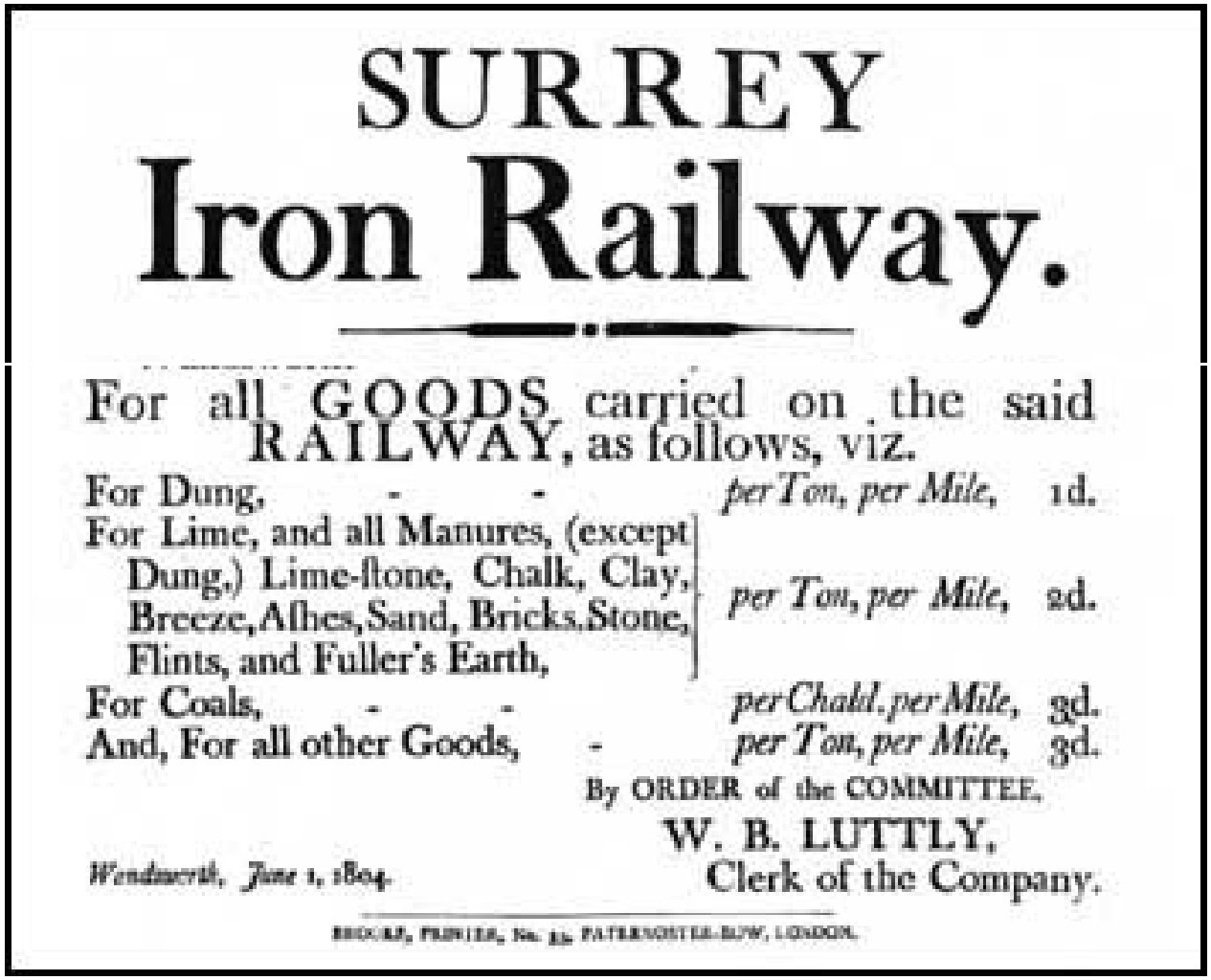
# Chairman's Address

## Efficiency & Opportunity In Railway Engineering



*Bill Reeve  Commercial Director, Transport Scotland*

# Government & Railways -1



SURREY

**Iron Railway.**

For all GOODS carried on the said RAILWAY, as follows, viz.

| | | |
|---|---|---|
| For Dung, - - | *per Ton, per Mile,* | 1d. |
| For Lime, and all Manures, (except Dung,) Lime-ſtone, Chalk, Clay, Breeze, Aſhes, Sand, Bricks, Stone, Flints, and Fuller's Earth, | *per Ton, per Mile,* | 2d. |
| For Coals, - - | *per Chald. per Mile,* | 3d. |
| And, For all other Goods, - | *per Ton, per Mile,* | 3d. |

By ORDER of the COMMITTEE,

W. B. LUTTLY,
Clerk of the Company.

*Wandsworth, June 1, 1804.*

BROOKS, PRINTER, No. 22 PATERNOSTER-ROW, LONDON.

- Opened in 1801
- Act of Parliament which set rates of carriage

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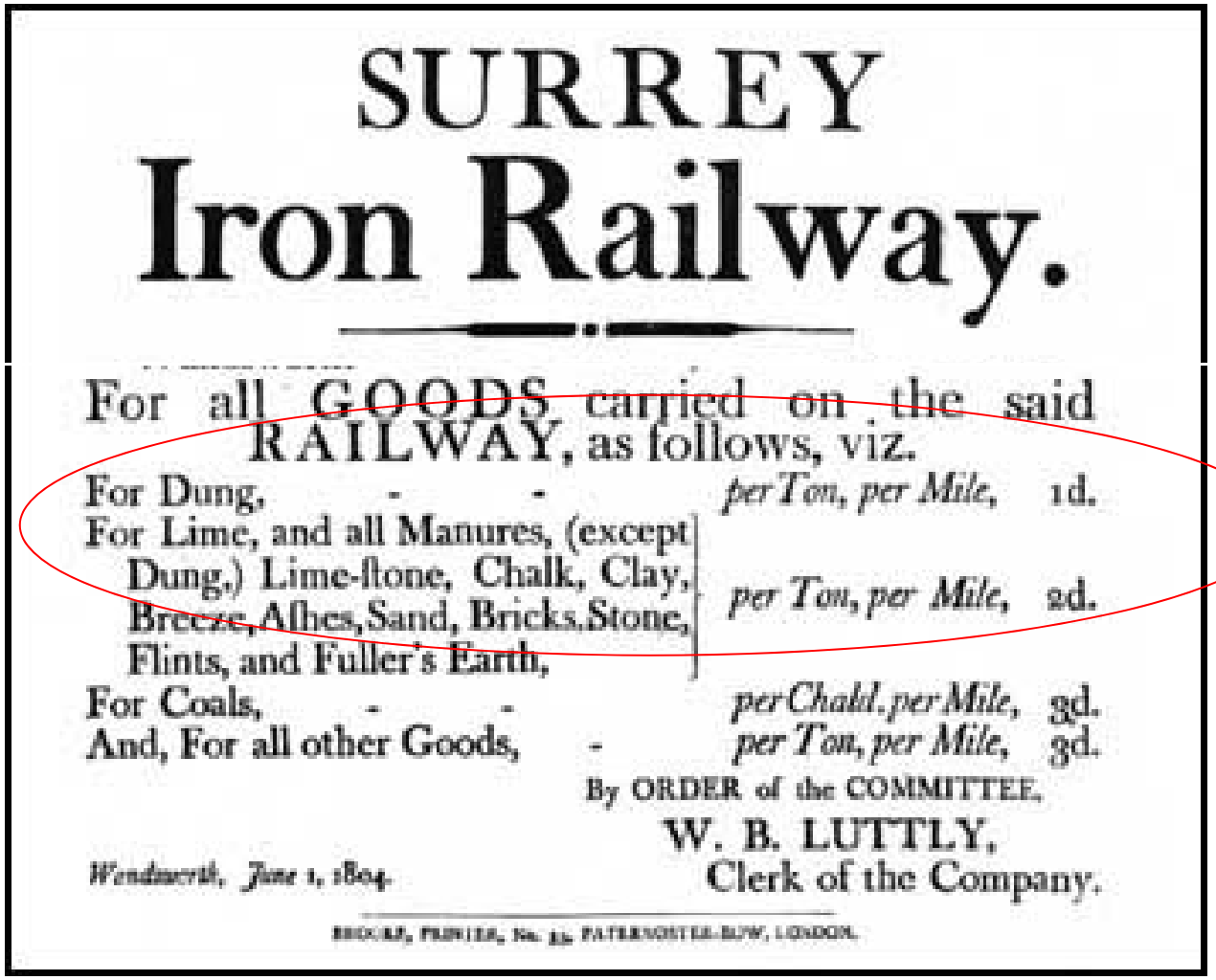

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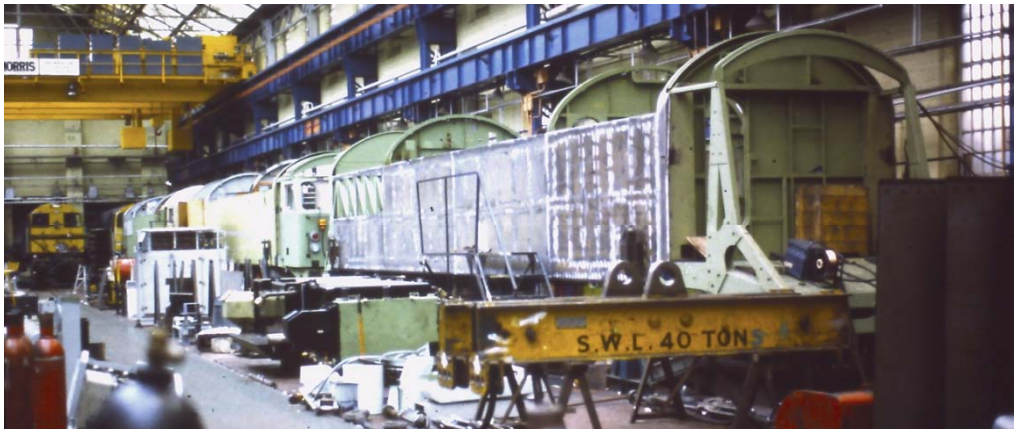
- Opened in 1801
- Act of Parliament which set rates of carriage
- MPs & Peers able to distinguish between “Dung” and “all Manures”

# Agenda

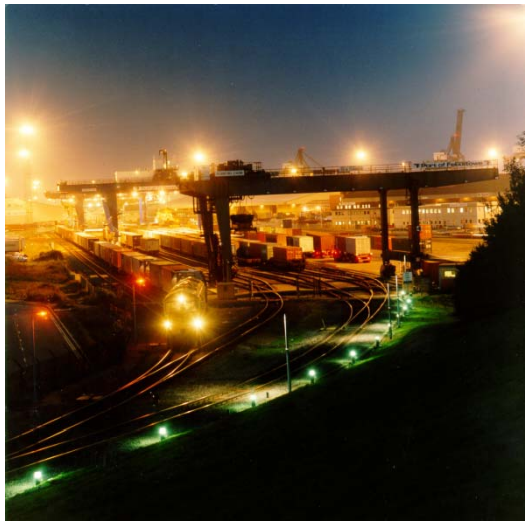
1. Reflections on efficient engineering.
2. An engineering question ?
3. Development of engineers.
4. A contribution from the I.Mech.E.

# Career Summary - Engineering




| | |
|---|---|
| *Engineering Management Trainee – Crewe Works - British Rail Engineering Ltd.* | *1983 - 1986* |
| *Senior Technical Officer – Gateshead Traction Maintenance Depot, M&EE, B.R.* | *1986 - 1988* |
| *Shift Production Manager – Tyseley Traction Maintenance Depot, M&EE, B.R.* | *1988 - 1990* |
| *Quality Project Manager – M&EE, B.R.* | *1990 - 1992* |

# Career Summary – Rail Freight



| | |
|---|---|
| *Planning and Evaluation Manager – Strategy & Investment Department, Trainload Coal, B.R.* | 1992 - 1994 |
| *Business Development Manager – Commercial Department, Mainline Freight Ltd., B.R.* | 1994 - 1996 |
| *Business Manager, Maritime Intermodal – Marketing Department, EWS Railway Ltd.* | 1996 - 2000 |

# Career Summary - Government

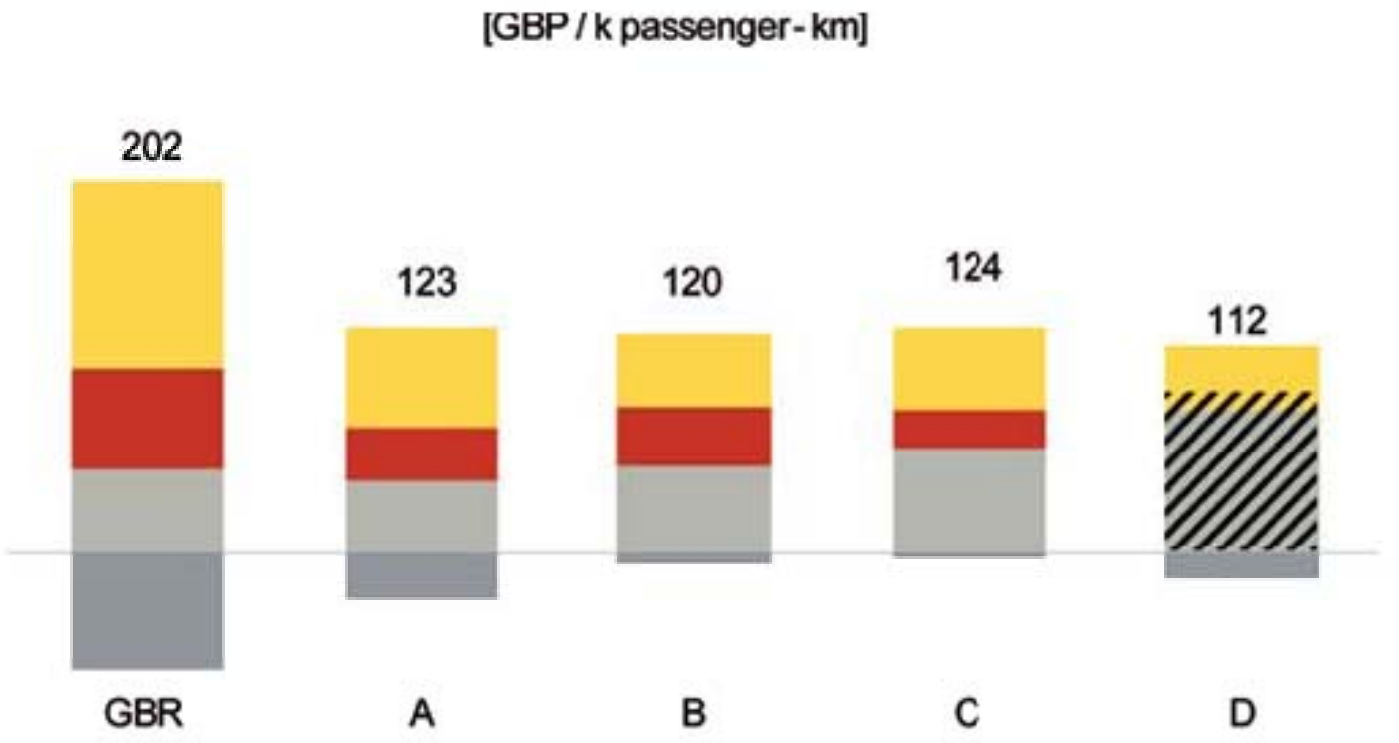


| | |
|---|---|
| *Assistant Director, Freight Network – Strategic Rail Authority* | 2000 – 2002 |
| *Director, Project Sponsorship - Strategic Rail Authority* | 2002 – 2005 |
| *Director, Rail Delivery, Transport Scotland* | 2005 – 2010 |
| *Commercial Director, Transport Scotland* | 2010 - |

