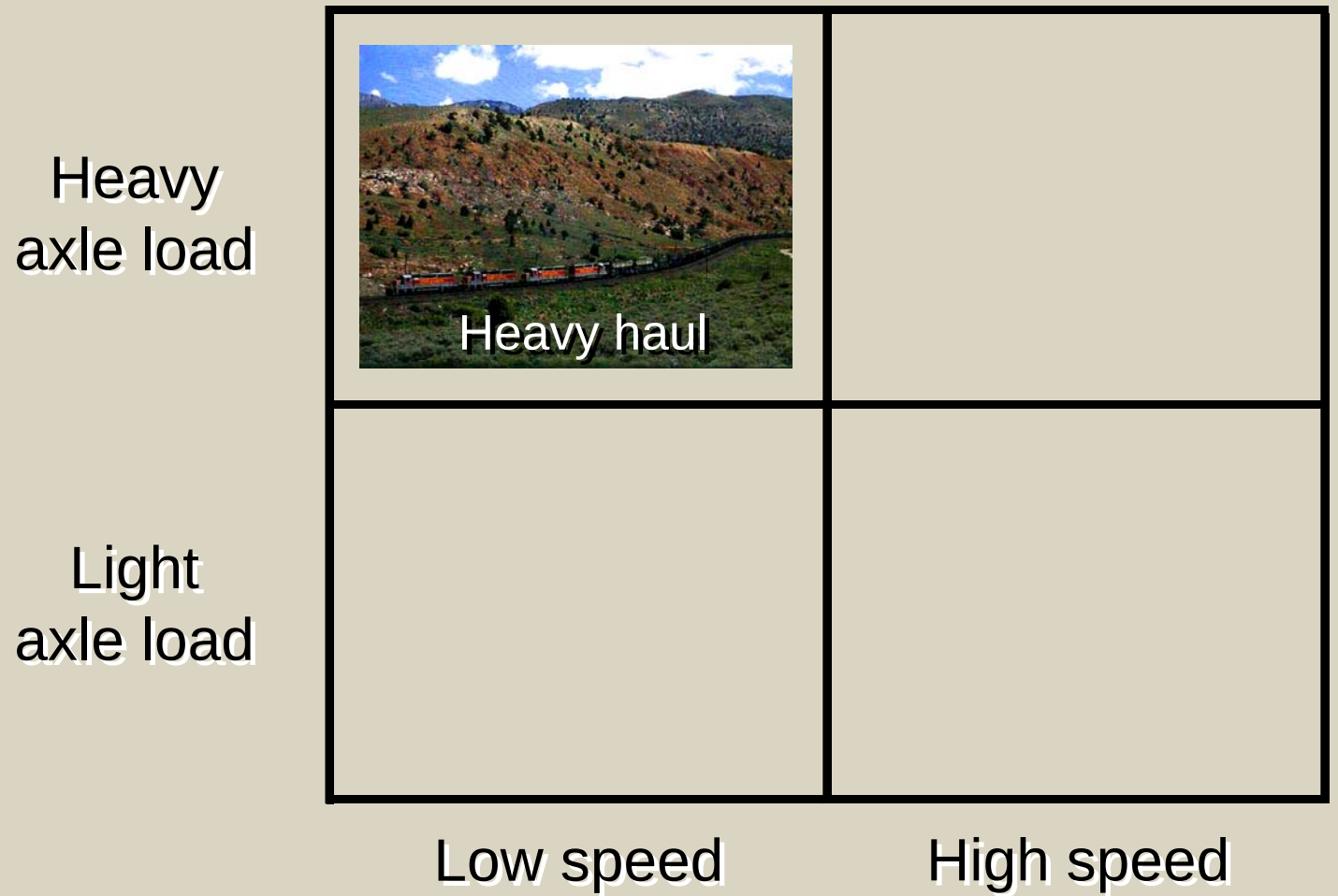
Heavy
axle load

High speed

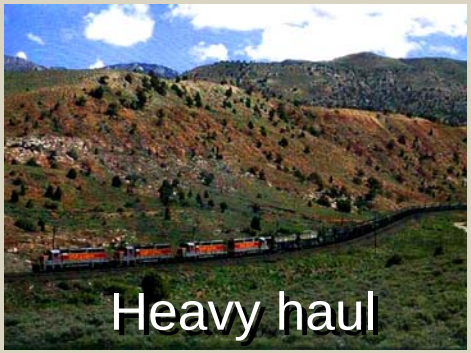
What compensatory trade-offs …



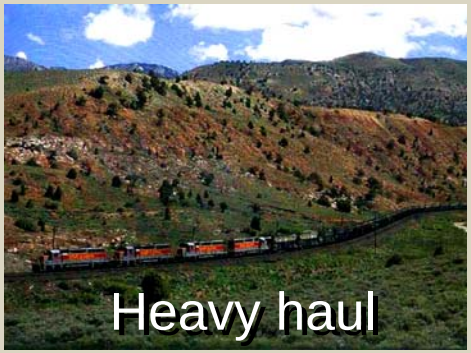
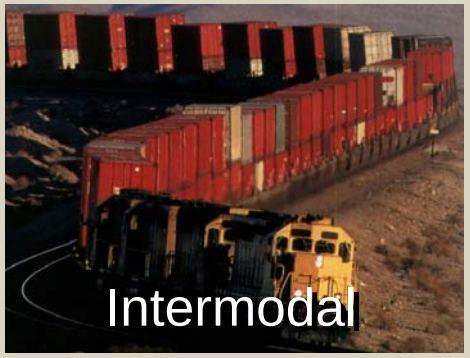
... give competitive advantage ?



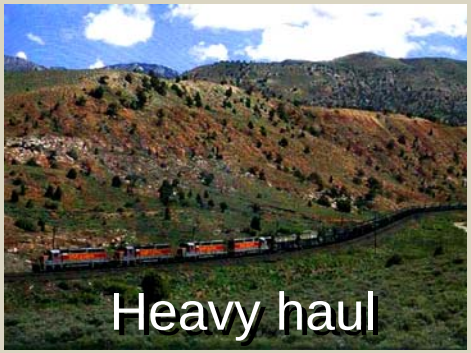
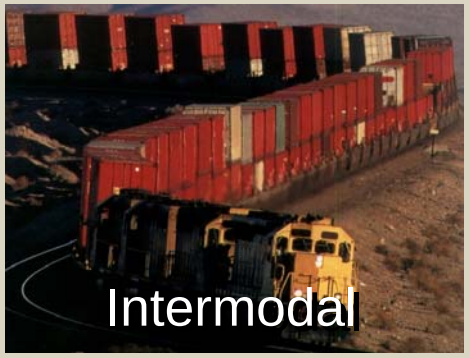
... give competitive advantage ?

	Low speed	High speed
Heavy axle load	 Heavy haul	
Light axle load		 Intercity

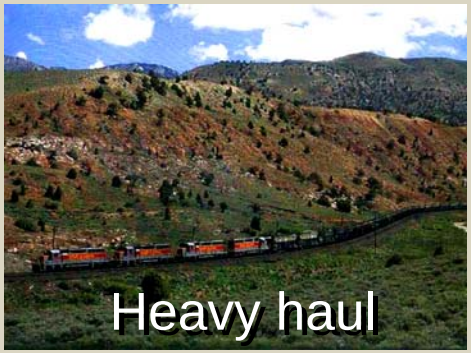
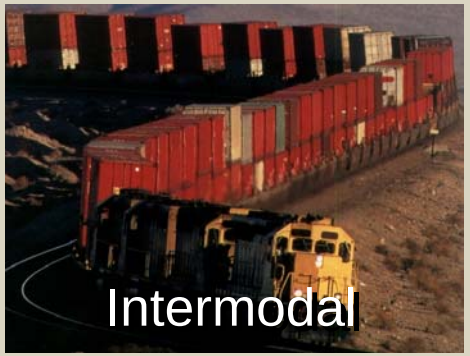
... give competitive advantage ?

