Birmingham Centre for Railway Research and Education

Engineering and Physical Sciences
School of Electronic, Electrical and Computer Engineering
Birmingham Centre for Railway Research and Education

Leading expertise in:
  - Aerodynamics
  - Condition monitoring
  - Data integration
  - Environmental engineering
  - Geotechnical engineering
  - Metallurgy and NDE
  - Modelling and computation
  - Power and energy
  - Risk and safety
  - Systems engineering
  - Railway capacity
  - Real-time traffic management
  - Railway education
Existing Collaborations

Types of collaboration:
- Directly funded contract research
- Industrial ‘Strategic Partnerships’
- Collaborative co-funded research
- Government funded research (EPSRC, DfT)
- European Commission funded research

Research collaborations in:
- UK, France, Germany, Italy, Sweden, Netherlands, Portugal, Greece, Spain, Belgium, USA, Japan, China, Hong Kong, Malaysia, Singapore
Postgraduate courses:
PhD/MPhil (various options) – see PG prospectus

Group Overview

Largest railway research group in Europe:
17 Academic staff, 18 Research staff, 3 Support staff,
45 PhD students, ~100 MSc/MRes students

A number of bespoke test rigs:
Aerodynamics rig, track bed rig, non-destructive test equipment,
traction test laboratory, train door test rig, level crossing rig,
spinning rail rig, robotic inspection equipment, in-service measurement trains, switch rig, environmental chambers, bearing test rig, anechoic chamber for acoustic tests
Railway Condition Monitoring
(to automatically detect faults)

- Developed algorithms for fault detection and diagnosis of point machines used on 5,000 switches for Network Rail – similar work is now being undertaken with Japan Central Railways
- Monitoring energy usage on the MerseyRail DC power network to quantify losses
- Instrumentation of in-service trains in the UK to measure track geometry and develop automatic event detection
- Development of condition monitoring for train doors
- In-service bearing test equipment developed for Hitachi
Data Integration and Management
(to connect systems and get value from data)

- Strategic Partnership with Network Rail in the area of Data Integration
- Development of a data architecture and models for future European Train Control Systems
- Signalling data architecture for Invensys
- Integration of train delay and climate data to predict and mitigate future disruption
- Further development of the RailML standard
Environmental Engineering
(forecasting and mitigating against climate)

- Development of winter preparation procedures for network rail
- Facility to testing switches in freezing conditions
- Practical test to measure the effect of the impact of temperature on rail infrastructure
- Undertaken a national project to spatially identify locations of track prone to railway buckling
- Modelling of economic costs of increased temperatures on the rail network in terms of increased track failures and thermal comfort
Power and Energy
(to gain energy savings)

- Single train simulator for calculating power and energy requirements and comparing new rolling stock designs
- Developed widely used multi-train simulator to understand power flows in AC and DC railway power networks
- Electrical Storage Integration Laboratory part-funded by ERDF
- Supporting the UK Department for Transport and Singapore Land Transit Authority with train procurement
- Development of methods for energy efficient timetables
- Helping industrial partners with the design of battery, hybrid (diesel-electric) and hydrogen powered trains
Railway Capacity
(to understand the complexity of operations)

- Reports for the UK Department for Transport on improved methods for capacity analysis
- Helping with capacity planning on London’s Thameslink line
- Development of new capacity analysis methods, now used by Network Rail, SNCF, RFI, Trafikverket
- Assessing timetables for robustness, resilience and stability
- Development of a new capacity measure to replace UIC406
Real-time Traffic Management
(to develop the next generation of train control)

- Supporting Network Rail with traffic management investment decisions
- Comparison and benchmarking of traffic management algorithms
- Development of a new traffic simulator for testing traffic management systems – hardware and humans in the loop
- Establishment of benchmark lines for comparing commercial systems in UK, France, Italy and Sweden
- Technical lead of the EU ‘ON-TIME’ project
Railway Education
(to educate and develop railway engineers)

- International MSc programme in Railway Systems Engineering with students from around the world
- Sponsored students from: UK, Ireland, Norway, Turkey, USA, Australia, China, Hong Kong, Malaysia, Singapore, Thailand
- MRes programme established in 2011
- Additional courses for: London Underground, Bechtel, Alstom and Department for Transport
- Railway text books published
Example of student projects
Joint MEng project with GE wind power conversion systems 2013

- Design process relies on software at the concept design stage
- Project idea developed during my placement and expected to start in Graduate training scheme
- Project also is a part of knowledge development and continuity to future projects

Renewable generation

GE 690 V 2.3 MW wind converter
UK designed and built
3.5 GW delivered in 2010

[Converteam Annual Report 2010]
10% of 35.8 GW global annual installed capacity

Signal to analyze

Selected signal: 25 cycles. FFT window (in red): 2 cycles

FFT analysis

Sampling time = 8e-007 s
Samples per cycle = 25000
DC component = 0.001247
Fundamental = 0.9033 peak (0.6387 rms)

Total Harmonic Distortion (THD) = 11.30%

Maximum harmonic frequency used for THD calculation = 624950.00 Hz (124x fundamental)

FFT settings

Display style:
List (relative to specified base)
Base value: 1.0
Frequency axis: Hertz
Max Frequency (Hz): 3000

Available signals
Structure:
scope_B2
Input:
input 2
Signal number:
1

FFT window
Start time (s): 0.4
Number of cycles: 2
Fundamental frequency (Hz):
50