# Reflections On Efficiency

# McNulty Challenge

**Comparison of whole system costs (partly normalised) £/k passenger-km**




1) Infrastructure has been fully normalised, train operation and rolling stock has been normalised for the countries where normalisation factors were known

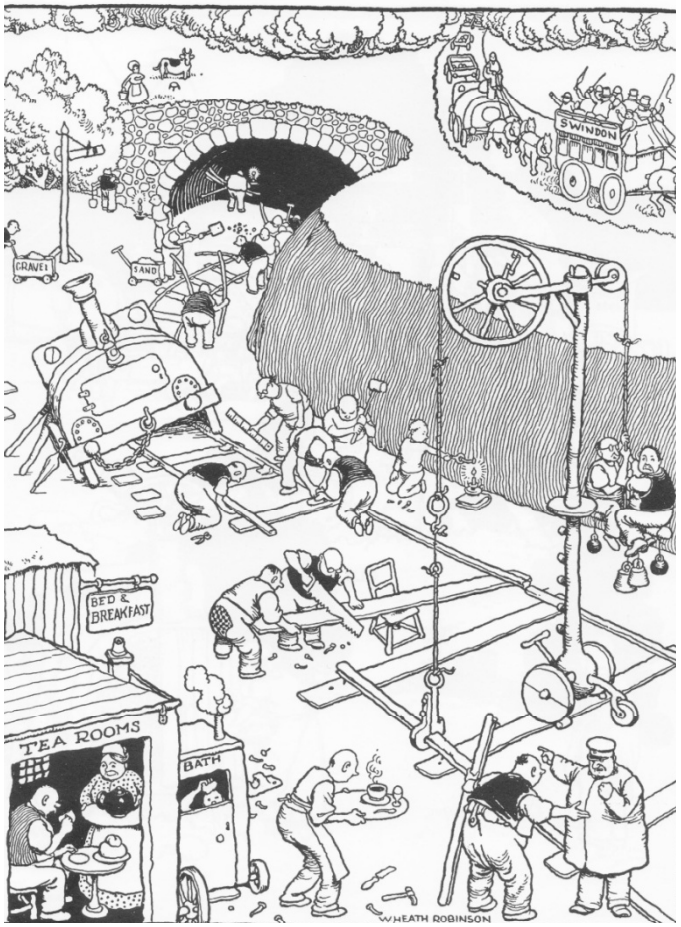
Numbers do not include track access charges

# Perils of Received Wisdom

# Railway Engineering Costs

- "this world is often difficult for an outsider to penetrate, and there are hazards in attempting broad generalisations reinforced with a measure of hindsight."

*source: Terry Gourvish – British Rail 1974 - 97*



# Railway Engineering Costs

| Engineering As Proportion Of Railway Operating Costs - 1980s | |
|---|---|
| M&EE | 24% |
| Civils | 20% |
| S&T | 6% |
| **Total** | **50%** |

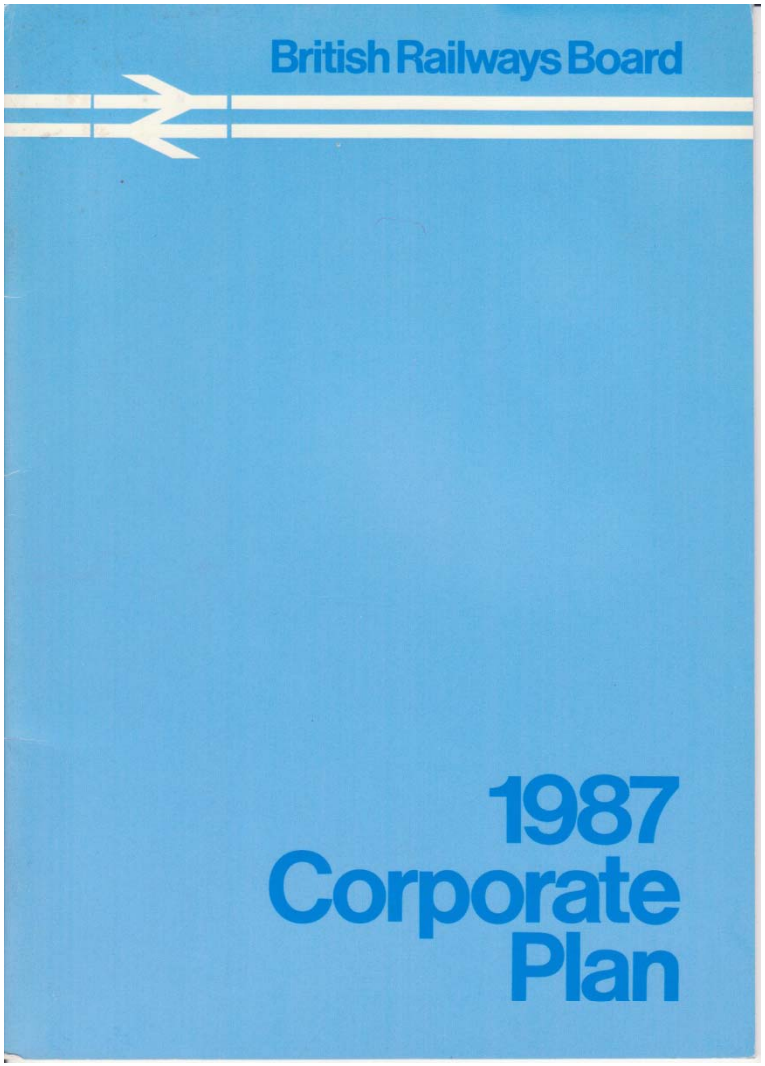
*source Terry Gourvish – British Rail 1974 - 97*

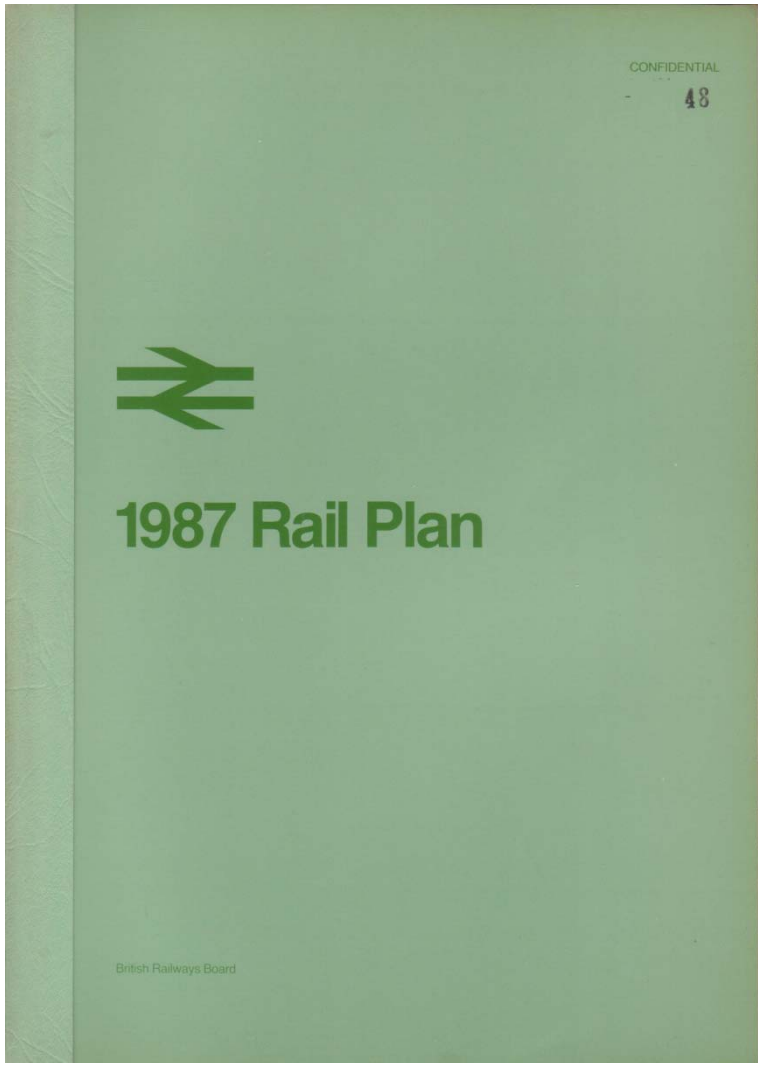
# Reducing Subsidy


FINANCIAL SUMMARY

| £m. @ 83 prices | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|
| Consolidated Profit and Loss | | | | | | |
| Railways before PSO | (960) | (891) | (840) | (736) | (670) | (639) |
| PSO | 943 | 877 | 845 | 772 | 727 | 708 |
| Railways after PSO grant | (17) | (14) | 5 | 36 | 57 | 69 |
| Other Activities | 15 | 6 | 12 | 17 | 19 | 24 |
| Consolidated Profit/(Loss) | (2) | (8) | 17 | 53 | 76 | 93 |
| Financing Requirement | | | | | | |
| Surplus/(Borrowing Requirement) | 180 | 43 | (43) | (31) | 18 | 70 |
| Investment charged to Capital and Revenue Accounts | | | | | | |
| Total Investment | 307 | 357 | 430 | 406 | 400 | 350 |

# Business Plans



# Engineering Led Savings

1987 Rail Plan Cost Forecasts

| £m @ 87/88 prices | 87/88 | 89/90 | 91/92 | Change | | % of total saving |
|---|---|---|---|---|---|---|
| | | | | | | |
| Operations | £1,048 | £1,022 | £1,030 | -£18 | -1.7% | 9.5% |
| | | | | | | |
| Total Engineering | £1,392 | £1,305 | £1,258 | -£134 | -9.7% | 70.3% |
| | | | | | | |
| Other (inc depreciation) | £592 | £525 | £554 | -£39 | -6.5% | 20.2% |
| | | | | | | |
| Total | £3,033 | £2,853 | £2,842 | -£191 | -6.3% | |

# Business–Led Railway

- Railway managed as set of coherent businesses which connected revenue with cost.
- Stretching targets to improve each business
- A striking contribution expected from Engineers
- What were the results ?

# Transformational Technology

- Real maintenance and overhaul costs fell from £102m to £44m from 1981 to 1987/8 – a reduction of 57%

- New sprinters allowing fleet reduction of 55%.


# Transformational Technology

- Radio Electronic Token Block
- "Born of necessity" to escape high cost of operation and maintenance of conventional signals on rural routes

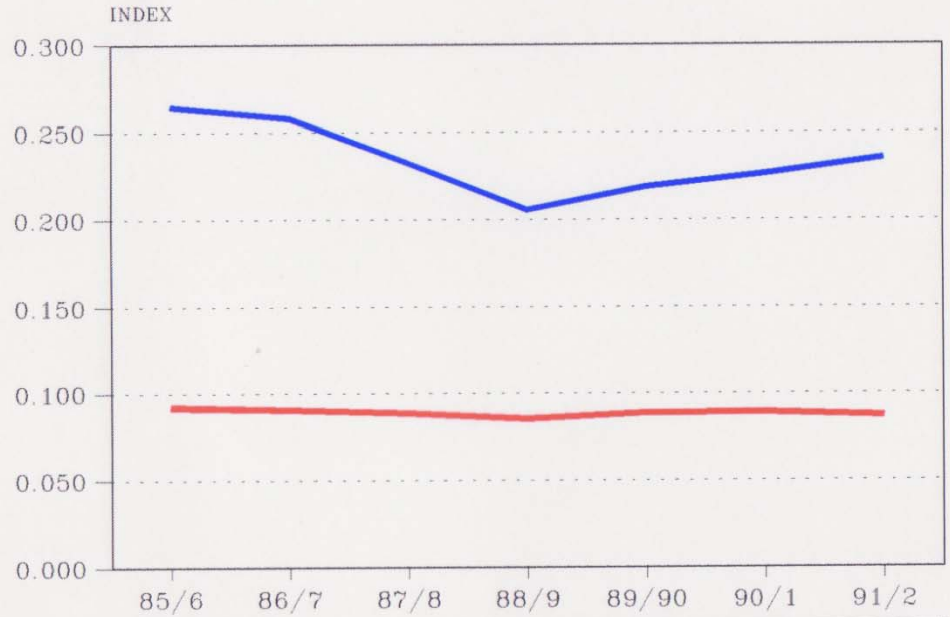

# Transformational Technology

- Introduced on Scottish rural routes from 1984
- Innovative application of available technology within tight budget constraints
- Re-engineered recently

# Improving Unit Costs

Graph 12

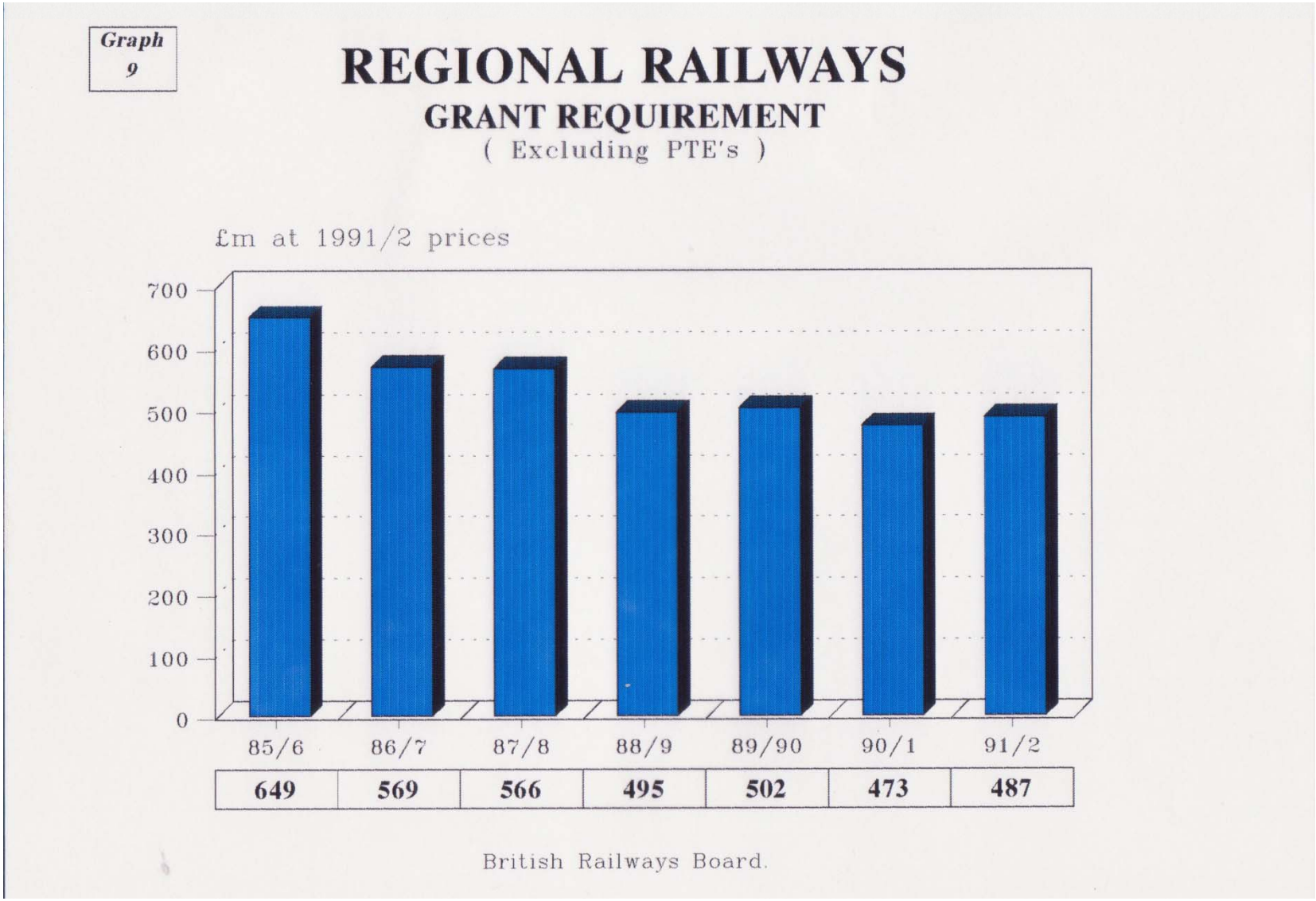
## REGIONAL RAILWAYS
## UNIT COSTS AND INCOME