	Low speed	High speed
Heavy axle load	 Heavy haul	 Intermodal
Light axle load		 Intercity

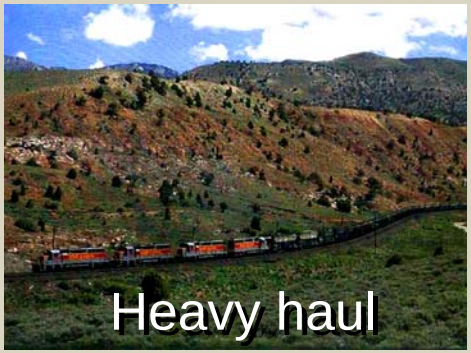
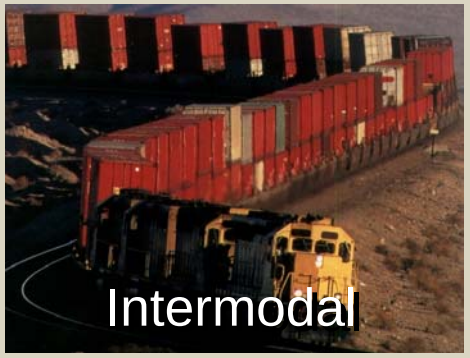
... and invite predatory attacks ?

	Low speed	High speed
Heavy axle load	 Heavy haul	 Intermodal
Light axle load	 City rail	 Intercity

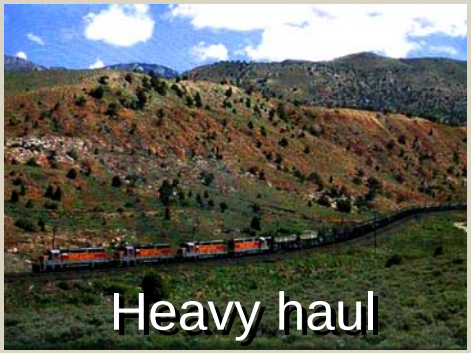
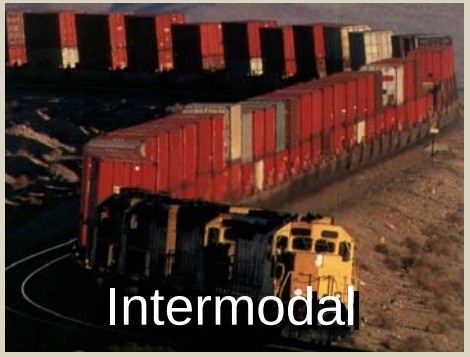
... and invite predatory attacks ?

	Low speed	High speed
Heavy axle load	 Heavy haul	 Intermodal
Light axle load	 Wagon-load freight	 Intercity

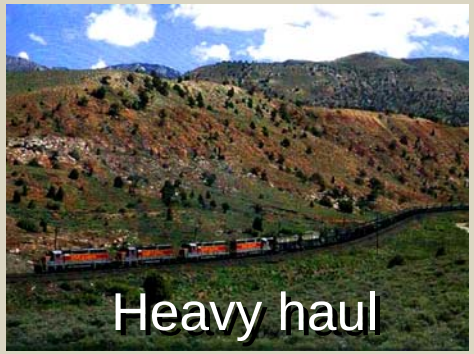
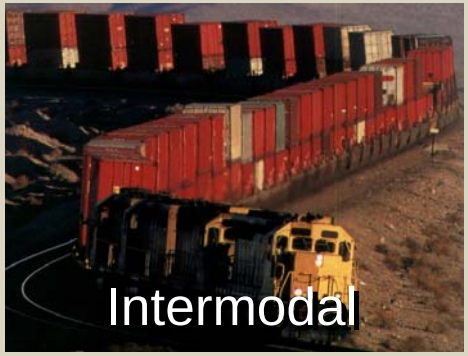
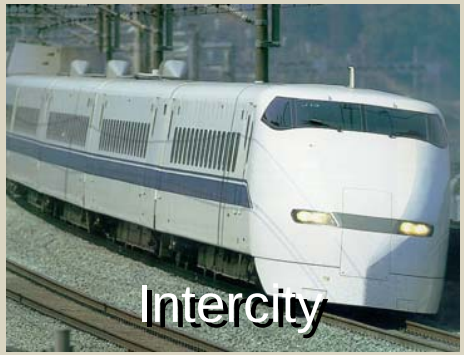
... and invite predatory attacks ?

	Low speed	High speed
Heavy axle load	 Heavy haul	 Intermodal
Light axle load	Railway mode is ecologically vulnerable	 Intercity

... and invite predatory attacks ?

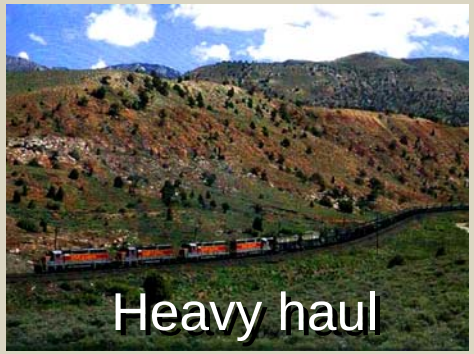
Heavy axle load	 Heavy haul	 Intermodal
Light axle load	The “non-level playing field” domain	 Intercity
	Low speed	High speed

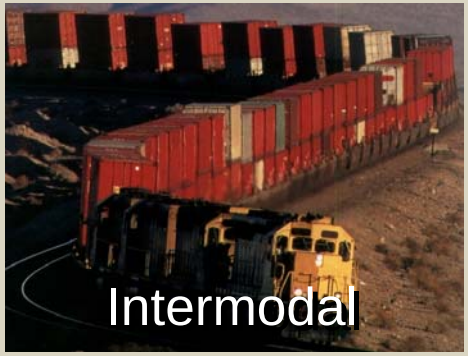
. and invite predatory attacks ?

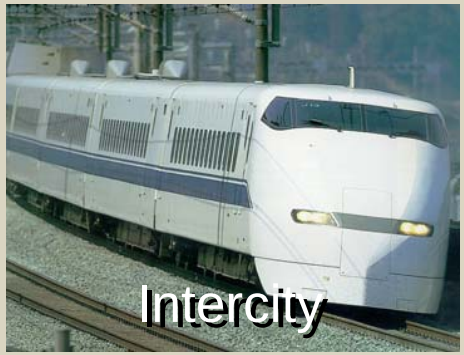
Heavy axle load	 Heavy haul	 Intermodal
Light axle load	Incumbents are being subsidized, hybridized, or annihilated	 Intercity

eaving three profitable quadrants

Heavy
axle load







Rites of passage
to railway profitability

- Japan & Europe have reached the high speed quadrant
- Several countries have reached the heavy axle load quadrant

  Australia, Brazil, Canada, China, Russia, South Africa, and United States are members of the International Heavy Haul Association

- United States, Canada, & Australia have

Some insights from long, heavy trains ...

Heavy haul *can do*

- High throughput capacity
- High asset utilization
- High labour productivity
- What can one leverage off this foundation?

Heavy haul exposes aspects of global role of railways

- Recognize what railways can do that other modes cannot do
- Recognize what railways cannot do well
- Regard the four quadrants as distinct modes, with own attributes and identity
- Recognize the presence of divergent and convergent drivers

Divergent drivers:

Passenger & freight stress

High speed intercity trains:

- Require wide curves
- Tolerate steep gradients
- Prefer new, dedicated, infrastructure
- Run at relatively high frequency

Divergent drivers:
Passenger & freight stress

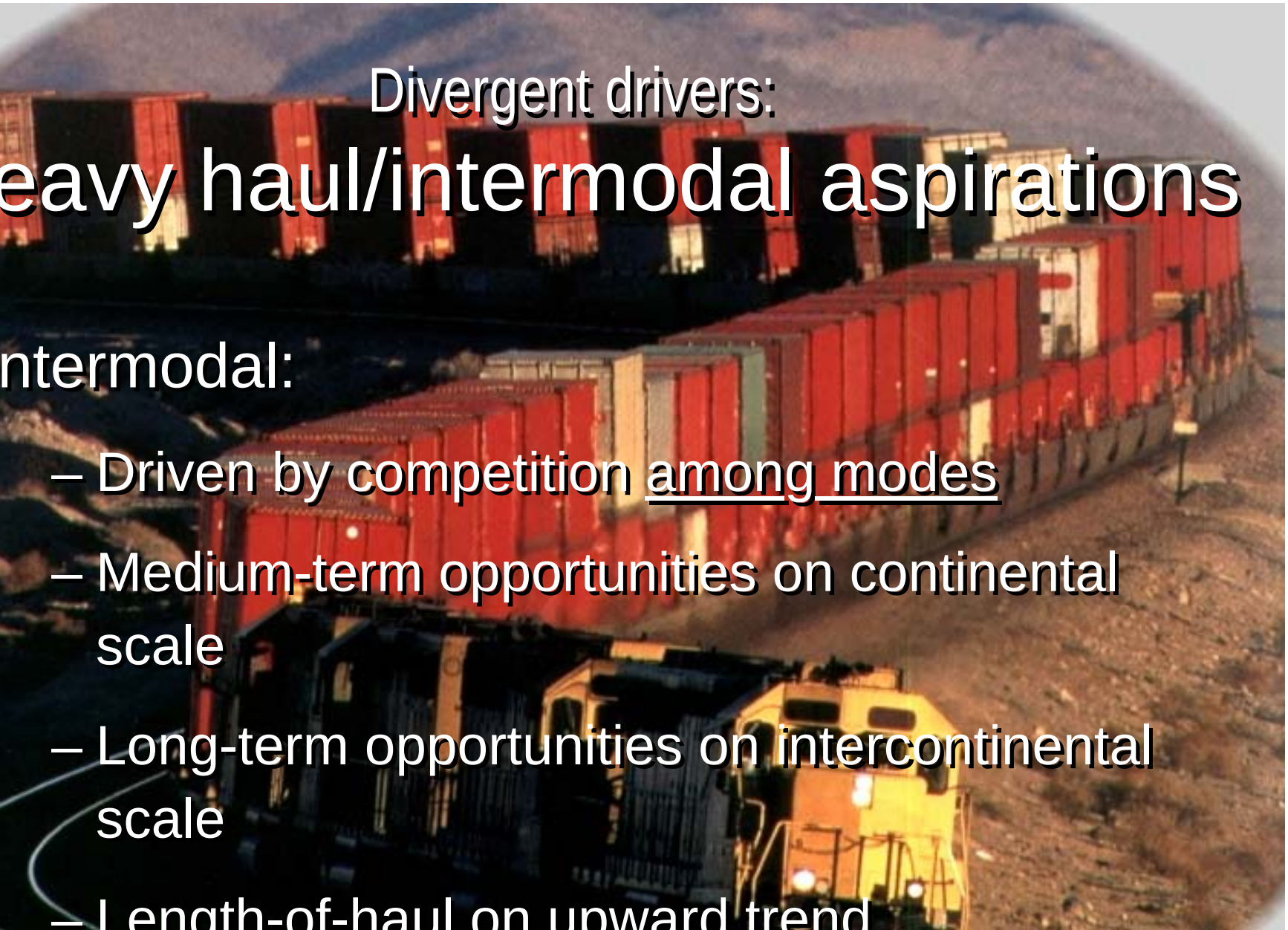
Heavy freight trains:

- Require easy gradients
- Tolerate sharp curves
- Accept legacy infrastructure with upgraded permissible axle load
- Run at relatively low frequency

Divergent drivers:
eavy haul/intermodal aspirations

Heavy haul:

- Driven by global competition among sources
- Symbiotic relation with customers
- Length-of-haul under downward pressure



Divergent drivers:

eavy haul/intermodal aspirations

ntermodal:

- Driven by competition among modes
- Medium-term opportunities on continental scale
- Long-term opportunities on intercontinental scale
- Length-of-haul on upward trend

New challenges: Time-sensitive freight characteristics

- Postponed manufacture
- Outsourced manufacture
- Few or single global suppliers
- Value-added logistics

- Volatile demand
- Short transit time
- High value/low density goods
- Focused versus multi-functional parts

New challenges: Time-sensitive freight characteristics ...

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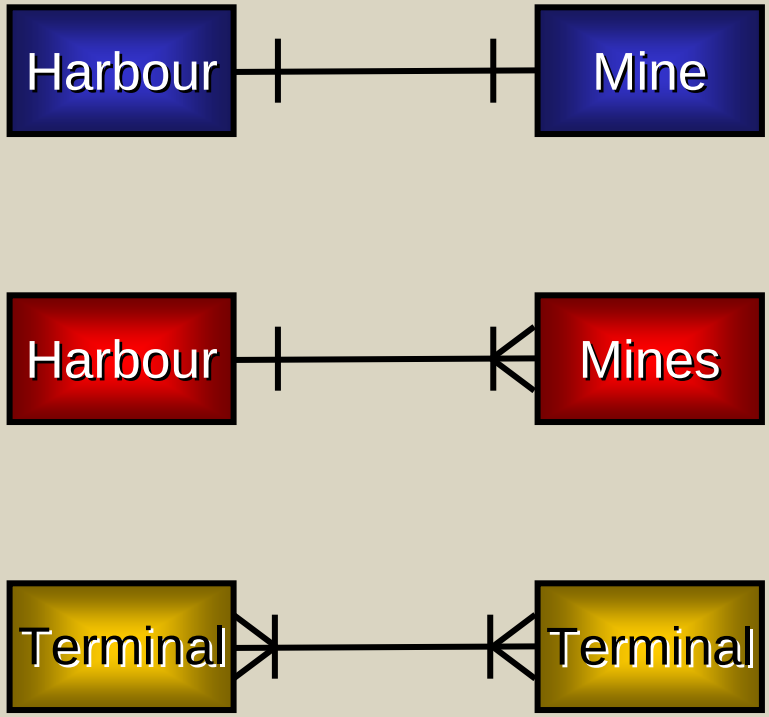
hanging relations among clients and service providers

- One to one (e.g. Sishen-Saldanha)
- Many to one (e.g. Ermelo-Richards Bay)
- Many to many (e.g. Freight Logistics Solutions)