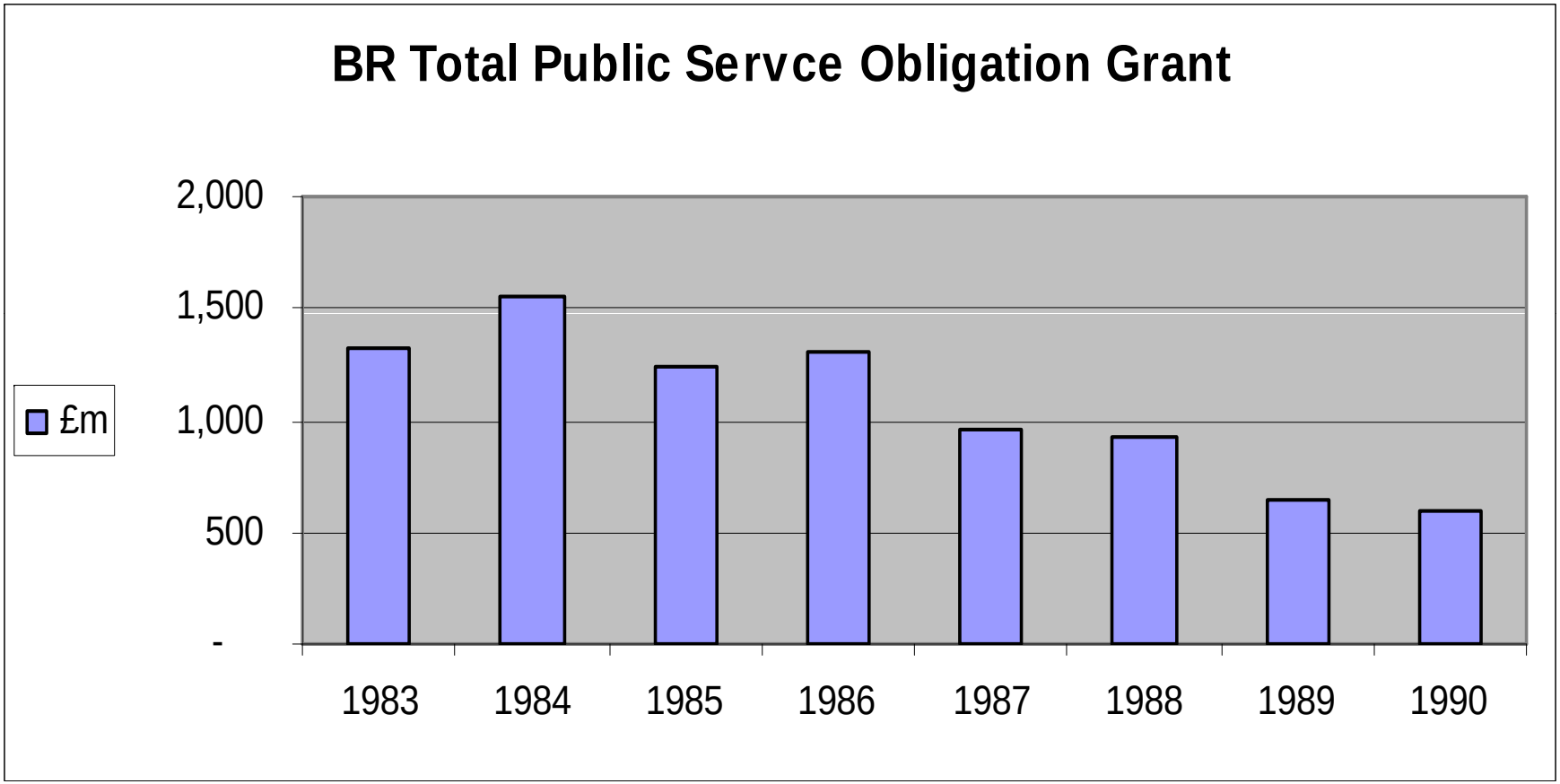

| | 85/6 | 86/7 | 87/8 | 88/9 | 89/90 | 90/1 | 91/2 |
|---|---|---|---|---|---|---|---|
| INCOME/PASS.MILE | 0.092 | 0.091 | 0.088 | 0.085 | 0.089 | 0.089 | 0.087 |
| COSTS/PASS.MILE | 0.264 | 0.258 | 0.232 | 0.206 | 0.219 | 0.226 | 0.235 |

British Railways Board.

# Reducing Grant Requirement



# Overall Cost To Government

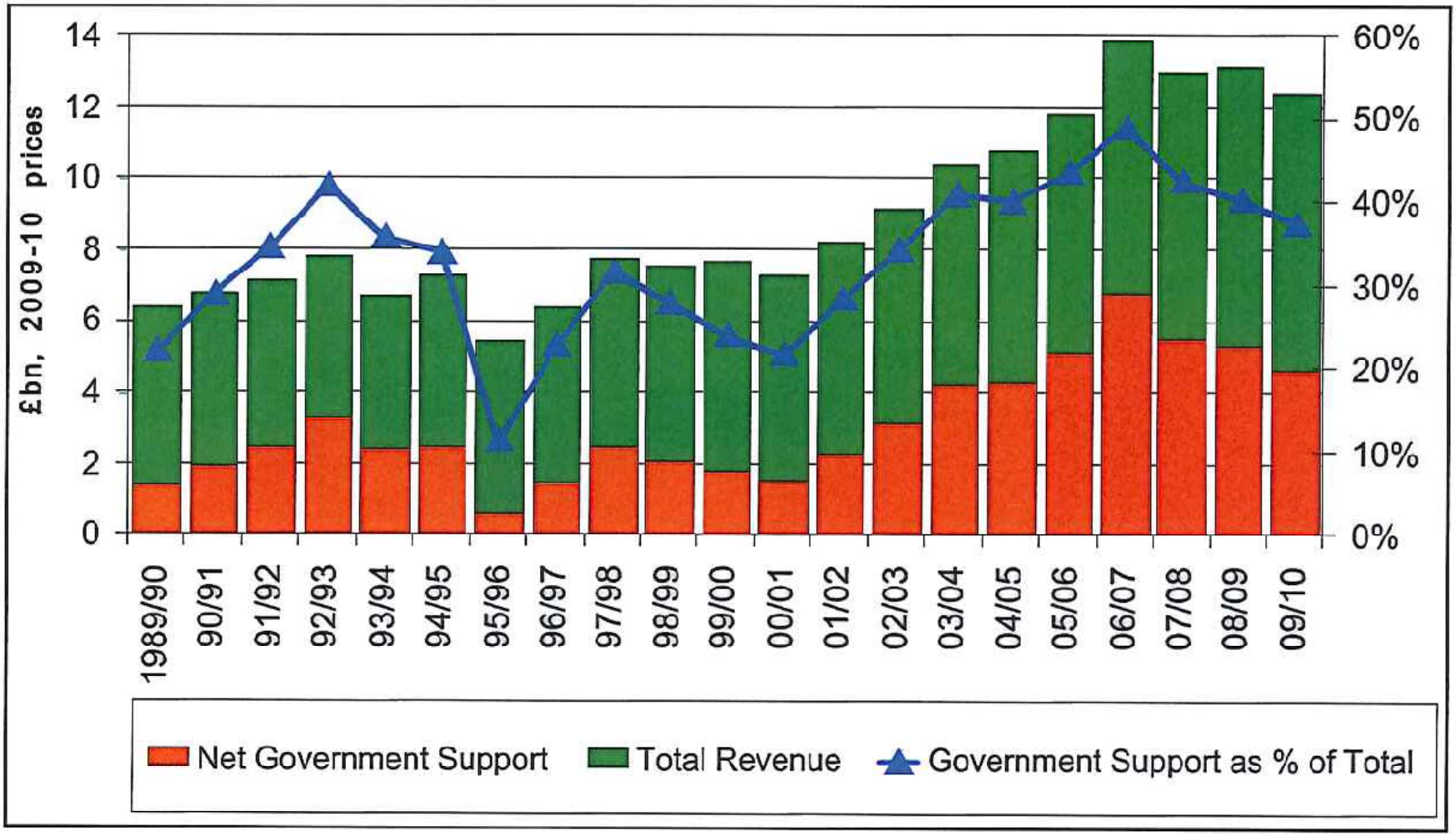



Constant 1989/90 prices

*Source Terry Gourvish – British Rail 1974 - 97*

# What Happened Next ?

Figure 2.5: Industry revenues and subsidy 1989/90 to 2009/10




*Source : Sir Roy McNulty Rail VFM Report*

# Business-Led Railway Lessons

1. Culture of economy.
2. Programme of transformational investments.
3. Objectives of railway business understandable at operational level.
4. Engineers connected to business :
   - Financial objective
   - Career development

# Trainload Coal

- BR's most profitable business sector
- Well engineered core product
- Coherent management of all costs and revenues
- "Charging what the traffic will bear"

# Securing the Revenue

- "Fixing a railway rate is, in one word, an art, not a science, and it is an art which must be exercised in a sort of twilight,….in an atmosphere of probabilities and doubt, where nothing is very clear, where there are some chances for many events, where there is much to be said for several courses, where nevertheless one course must be determinedly chosen and fixedly adhered to."

  *WM Ackworth The Elements Of Railway Economics - 1904 edition*

# Trainload Coal 1993-94

## BR's Most Profitable Business : Final Year

| | |
|---|---|
| Revenue | £249m |
| Fully Allocated Costs<br>(including 100% of coal only infrastructure costs and fully allocated contribution to shared network) | £89m |
| Contribution to other BR businesses | £160m |

# Railways and Government -2

- "It passes the wit of the most experienced official of the executive government, of the most learned judge of a railway tribunal, to decide whether a given rate of, say, one penny per mile is *per se* reasonable"

*WM Ackworth The Elements Of Railway Economics - 1904 edition*

# The Intermodal Challenge

***Typical 250 Mile Flow : late 1990s***

| | |
|---|---|
| Road Rate | £240 |
| Port rail handling cost | £40 |
| Terminal box lift cost | £20 |
| Road Cartage | £80 |
| Available Rail Rate | £100 |


| | |
|---|---|
| Train Cost - Round Trip | £4800 |
| > 48 boxes | Profit |
| < 48 boxes | Loss |

# Engineering & Freight Costs

***A worked example :***

| Train Type | 24 Standard 60’ Container Flats | 35 Standard 60’Container Flats | 24 Well Wagons for 9’6” Containers |
|---|---|---|---|
| Unit Cost per Container | £134 | £98 | £183 |

# EWS -The Burckhardt Model

- KISS Principle (Keep It Simple Stupid)
- Reduce costs
- Market aggressively

- BUT

- Separation of management of revenue from management of cost

# Transformational Technology




# Perils Of Optimism

- Q. How do you make a small fortune from wagonload freight business ?

# Perils Of Optimism

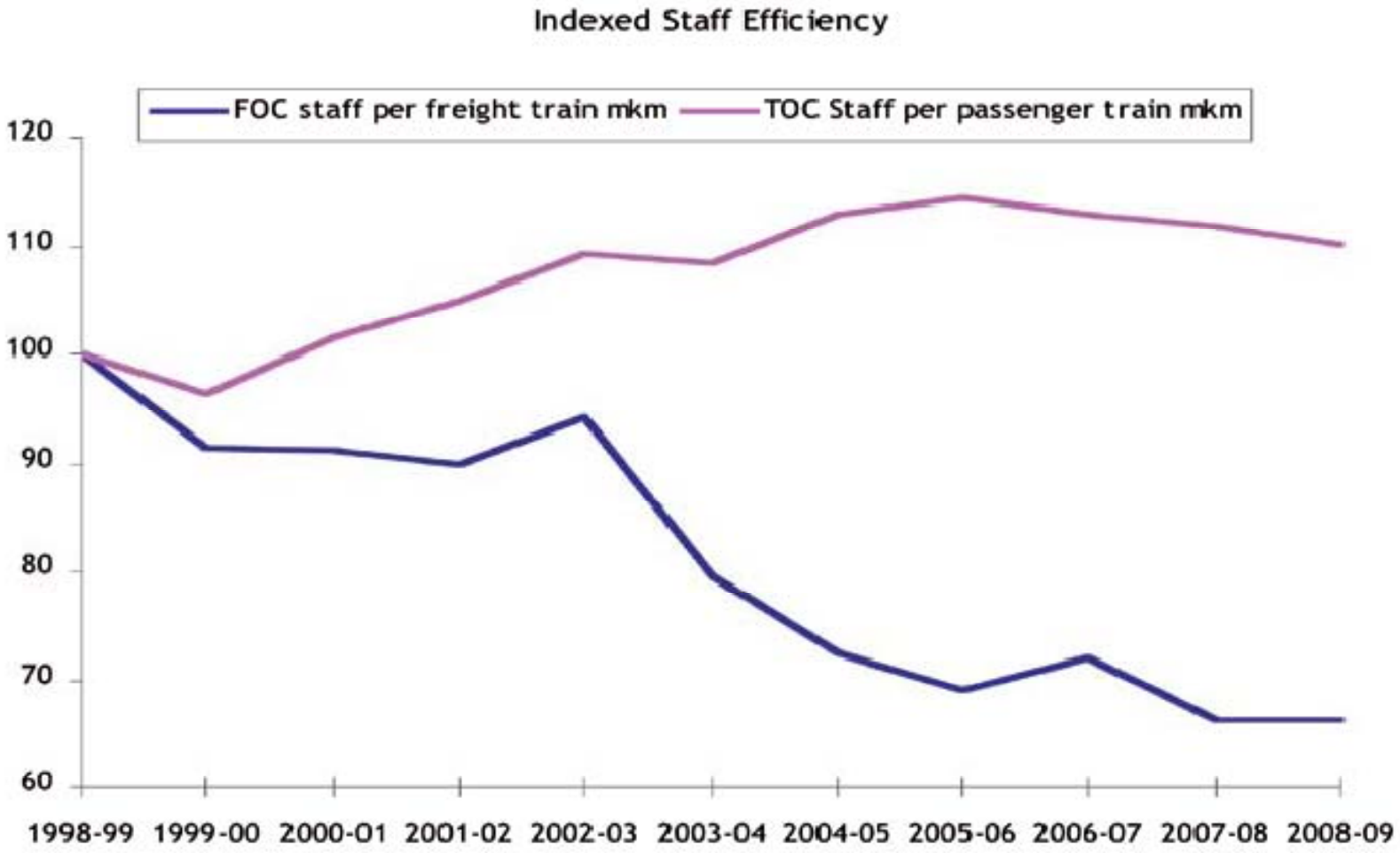
- Q. How do you make a small fortune from wagonload freight business ?