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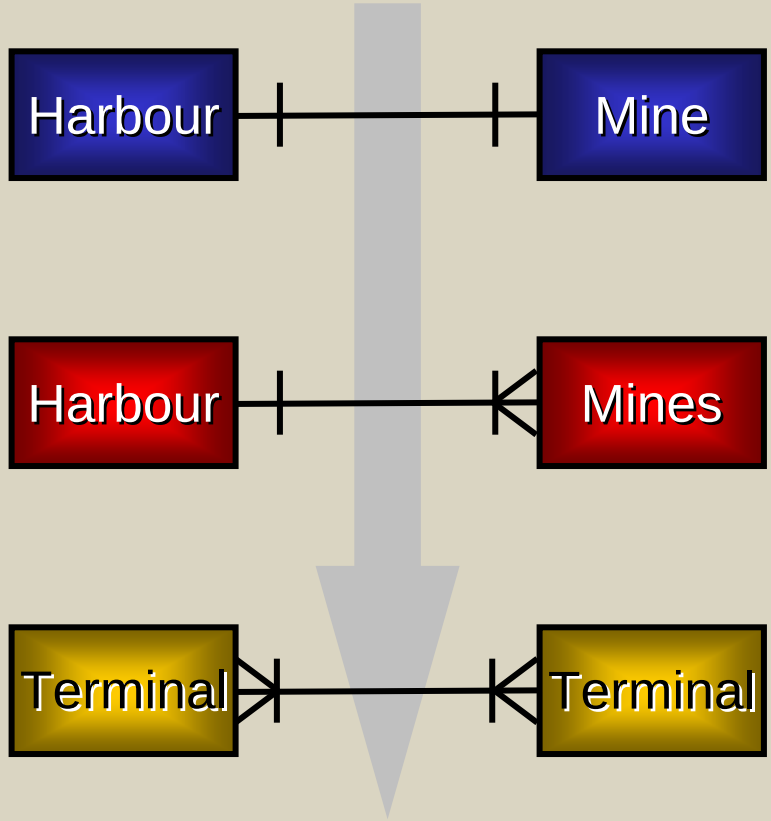
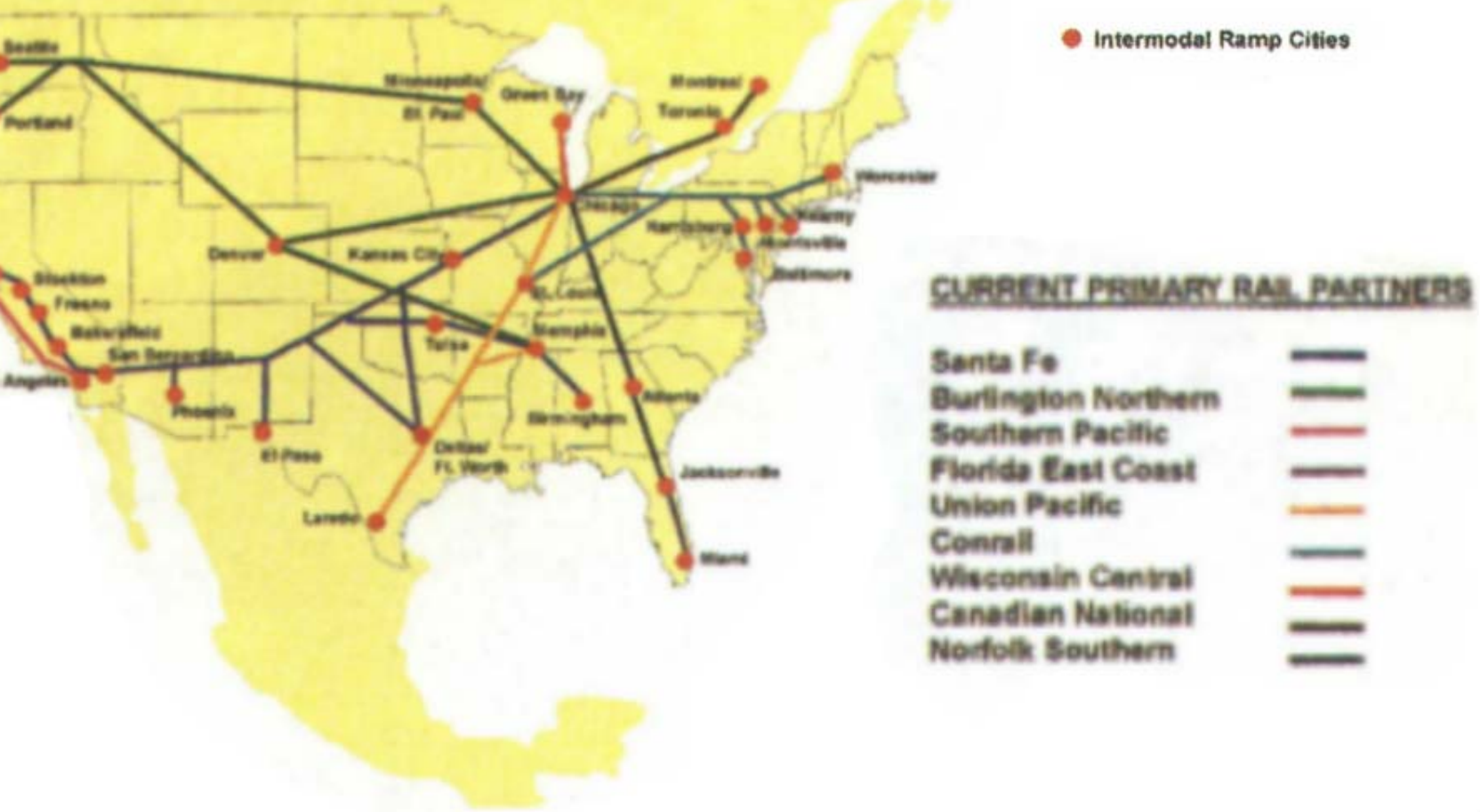


Define railway business:

Intermodal or internodal?



4

Potential for alignment and cooperation

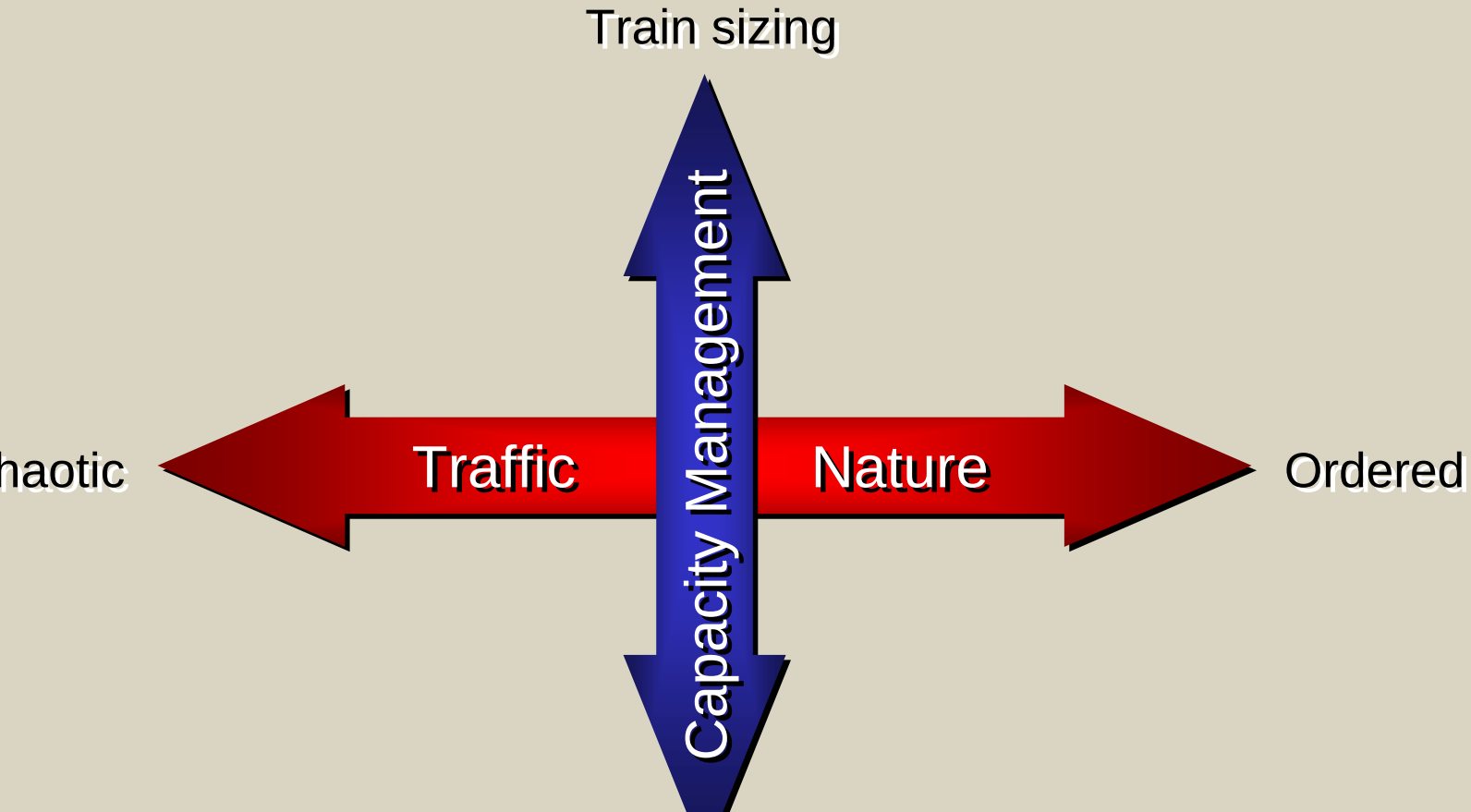
Convergent drivers:

Alignment philosophies

- Only one, interoperable, technology set will ultimately dominate a transport mode
- Railway technologies are becoming global, and hence standardized
- There is virtue in global unification around graduated release, without compromising train length

Convergent drivers:

Service scalability ...



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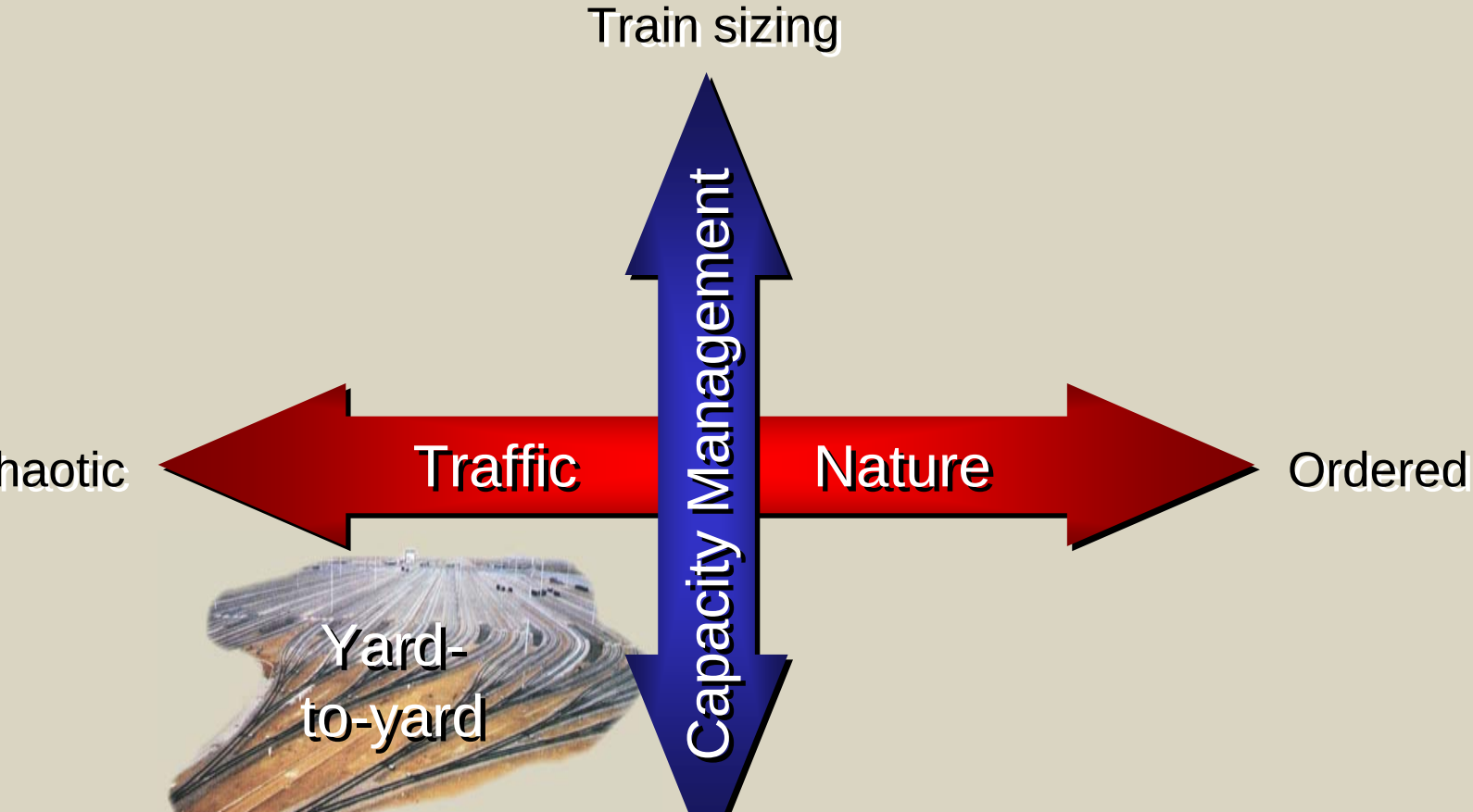