- A. Start with a large one.

# Lessons From Freight

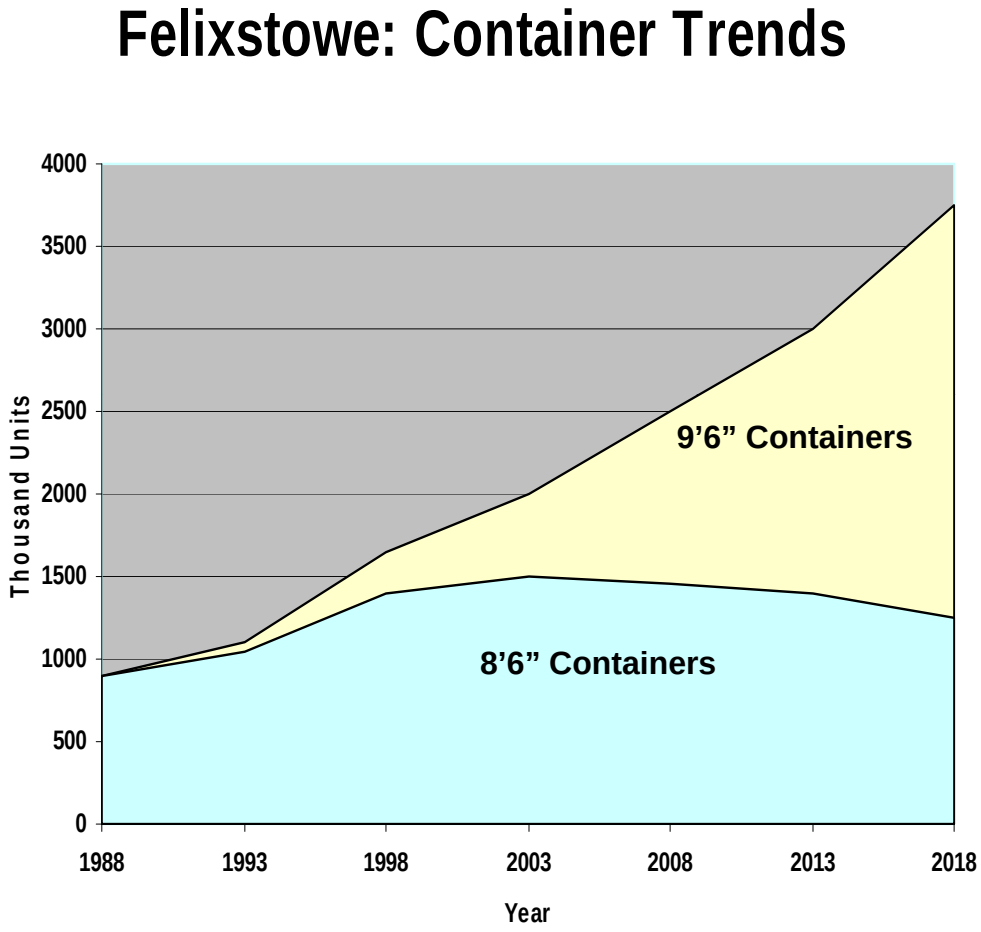
1. Manage total cost and revenue together.
2. Rail products must be designed to a price.
3. Good engineering delivers competitive advantage.
4. Charge what the traffic will bear.
5. Real competition drives attention to costs.

# The Effect Of Competition



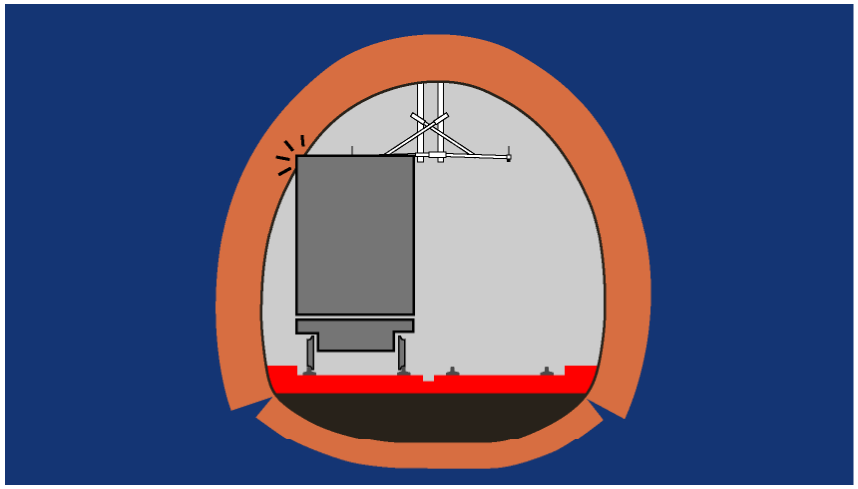

*Source: McNulty Rail VFM Report*

# SRA – Freight Projects

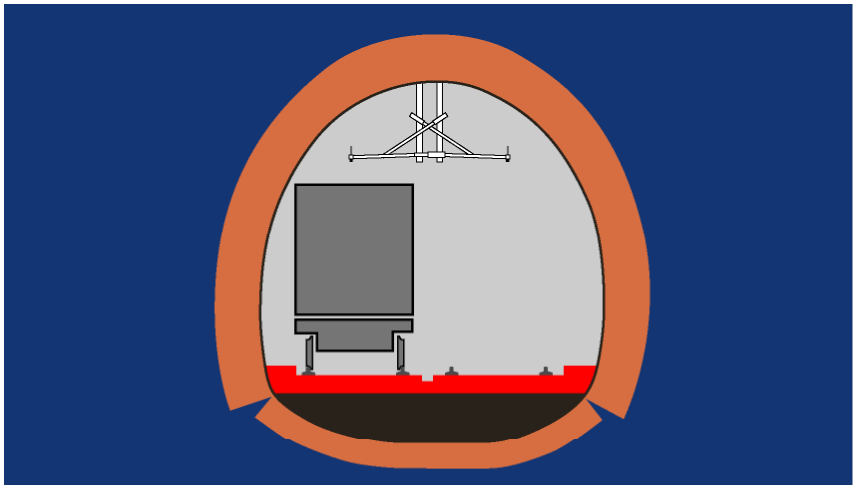



## Adapt GB Intermodal Network for 9'6" Containers

# The Secrets of Gauging



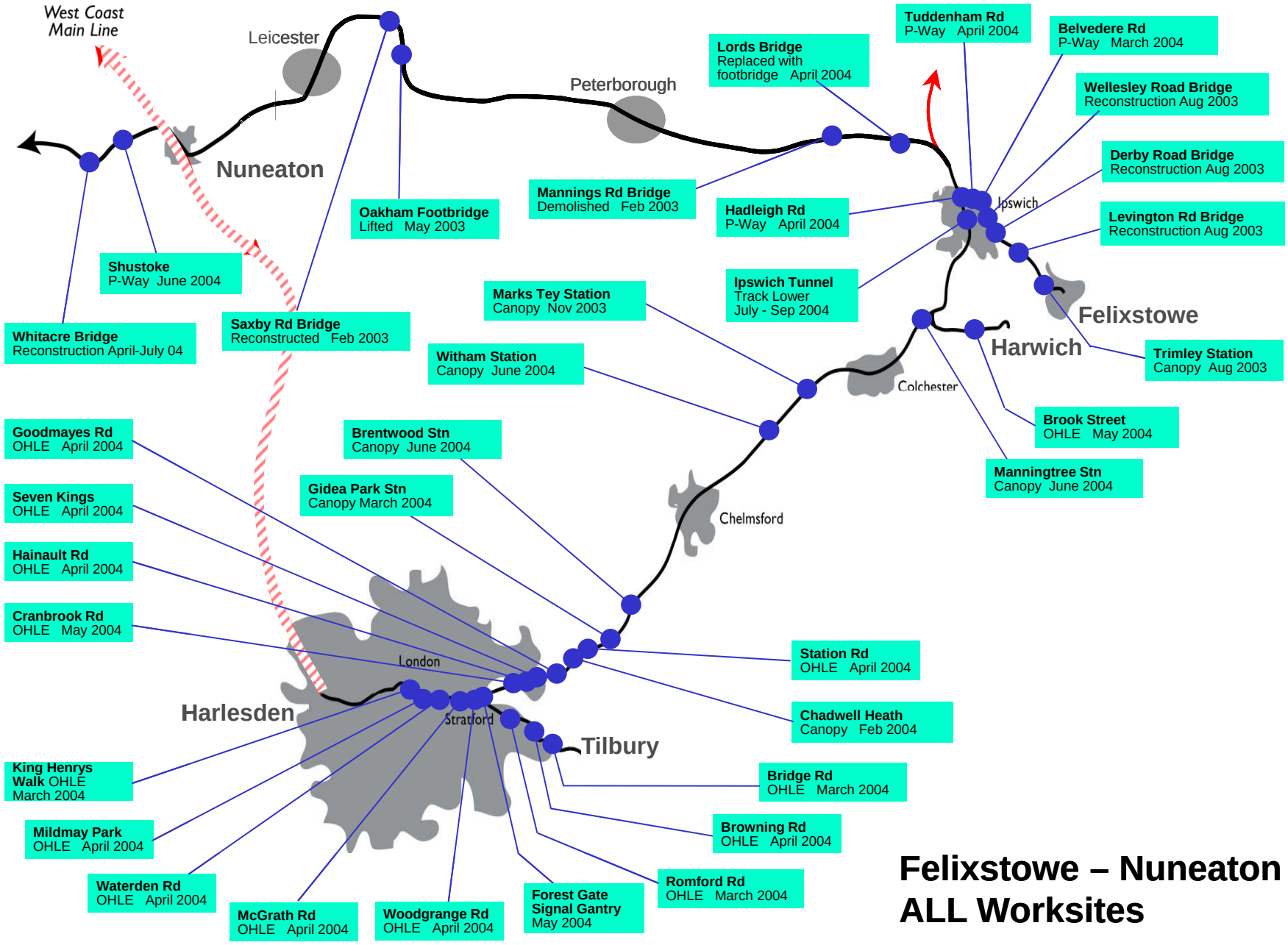
This is BAD



This is GOOD

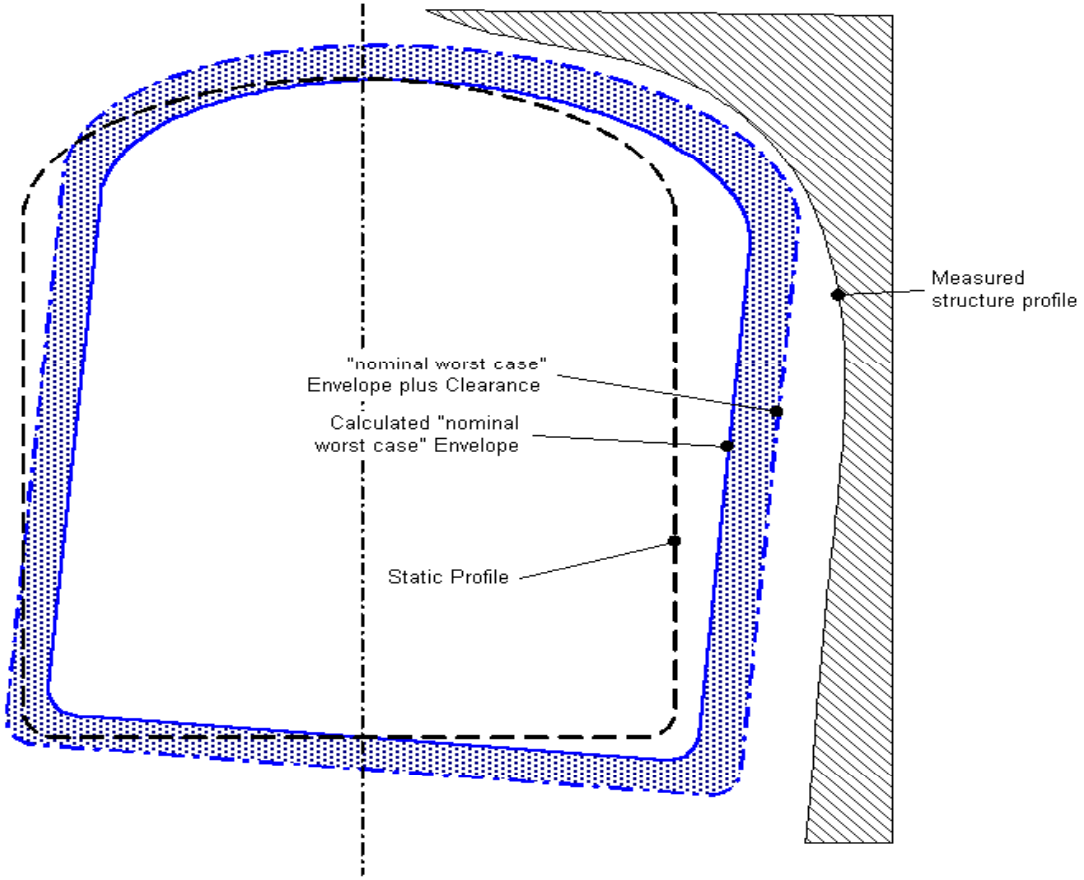
# The Gauging Challenge 2000

| | |
|---|---|
| Network upgrade estimates supplied by Railtrack | >£650 m |
| Annual rail intermodal turnover | ~£150 m |