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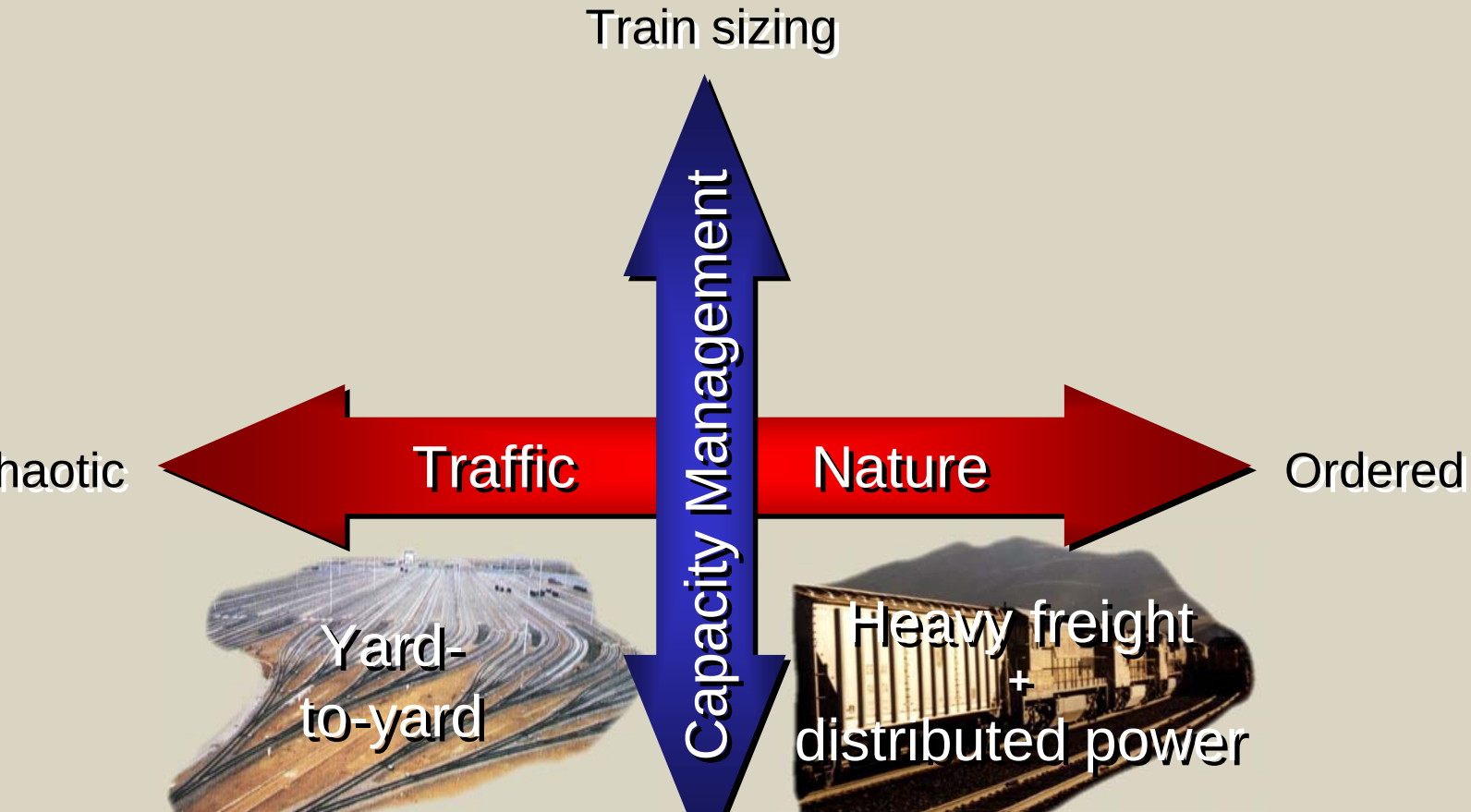

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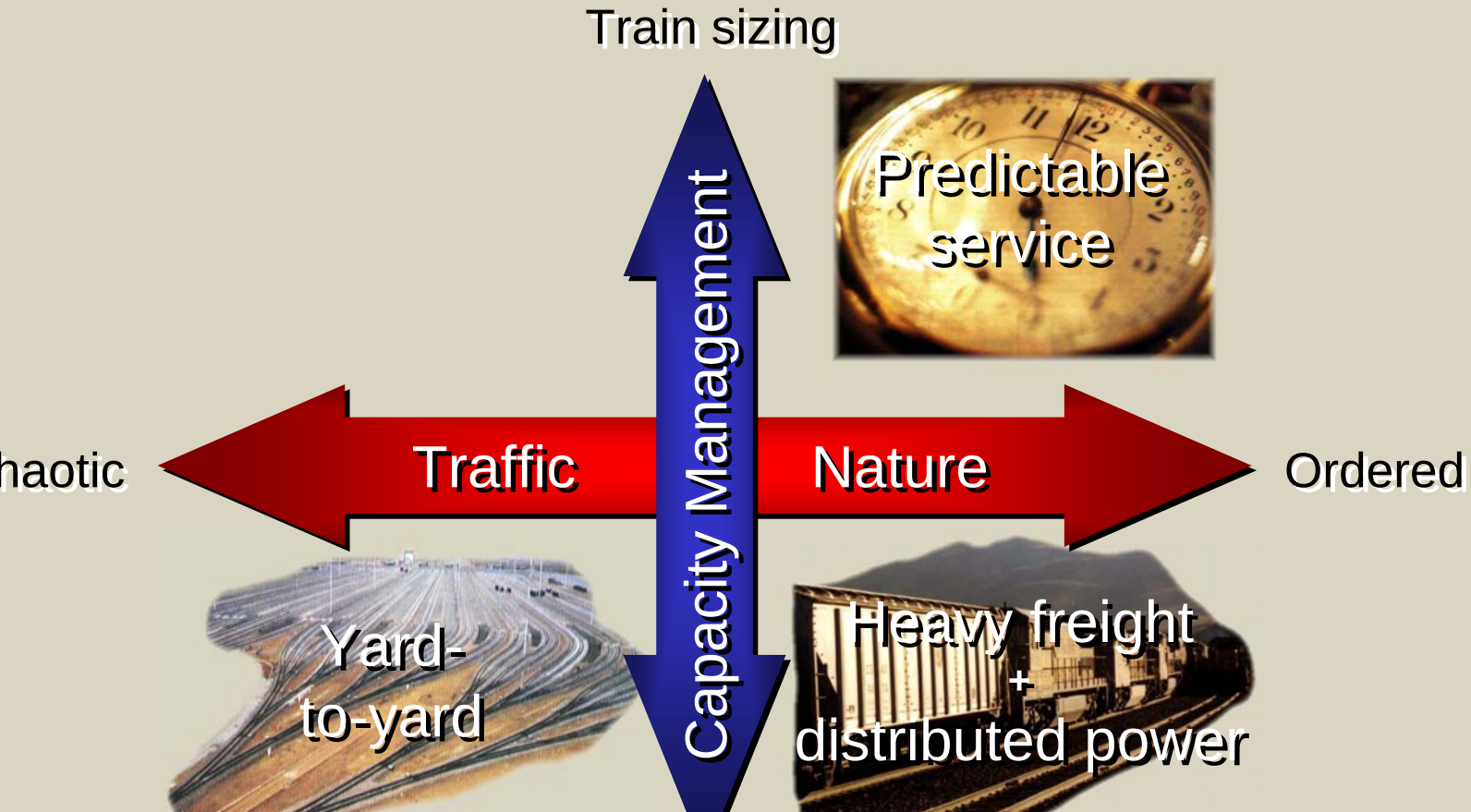