# Felixstowe – Nuneaton
# ALL Worksites

# Expensive Devils In Detail



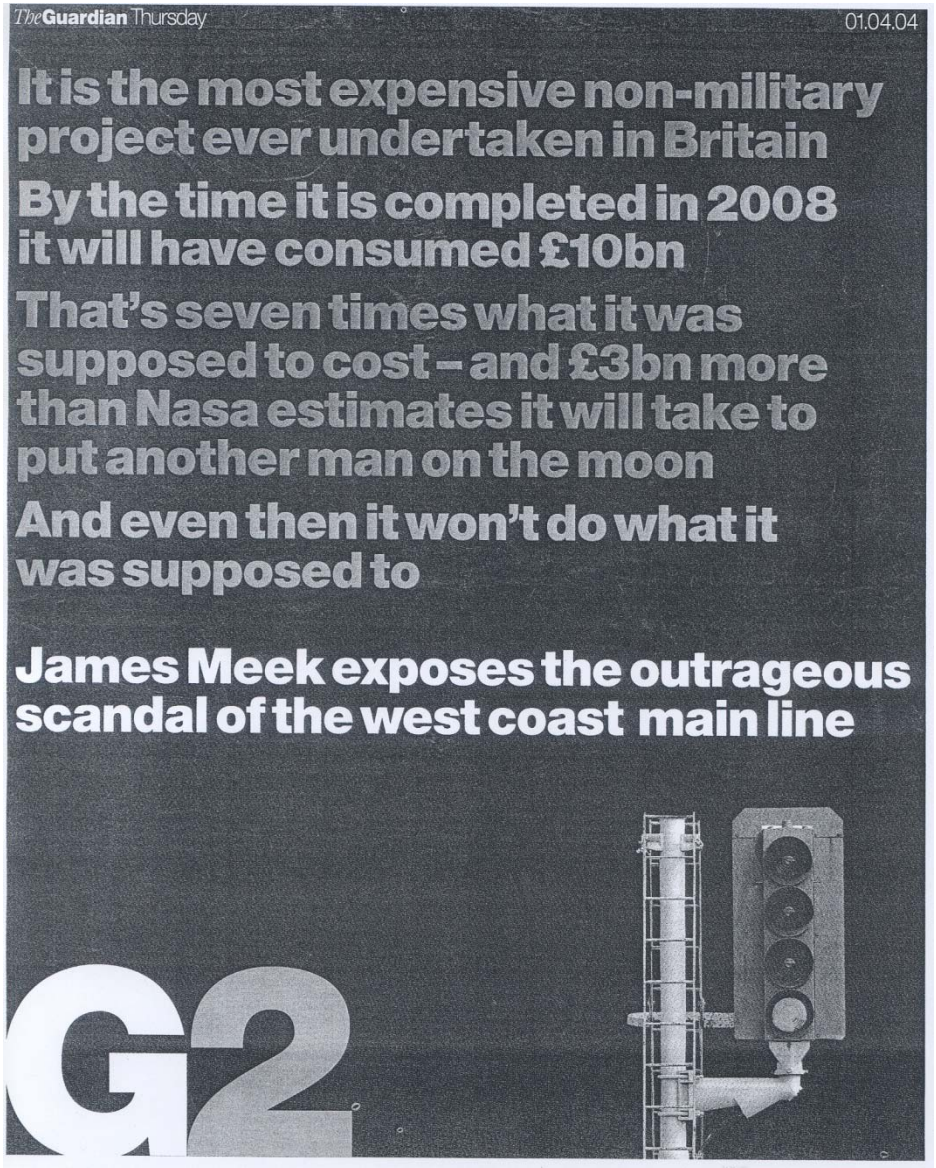

| | |
|---|---|
| Wrong | Clear new route £200m |
| Right | Slew track <£1m |

Standards and their intelligent application matter

# The Big Picture - 2002

| £ billion | 1999-00 | 2002-03 |
|---|---|---|
| Infrastructure Operations, Maintenance & Renewal | (2.8) | (5.0) |
| Franchised Passenger & Freight Train Provisions | (3.3) | (4.0) |
| **Industry-wide underlying spend** | **(6.1)** | **(9.0)** |
| **Industry-wide revenue before support payments** | **4.5** | **5.0** |
| | | |
| **INDUSTRY-WIDE OPERATING SURPLUS/(DEFICIT)** | **(1.6)** | **(4.0)** |

# WCML Upgrade



The Guardian Thursday 01.04.04

**It is the most expensive non-military project ever undertaken in Britain**

**By the time it is completed in 2008 it will have consumed £10bn**

**That's seven times what it was supposed to cost – and £3bn more than Nasa estimates it will take to put another man on the moon**

**And even then it won't do what it was supposed to**

**James Meek exposes the outrageous scandal of the west coast main line**

G2

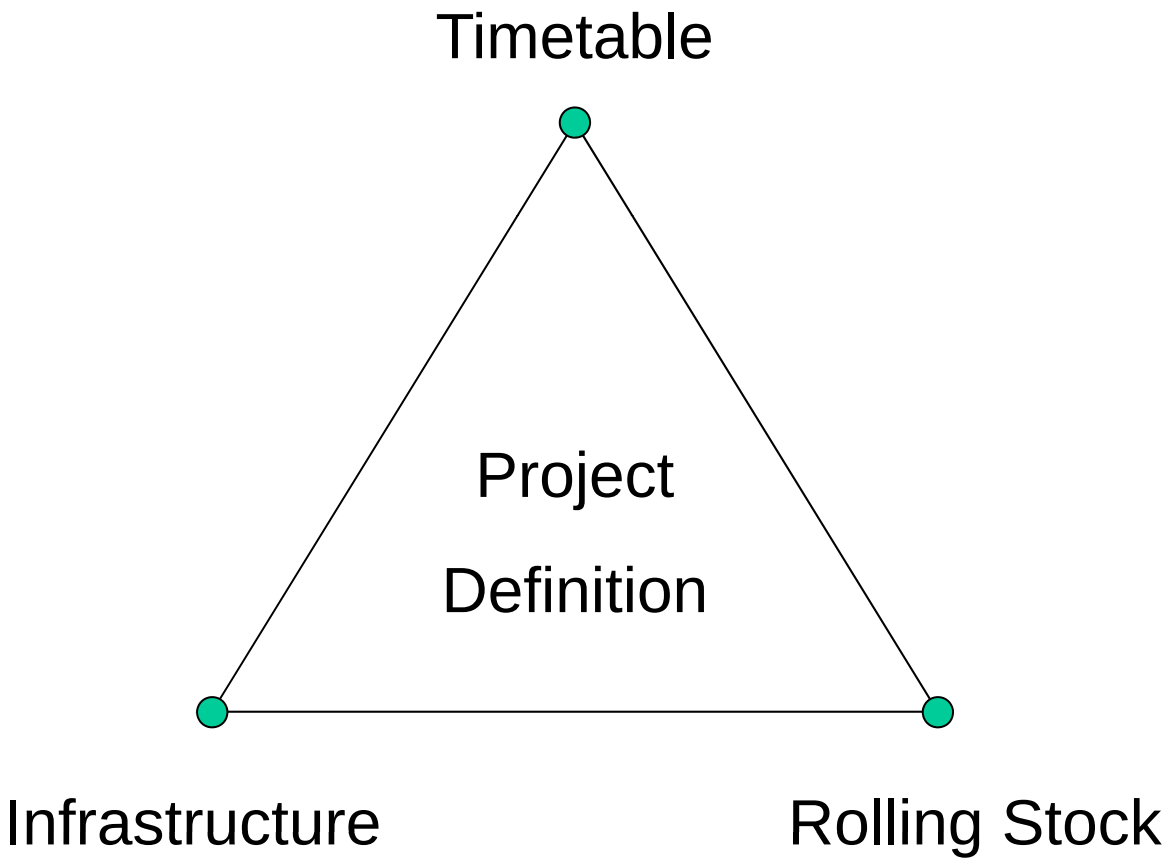
# Curious Case of the Crossover

Warrington Bank Quay trailing crossover.

- UIC 60 rail to replace 113lb rail turnouts.
- This would require a new geometry.
- Which in turn entailed remodelling of Warrington.
- Crossover not used by any traffic.

# Understand The Whole System

*Source – SBB Bahn 2000 Programme*



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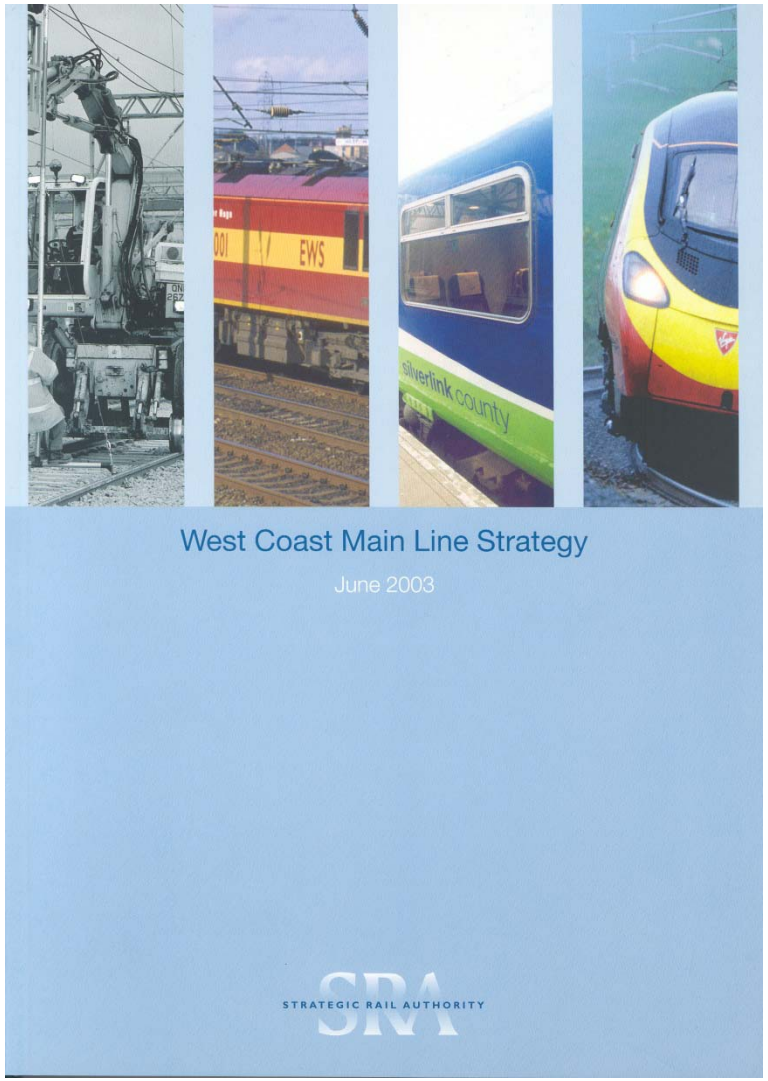


*Editor and controlling mind: Stuart Baker*

# Southern New Trains

Driven by HSE Deadline :
1 January 2003

- 1,738 Mk1 vehicles to be replaced with 2000 + new vehicles
- Power Supply Upgrade : 90 DC sites + High voltage routes
- Lengthened Platforms
- New Depots
- Etc…….

# Southern New Trains

| | |
|---|---|
| Old 4 CIG | 152 t |
| New 4 Car Electrostar | 173 t |
| Increase in weight | 14% |

# Southern New Trains

| | |
|---|---|
| Old substations in Brighton area | 10 MW |
| New substations in Brighton area | 22.5 MW |
| Increase in power | 125% |

# Southern New Trains

With NR and Southern TOC teams :

- Tested power model with measurements
- Concentrated on critical sites
- Revised guidance on long trains at short platforms
- Detailed scope control process
- Developed standard designs & processes

# Southern Region New Trains

| Southern Region Power Supply Upgrade | |
|---|---|
| Original Estimate | £100m |
| NR Largest Estimate | £1.2bn |

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| Value Of Traffic | £500m |

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| Southern Region Power Supply Upgrade | |
|---|---|
| Original Estimate | £100m |
| NR Largest Estimate | £1.2bn |
| Delivered Cost | £652m |
| Value Of Traffic | £500m |
| Efficient Specification | £100m - £200m ?? |

# SRA Sponsorship - Results

| Project | Original Estimate | Largest Estimate | Delivery Cost |
|---|---|---|---|
| Felixstowe – WCML Gauge | ?? | £180m | <£28m |
| WCML Upgrade | £500m | >£13bn | <£9bn |
| Southern Power | £100m | £1.2bn | £652m |
| ECML Upgrade | £1bn | £4bn | £300m (Postponed) |

# Some Reflections

"Engineers will go on forever trying to get a bit more in ... make it better and better," says Mr Armitt. "Somebody has to say: 'We can't afford that'." *House of Commons Standard Note - WCML*

“The Strategic Rail Authority clarified the direction, scope and expected outputs of the programme in the June 2003 *West Coast Main Line Strategy* and engaged stakeholders in support of the programme.” *NAO Report – The Modernisation of the WCML*

“A directing mind, even if lacking full executive authority was able to produce significant results within a fragmented institutional framework” *Terry Gourvish – Britain’s Railways 1997 to 2005*

# Lessons From SRA Projects -1

1. Project teams may not :

   - Understand value of traffic

   - Have incentives aligned to whole rail business

   - Have time to challenge standards and their application

# Lessons From SRA Projects -2

1. Leadership is necessary.

2. Specify complete systems.

3. Engineering detail drives cost:

   - Review standards in advance

   - Measurement beats modelling

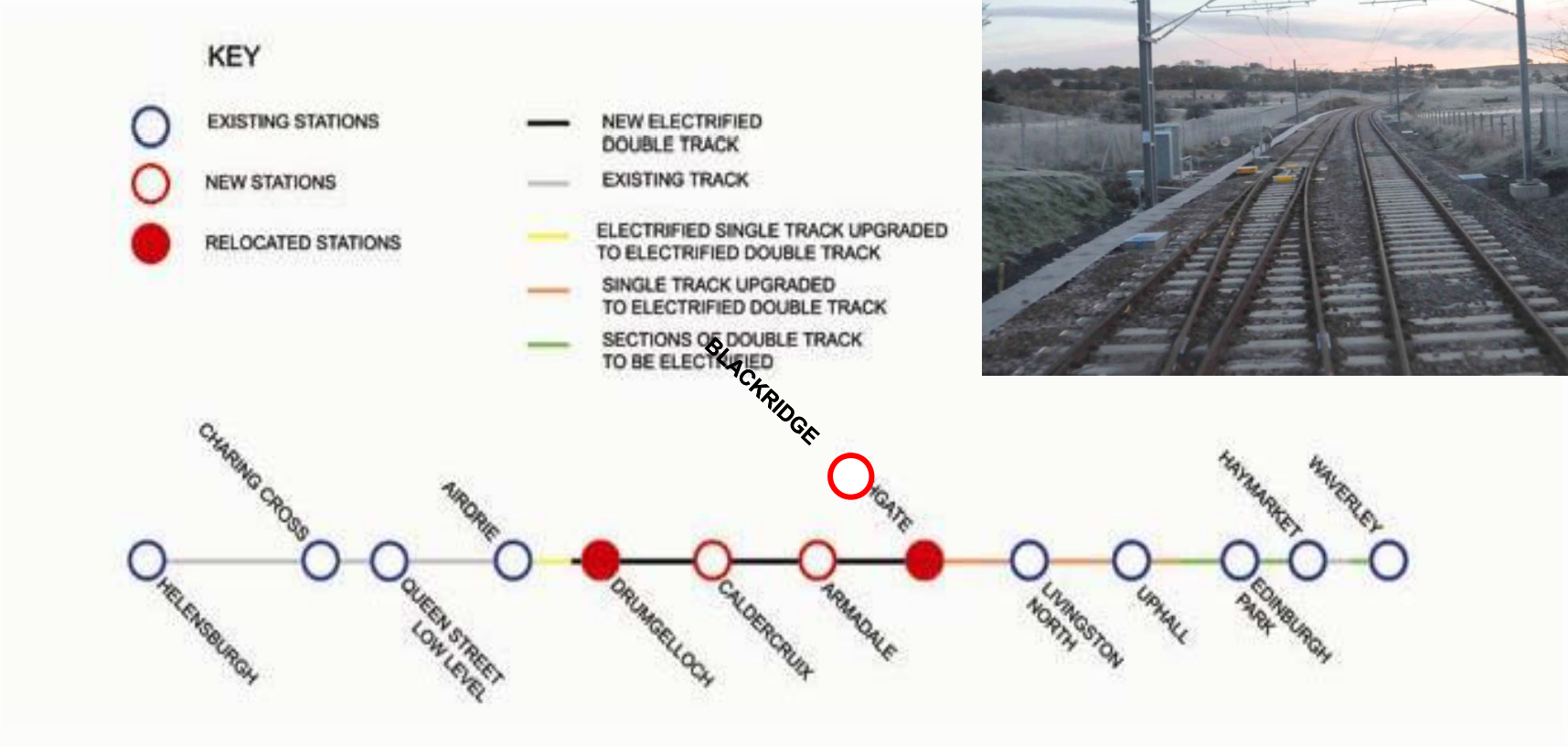
# Scotland - Class 380 EMUs

| | Length | Weight |
|---|---|---|
| Class 350 | 4x 20m | 179.3 t |
| Class 380 | 4 x 23m | 168.0 t |


- 3 car acceleration – 1 m/s²
- 4 car acceleration – 0.9 m/s²

- Dwell time of 30s

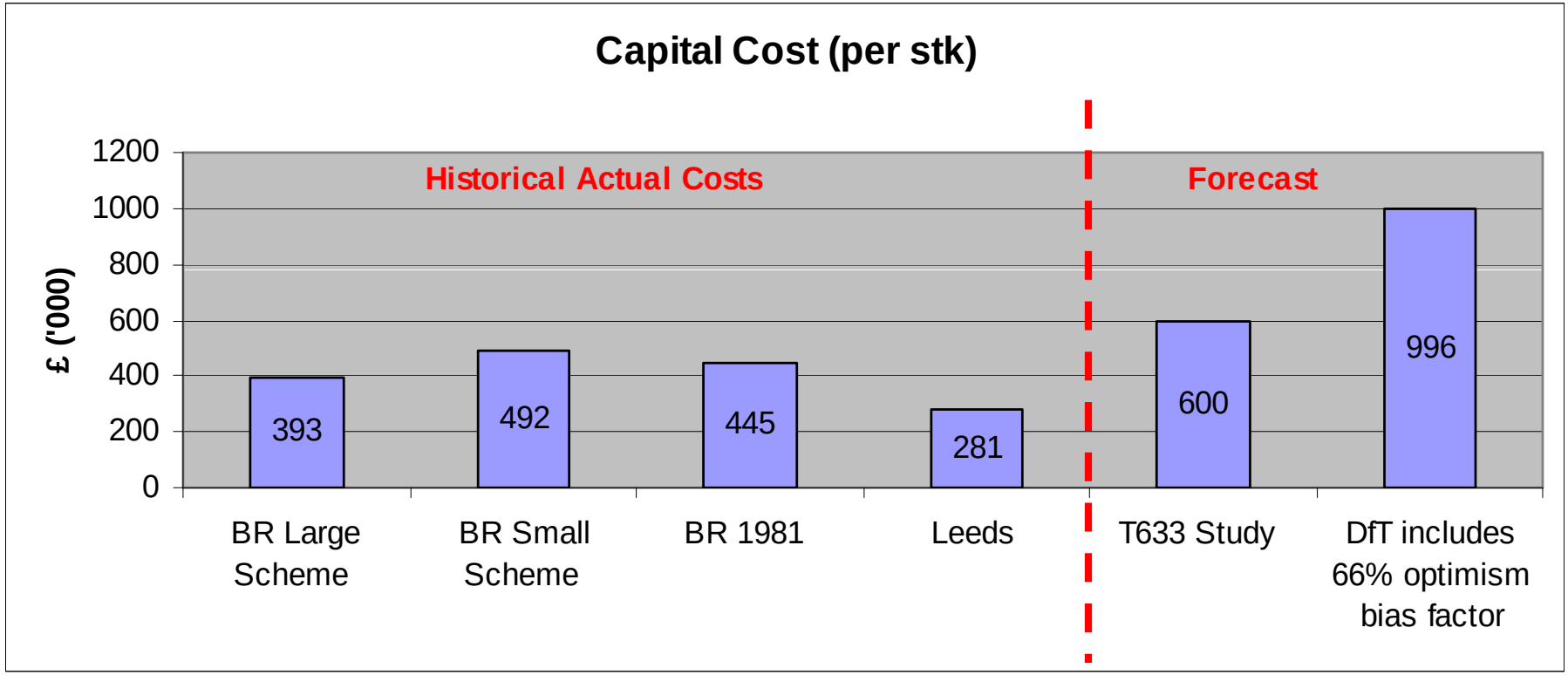
# Scotland : Airdrie - Bathgate



# A-B Fixed Price £370m

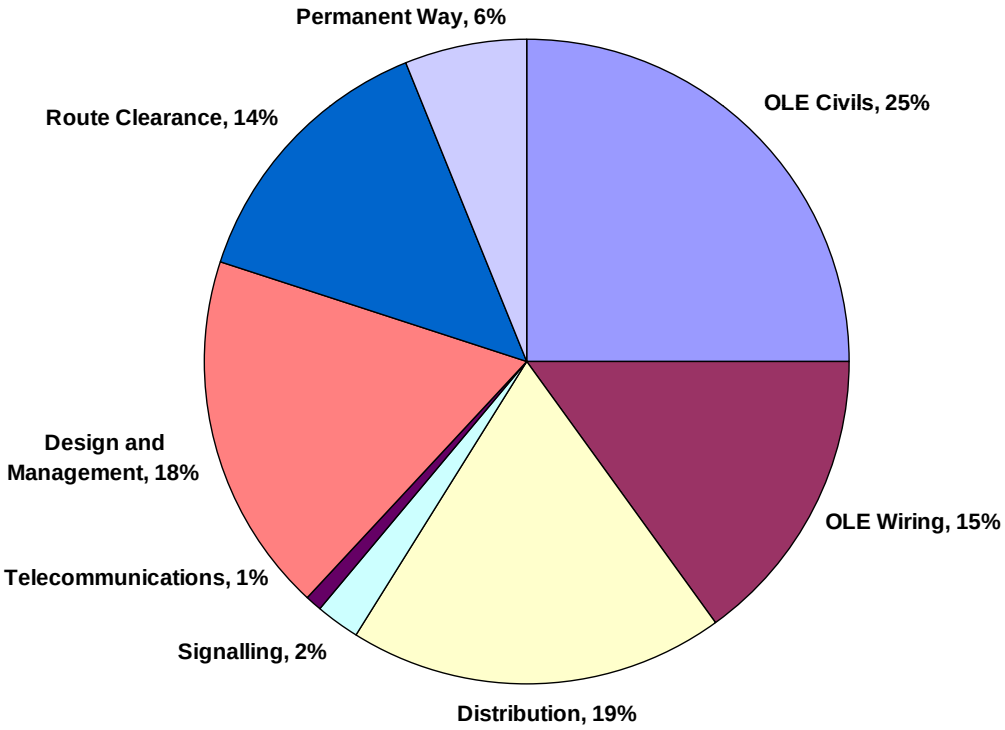
- Price fixed at GRIP 4
- On time and at price
- Fixed price has driven NR innovation
- 6 years from Inception to Opening

# Electrification Cost Challenge



# Edinburgh – Glasgow Electrification

## *Initial Grip 1 Estimate*




**> £1 m single track km (no compensation costs included)**

# Signalling Progress

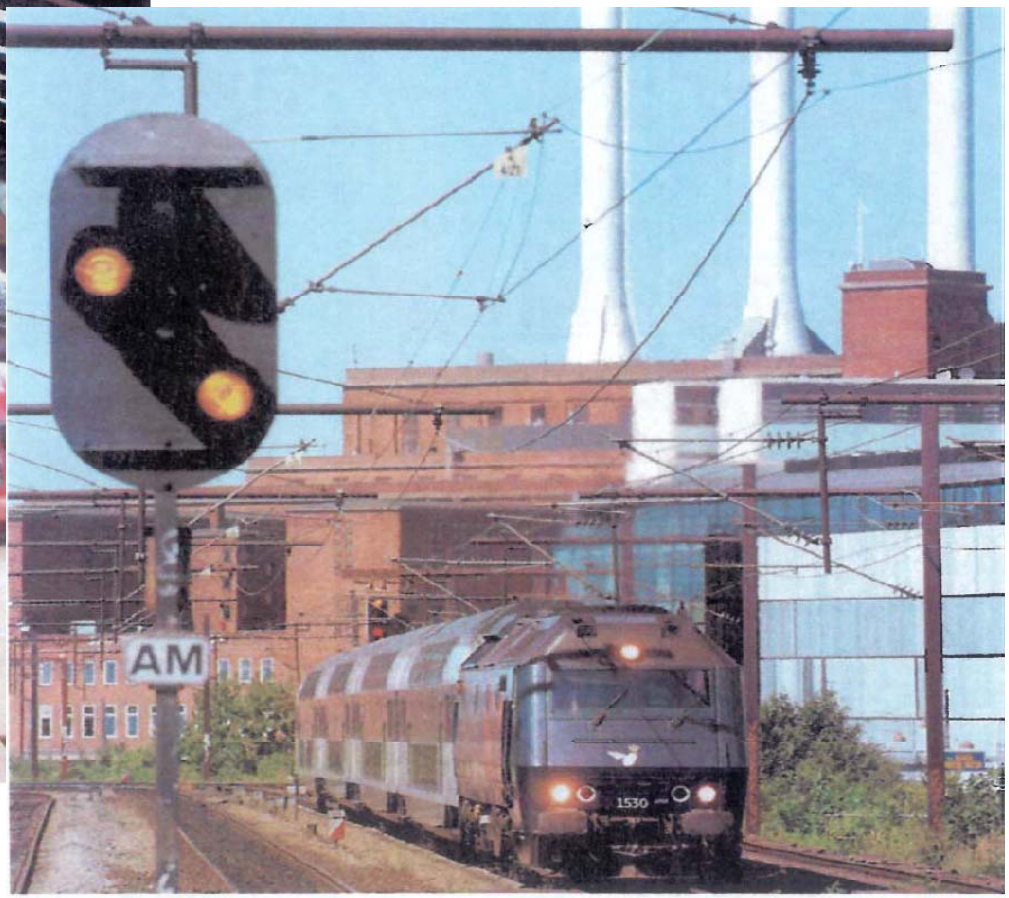
| Technology | Cost Of New Siding |
|---|---|
| ERTMS | ??? |
| Computer Based Interlocking | High |
| Solid State Interlocking | |
| Route Relay Interlocking | |
| Mechanical Interlocking | |
| Handpoints | Low |

# Signalling Progress ?

Institution of MECHANICAL ENGINEERS

# Funny Foreign Things

Denmark




Norway

# Efficiency - Overall Lessons

1. Engineering can transform railway economics.

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5. Benchmark for best practice.

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2. Cost must be controlled by real connection to revenue and value.
3. Whole system specifications are necessary.
4. Attention to detail pays dividends (and if left to project teams in delivery may be too late).
5. Benchmark for best practice.
6. Informed Leadership is essential.

# Railways and Government - 3

"Though very large savings have been made on railways during the past few years, I know that railway administrations would be the last to claim that all possible economies have been effected.

The many phases of railway operation are under constant examination with the object of further reducing costs.

Railways are also fully alive to the urgent necessity of increasing revenues and improving their services to meet the changing needs of traffic. "

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*Earl of Linlithgow, Viceroy of India to Annual Meeting of Associated Chambers of Commerce in India. 22/12/1936*

# A Question Of Brakes

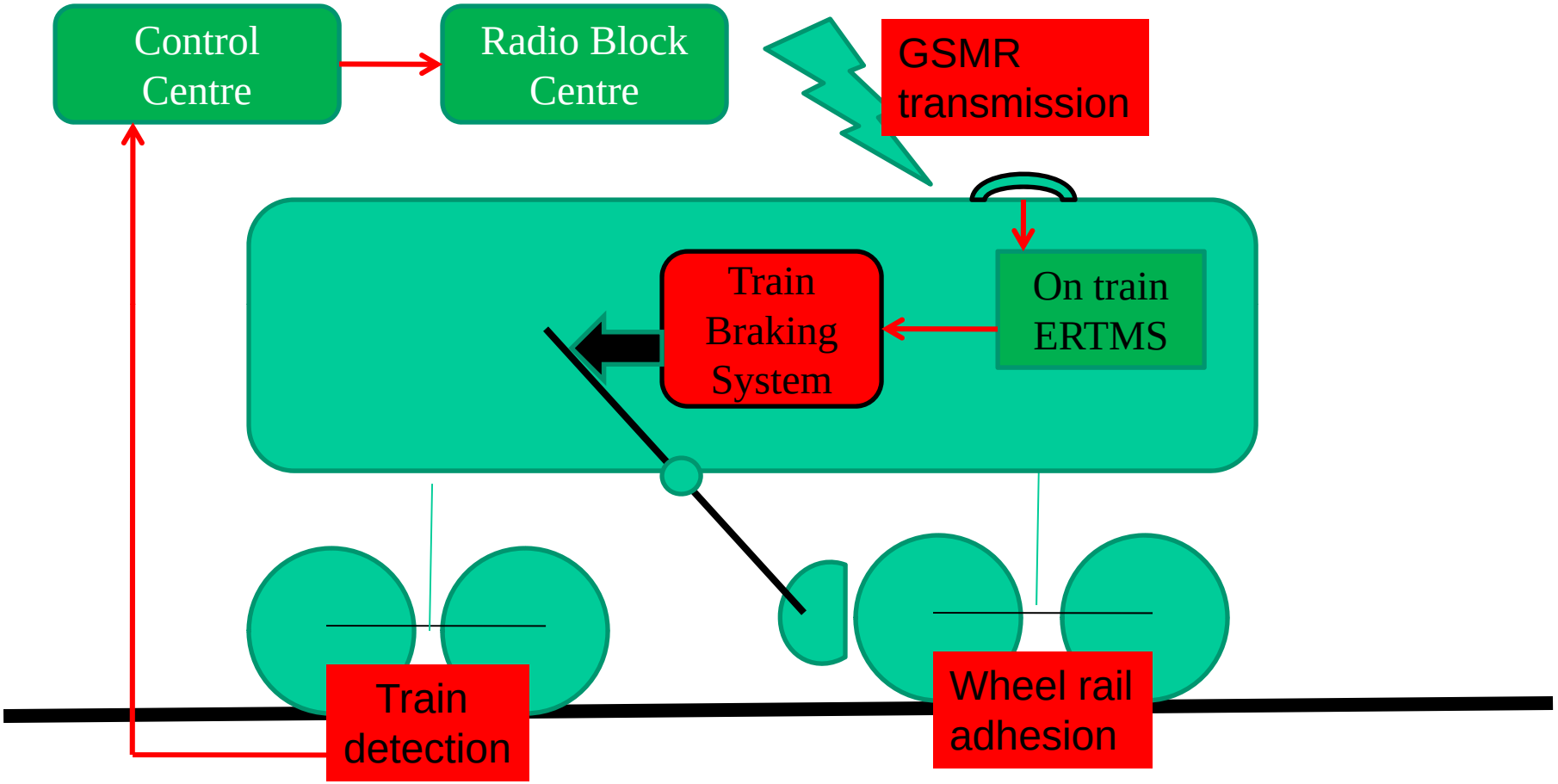
# Coherent Safety System ?

| System | Safety Integrity Level |
|---|---|
| Signalling System | SIL 4 |
| Management of co-efficient of friction at wheel-rail interface | SIL 0 ??? |

"It's brakes that stop trains, not signals !"