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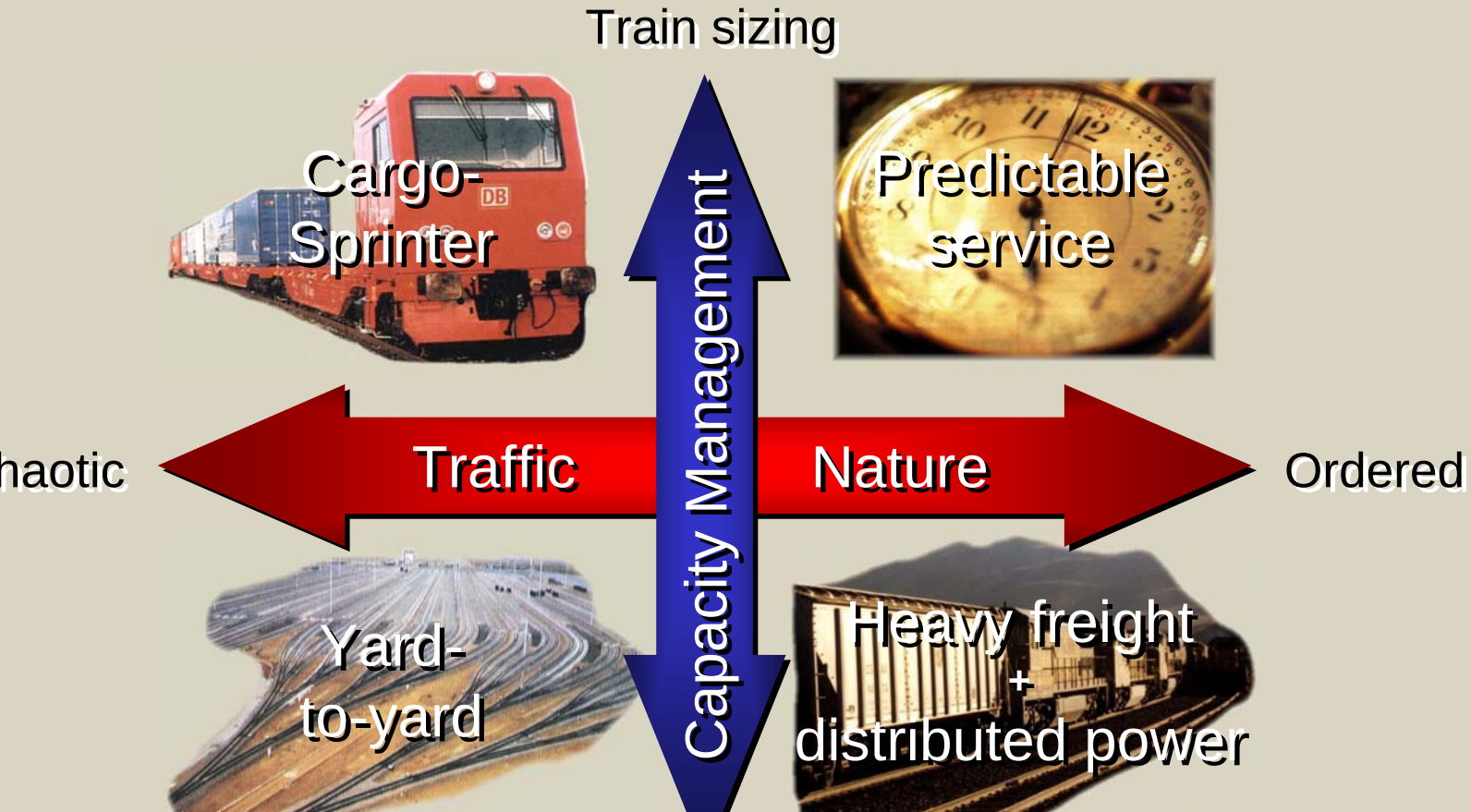
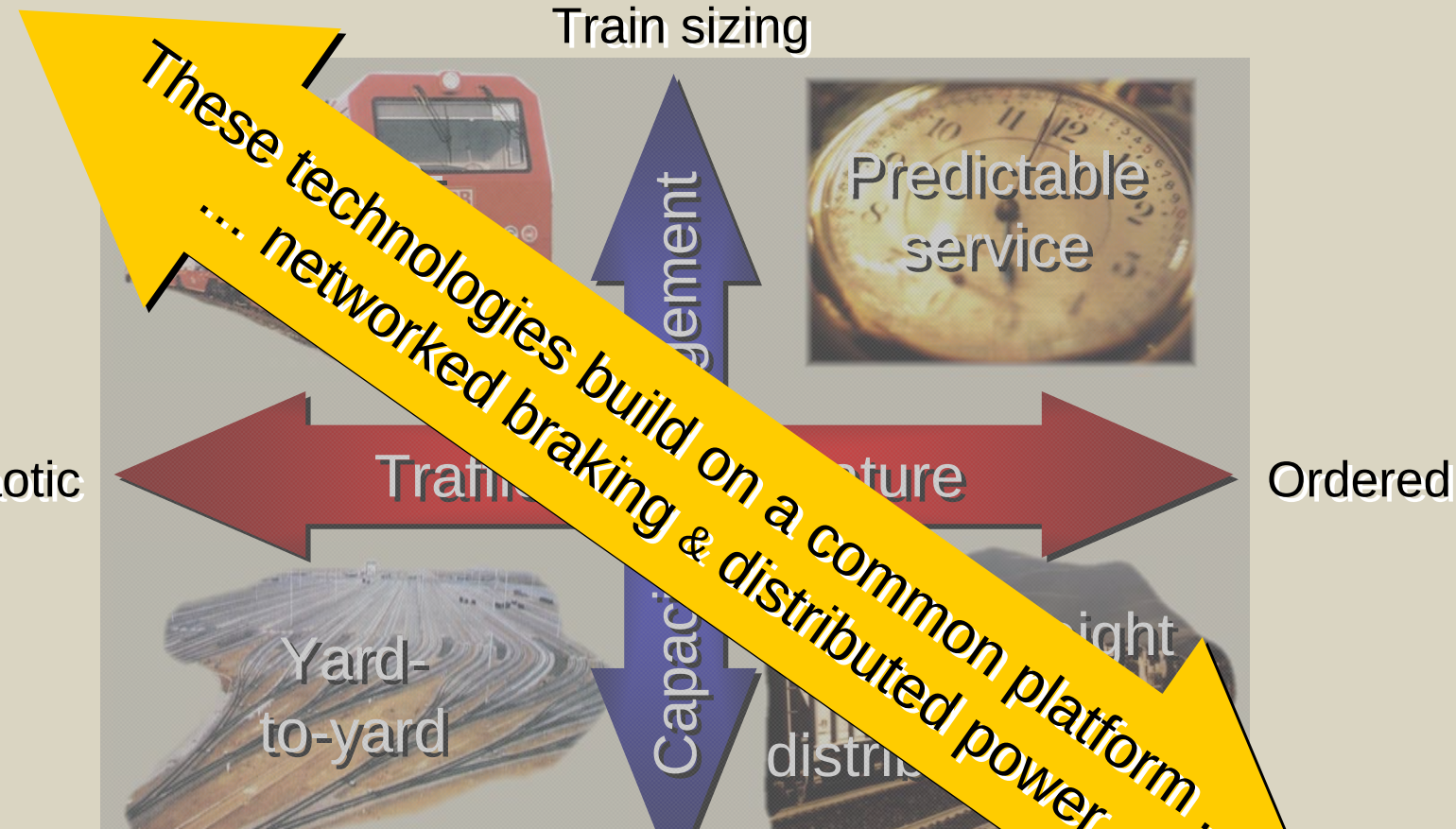


Convergent drivers:

... could shape train technology



Convergent drivers:

Impact of a common platform

- Reduces interchange and interoperability contention
- Encourages adoption of other harmonization requirements
- Simplifies understanding of a railway
- Complements information technology in facilitating seamless service

Convergent drivers:

Intra-train communication

- A data network is a prerequisite
- Spoornet has an ECP braking & DP pilot scheme under way
- Related to European initiatives (EBAS, TCN, etc.)
- Information and bandwidth requirements are still open issues

Convergent drivers:

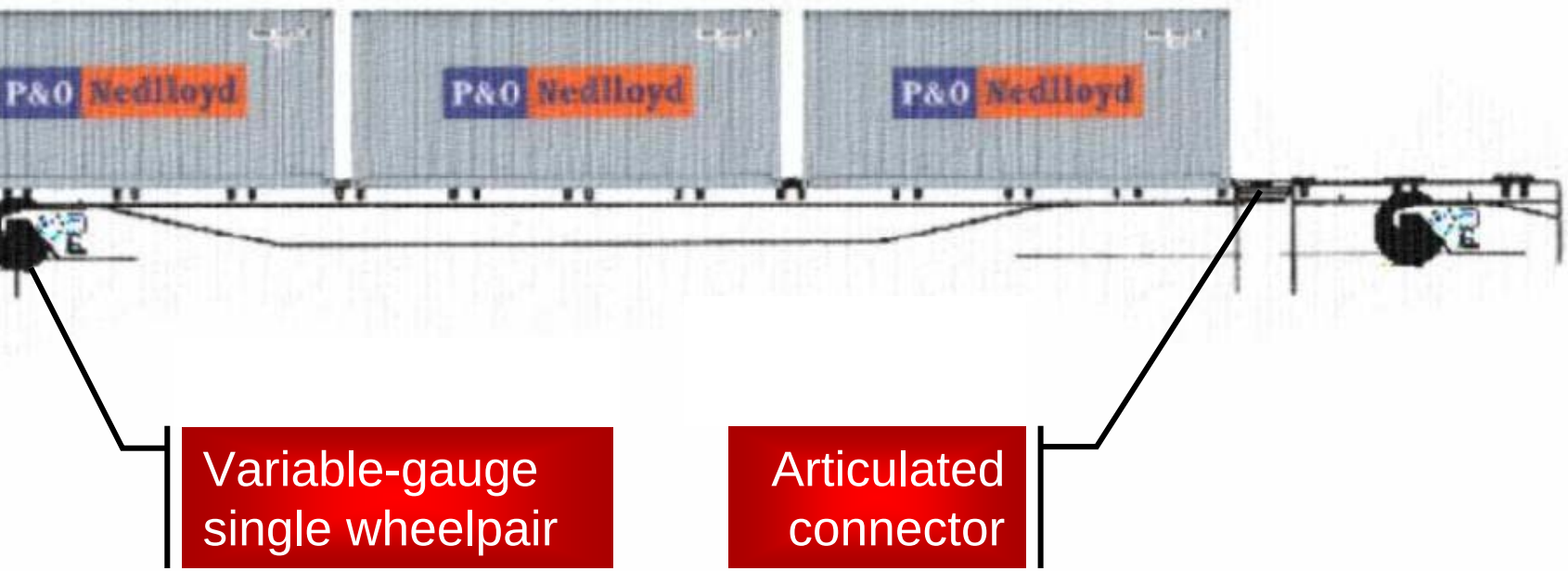
utomation of long, heavy, trains

- Competing modes (air and sea) routinely automate long hauls
- Graduated release a prerequisite
- ECP braking has filled the missing link
- Spoornet’s 300-wagon train demonstrated understanding of handling principles

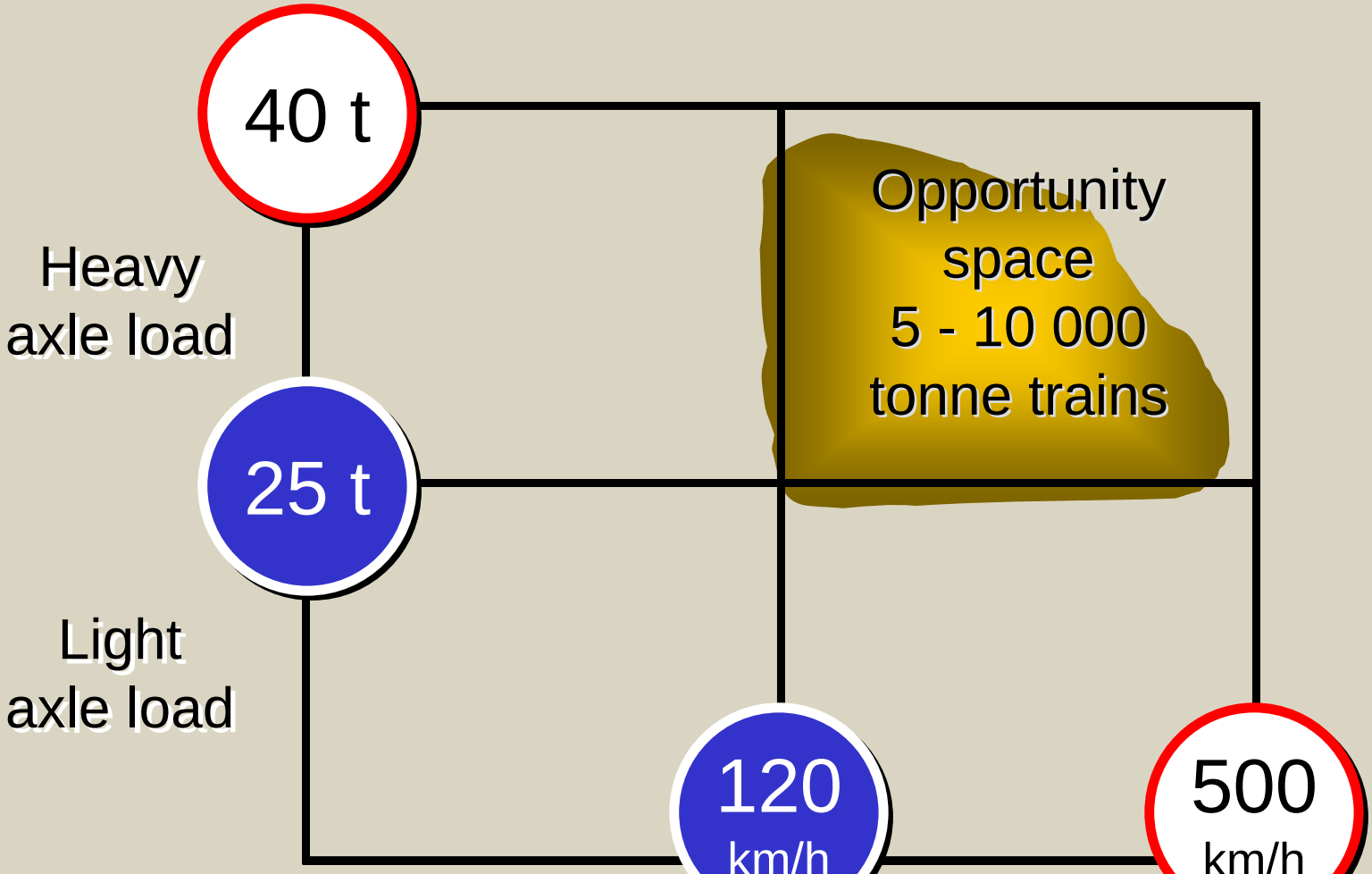
he 79 miles-per-hour constraint

- The existing intermodal mindset
  is predicated, among other,
  on a long-standing US statutory limit
- When will technology
  topple this constraint?
- Anticipate the role
  of transmission-based signaling!

A single-stack, high axle-load, ntercontinental, intermodal car*



Speculative thresholds & limits



A prognosis

- *Heavy haul* and *high-speed intercity* were killer apps for railways in the 20th century
- Railways have competitive advantages vis-à-vis other modes
- Opportunities for breakthrough exist
- *Intermodal* could be the killer app in the new millennium – but

... we need global cooperation to converge high speed and heavy axle load

- Spoornet, and others,
  have the heavy haul expertise
- Europe, and others,
  have the high speed expertise
- Maritime and air transport are our prey


There is a difference between
knowing what needs to be done
and knowing how to do it