*Past President IRSE*

# An Integrated Approach to Collision Risk ?




High SIL Low SIL

*Source – Richard Lockett, RD Past Chairman*

# Adhesion Management

- "Low adhesion remains a significant concern and we are not convinced that the industry has a reliable strategy, both for existing rolling stock and specification for new rolling stock. Consequently, we are examining all aspects of low adhesion and the practicability of introducing a best common European practice."

*ORR Health and Safety Report, July 2011*

# Track Brakes - Magnetic


- Mandatory in Germany above 140 kph

# Track Brakes - Induction

- Mandatory in Germany above 250 kph

# Braking Comparisons

| Train | Full Service Braking Rates m/s/s | Emergency Braking Rates m/s/s |
|---|---|---|
| Germany | | |
| ICE > 220 km/h | 0.9 | 0.9 |
| ICE < 220 km/h | 0.9 | 1.5 |
| German LCHS | 0.9 | 1.5 |
| German emu/dmu | 0.9 | 1.5 |
| Britain | | |
| HST | 0.9 | 0.9 |
| Class 170 dmu | 0.9 | 1.2 |
| Class 380 emu | 1.0 | 1.2 |

# Impact on Accidents

| Accident | Description | Estimated Effect Of Track Brakes |
|---|---|---|
| Clapham | Mk1 emu ran past faulty signal into rear of stopped train at 35 mph. 3rd train ran into crashed vehicles.<br>**35 killed** | Closing speed reduced from 35 mph to 21 mph.<br>**Kinetic energy at first impact reduced by 60%** |
| Southall | HST ran past signal at danger into freight train.<br>**7 killed** | HST would have stopped in less than 2/3rds of available distance<br>**Collision Avoided** |
| Ladbroke Grove | Thames Turbo ran past signal at danger into path of HST.<br>**31 killed** | Closing speed reduced from 130mph to 105 mph.<br>**Small reduction in kinetic energy** |

# Capacity & Journey Time

| Train | Full Service Braking Rates m/s/s | Emergency Braking Rates m/s/s | Braking rates for operational planning m/s/s |
|---|---|---|---|
| HST | 0.9 | 0.9 | 0.67 |
| Class 170 dmu | 0.9 | 1.2 | 0.78 |
| Class 380 emu | 0.9 | 1.2 | 0.78 |

If track brakes improve the dependability of braking rates, then timetables may be planned with higher braking rates.

# A Timely Debate

- RAIB recommendation
  - **Autumn Adhesion Investigation Pt1 :** Report Number: 25/2006 **Recommendation 23**

    "RSSB to initiate a project to evaluate the costs and benefits of equipping multiple units operating over the British mainline network with magnetic track brakes for use in emergencies under low adhesion conditions."

•Is it time to adopt the observable benefits of track brake technology in Britain ?

# Part 3

# Opportunity For All

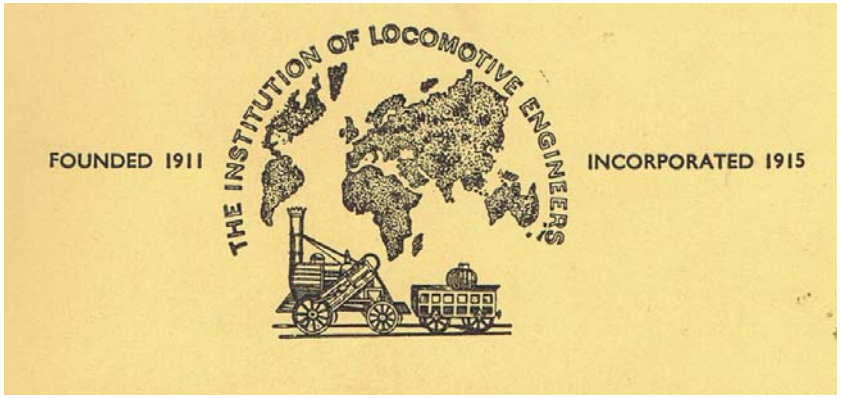
# Origins Of Railway Division

- Institution of Mechanical Engineers founded 1847 following lineside discussion at Bromsgrove
- George Stephenson first President

# Origins Of Railway Division

Institution Of Locomotive Engineers - 1911

This is our Centenary




- Objectives :
  - The reading and discussion of papers
  - The dissemination of information concerning locomotive engineering and the allied sciences
  - The visiting of locomotive works and running departments of interest
  - The mutual assistance and intercourse of members
- Merged with I.Mech.E in 1969

# Origins Of Railway Division

- "that by uniting their talent together they would be in a Condition to compete with any other nation in the world"

- "perseverance was particularly required in getting on in Engineering and they must make up their minds to throw all difficulties over if they were right in their Mechanical notions they would be sure in the end to succeed"

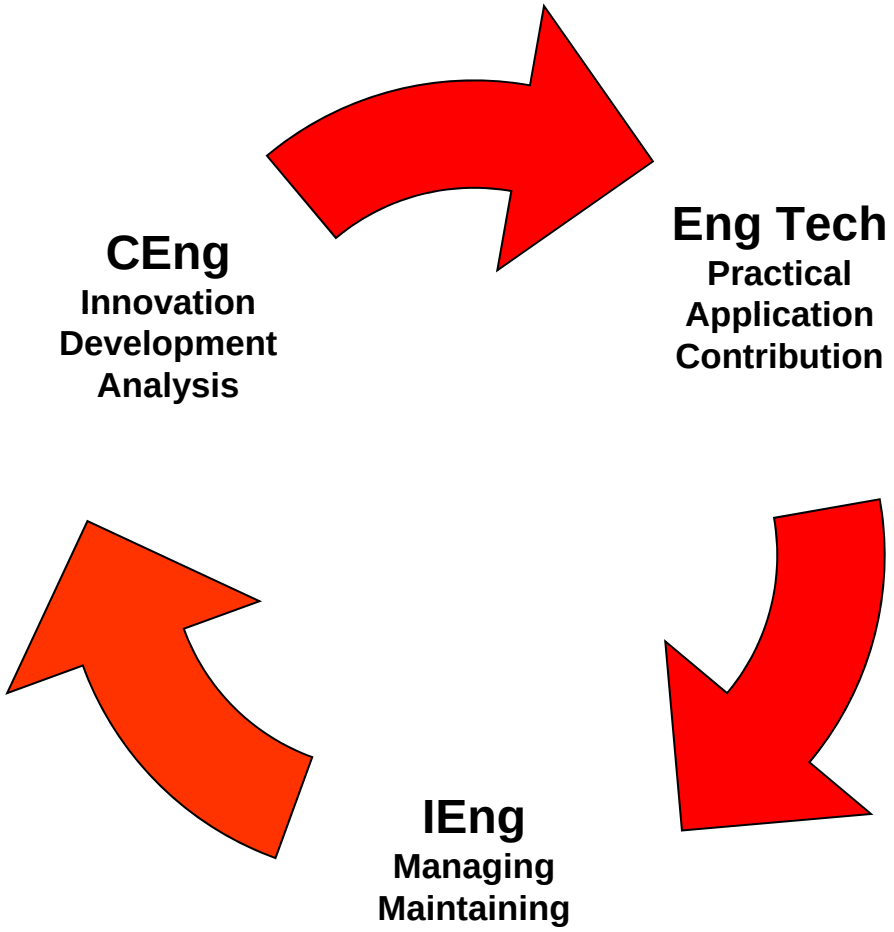
*George Stephenson*

# Types of Membership

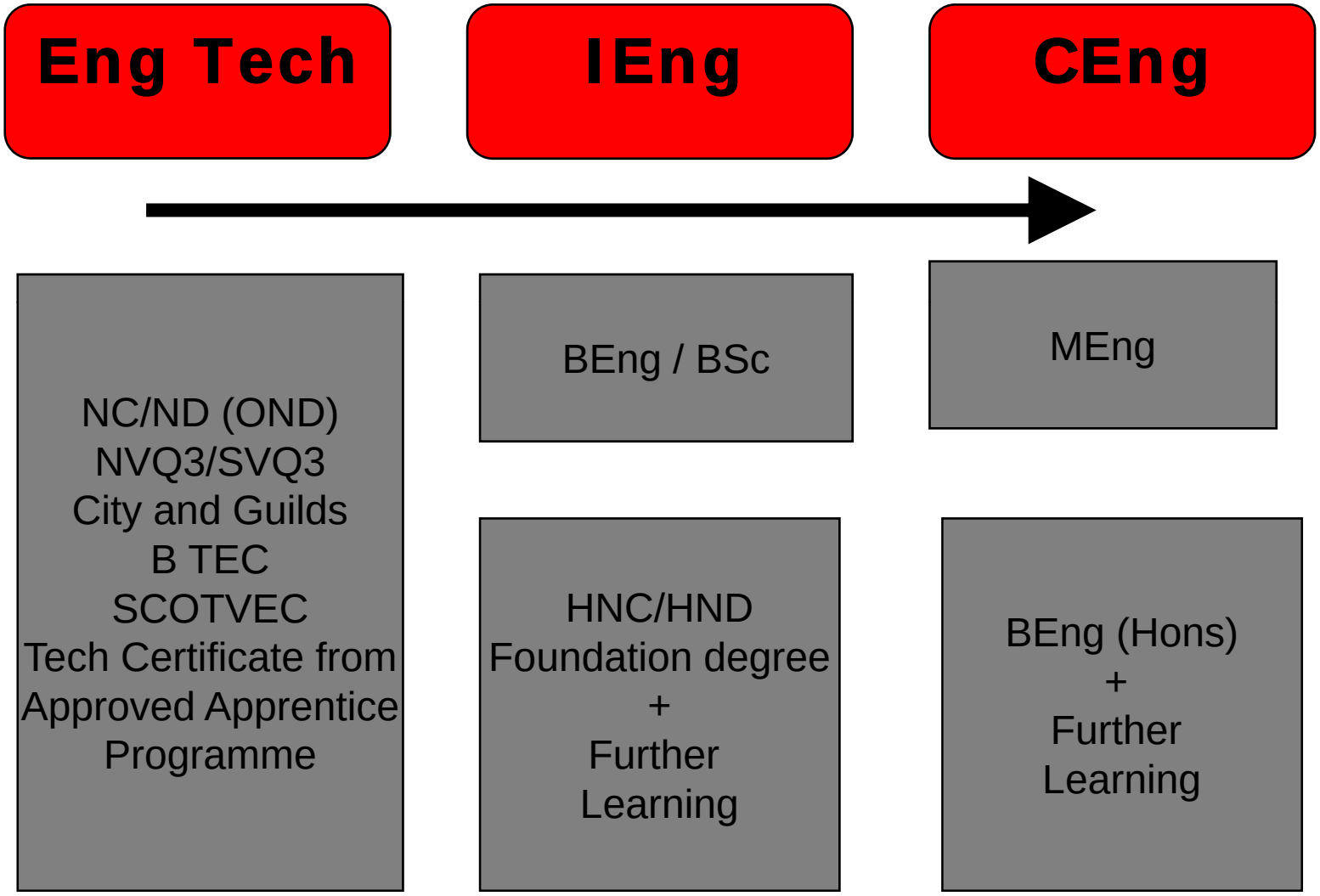
**Engineering Technician**

**Incorporated Engineer**

**Chartered Engineer**



# Current Qualifications required to gain Professional Registration



# Railway Division Membership

| | |
|---|---|
| Fellows | 17 % |
| Chartered Engineer | 59 % |
| Associate Member (Graduate) | 23 % |
| Incorporated Engineer | 0.4 % |
| Engineering Technician | 0.1 % |

# Apprenticeship To Fellowship

The National Skills Academy
RAILWAY ENGINEERING

**NSARE CONFERENCE,**
**22nd June 2011**

**The scheme will enable apprentices to gain professional recognition at all levels within their Engineering Institution, and will provide an equally valued route to the top of the engineering profession in addition to the traditional academic route.**
**It will transform career opportunities for engineering apprentices joining the railway industry.**

# Membership Initiatives

- NSARE Professional Engineering Institutions Policy Group - Chaired by Stephen Tetlow - Chief Exec. IMechE
- Railway Engineering Training Courses
  - Rolling Stock
  - Signalling (in partnership with other bodies)
  - More to follow
- Network Rail apprentices as Affiliate Members

# A Centenary Vision

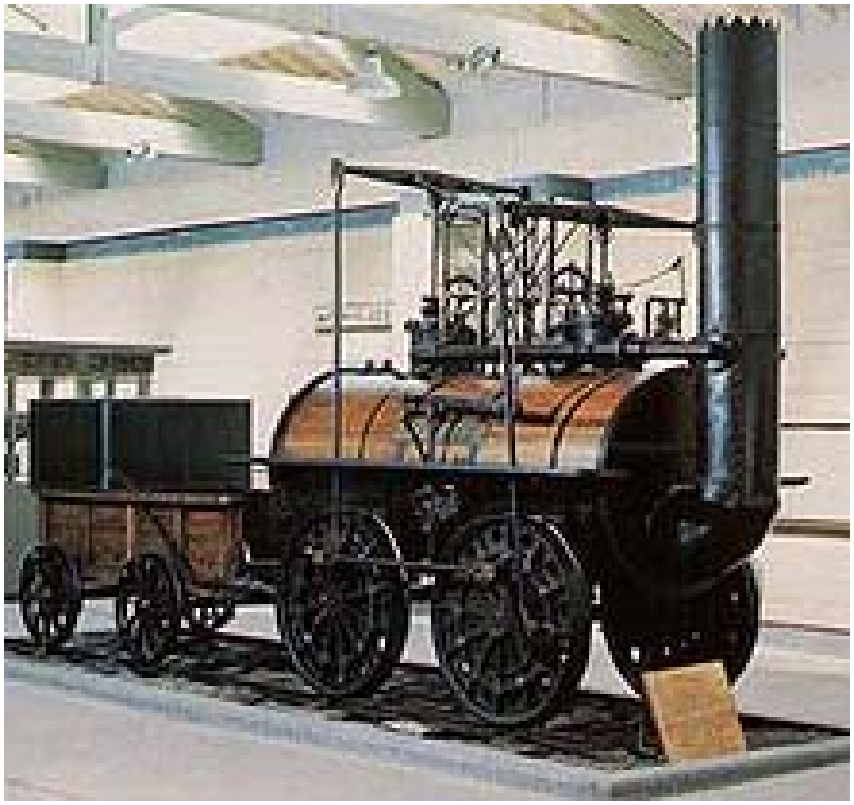
The Railway Division promotes
**Excellence and Opportunity**
in Railway Engineering.

- **Excellence** by exchange of knowledge and best practice through lectures, seminars, technical visits and publications as a Learned Society.

- **Opportunity** by providing a framework within which **people who combine aptitude with application** can advance their competence and professional recognition.

# Railways & Government - 4

- "when he went to Parliament with his little tin model of this locomotive engine and stated to the Committee that he would make an engine to go 10 or 15 Miles an hour he was at that time taken by some to be a foreigner and other thought him mad."



*George Stephenson*

# Part 4

# Innovation

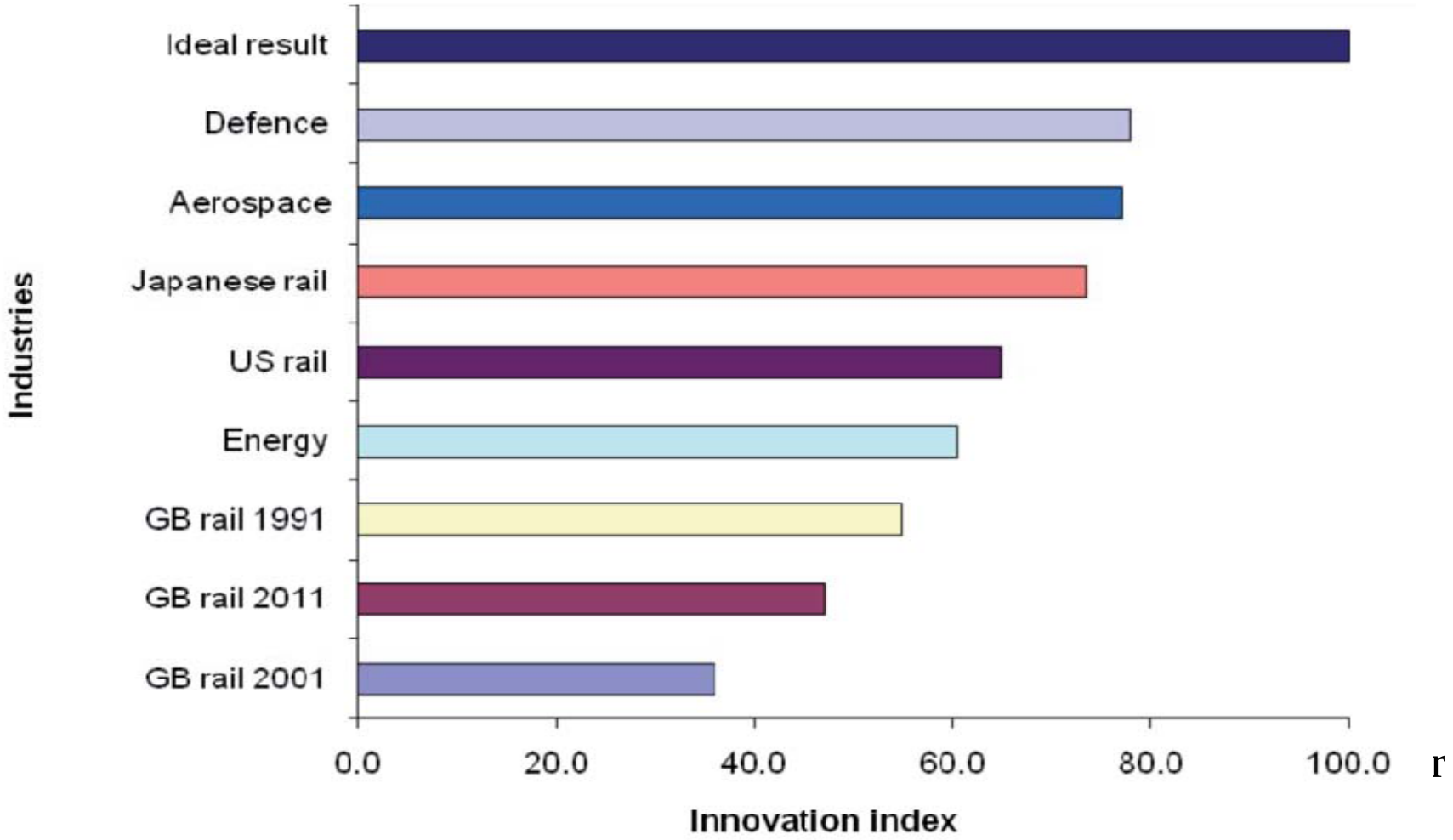
# Innovation

- "A common theme across all the areas of research undertaken by the Study was that improving innovation in the rail industry would reduce its costs."

- "There was a widespread recognition that, in terms of innovation, the GB rail industry lagged behind other railways, other transport modes and other industries"

*Source : McNulty - Detailed Report*

# Innovation


Ideal result
Defence
Aerospace
Japanese rail
US rail
Energy
GB rail 1991
GB rail 2011
GB rail 2001
Industries
0.0
20.0
40.0
60.0
80.0
100.0
Innovation index

NATIONAL RAIL AWARDS 2011

Presented by RAIL Business Events

Institution of MECHANICAL ENGINEERS

# The Stephenson Award

## For Practical Engineering Innovation

# Summary

1. Reflections on efficient engineering.
2. Time for track brakes ?
3. Development of all engineers.
4. Stephenson Award For Engineering Innovation.

# Chairman's Address

## Efficiency & Opportunity In Railway Engineering



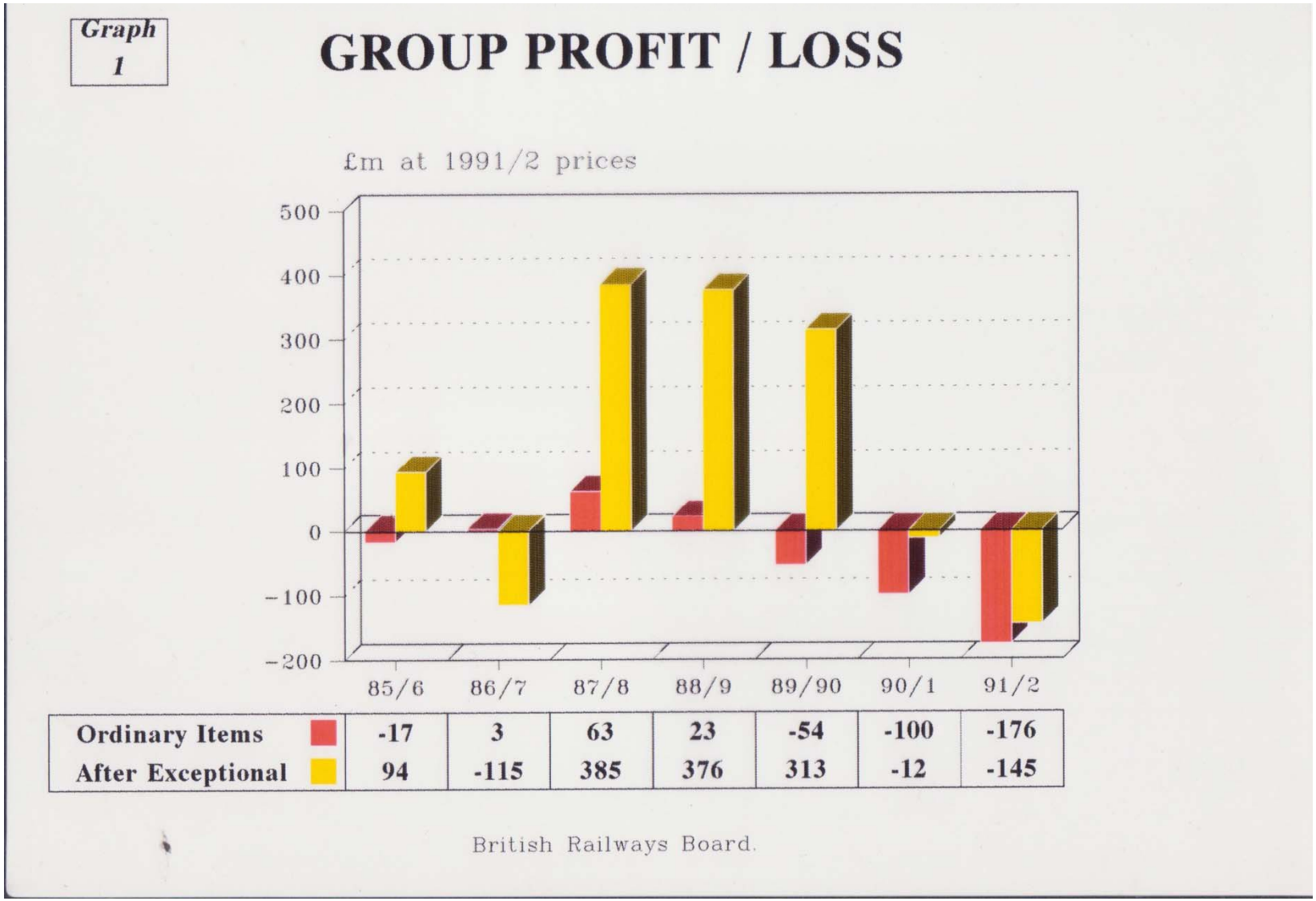
*Bill Reeve  Commercial Director, Transport Scotland*

# Reducing Subsidy


FINANCIAL SUMMARY

| £m. @ 83 prices | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|
| Consolidated Profit and Loss | | | | | | |
| Railways before PSO | (960) | (891) | (840) | (736) | (670) | (639) |
| PSO | 943 | 877 | 845 | 772 | 727 | 708 |
| Railways after PSO grant | (17) | (14) | 5 | 36 | 57 | 69 |
| Other Activities | 15 | 6 | 12 | 17 | 19 | 24 |
| Consolidated Profit/(Loss) | (2) | (8) | 17 | 53 | 76 | 93 |
| Financing Requirement | | | | | | |
| Surplus/(Borrowing Requirement) | 180 | 43 | (43) | (31) | 18 | 70 |
| Investment charged to Capital and Revenue Accounts | | | | | | |
| Total Investment | 307 | 357 | 430 | 406 | 400 | 350 |

# Profitable-ish Railway



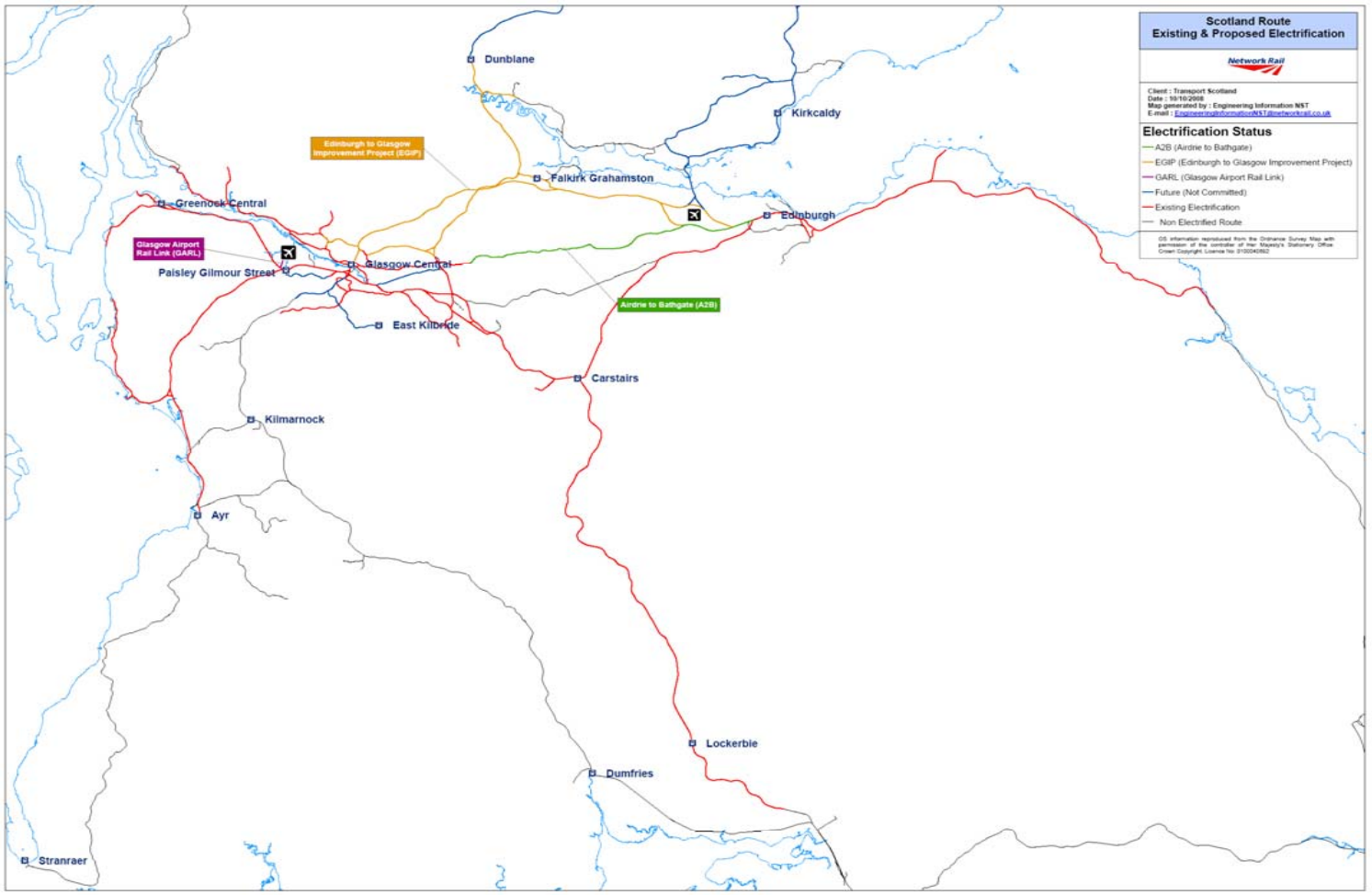
# Crewe Works

- “Sons were often sent to Crewe because fathers felt it was the only hope for boys whose school results were too depressing for any of the traditional professions. If not the Church, then Crewe would have to do.”

# The Intermodal Challenge

- At the competitive limits of rail freight
- Rail freight rate = road rate - lift costs - road cartage costs - competitive margin
- Profit = rail freight rate - costs


# Scottish Electrification



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RAILWAY ENGINEERING

**Professional Engineering Institutions Policy Group**

- **Chaired by Stephen Tetlow - Chief Exec. IMechE**

- **Membership: All Engineering Institutions with an interest in railways + Engineering Council + NSARE**

# Summary

1. Reflections on efficient engineering
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