Sustainable Infrastructure Systems

UNIVERSITY OF Southampton

Third Annual CDT-SIS Conference:

Infrastructure and the Environment

EPSRC
Engineering and Physical Sciences Research Council

8th November 2017

Live tweet questions and comments throughout the day of the conference:

@CDTConference

Centre for Doctoral Training in Sustainable Infrastructure Systems
Graduate School Office
Faculty of Engineering and the Environment
Building 13, Room 2043
University of Southampton
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Contents

Welcome to "Infrastructure and the Environment" 2017

Welcome to the 2017 Centre for Doctoral Training in Sustainable Infrastructure Systems student run conference. The CDT plays an important role in enabling and carrying out world class research in collaboration with industry, in the strategically vital area of transport, water and energy. The increasing relevance of the CDT to industry, the environment and society is amply and ably demonstrated by the range and significance of the projects outlined herein.

Our Doctoral Training Centre is funded by a £5M grant from the Engineering and Physical Sciences Research Council (EPSRC), together with contributions from a wide range of industry partners. I am delighted to have this opportunity to thank our sponsors and congratulate our students and their supervisors on the breadth, excitement and impact of their work, summarised in this conference.

William Powrie FREng, Dean, Faculty of Engineering and the Environment

CDT in Sustainable Infrastructure Systems/ EngD in Transport & The Environment

Welcome to the annual cohort conference for the EPSRC funded Centre for Doctoral Training in Sustainable Infrastructure Systems (CDT-SIS) held in collaboration with the Engineering Doctorate (EngD) programme in Transport and the Environment (EngD in T&E).

The CDT-SIS focuses on the 3 key infrastructure sectors of *Water*, *Energy* and *Transport* with the view to training future leaders in engineering and science needed to develop the national and global infrastructure systems that are essential for economic growth, security, societal wellbeing and environmental sustainability. The EPSRC Centre is developing a new way of thinking amongst engineers and scientists capable of leading the transformation of the national infrastructure from our current sectorized, carbon intensive inheritance to the integrated, low carbon, digitally enabled systems that will be the hallmark of successful economies in the 21st century.

The Faculty of Engineering and the Environment at the University of Southampton provides an ideal base because of the strength and breadth of its engineering and applied science expertise, and its excellent links to industry and academia across the globe. CDT-SIS and the EngD in T&E align in their shared ethos of developing and applying the fundamental science and engineering research needed to address the key problems facing society today, within the context of social responsibility and environmental sustainability.

The success of the CDT and EngD programmes depends first and foremost on the hard work and application of the cohort of students. However, it would not be possible without the support of the industrial partners, a pool of supervisory academics, and the administrative team based within the Graduate School of the Faculty of Engineering and Environment. I would especially like to thank Lee Chisman, our CDT-SIS administrator, for all his unstinting hard work. Finally, I congratulate the EngD T&E students listed overleaf who have successfully completed their studies in the past year.

Professor Paul Kemp,

Director, Centre for Doctoral Training in Sustainable Infrastructure Systems

City Map, Conference Venue & Getting Here

Car

- Postcode for satnav: SO17 1BJ
- Visitor parking: Pay and Display car park for visitors can be accessed from University Road. Please note it can fill up very quickly in the morning
- From the M3: Exit at junction 14 (Southampton A33)
- From the M27: Exit at junction 5 (Southampton Airport)

Rail

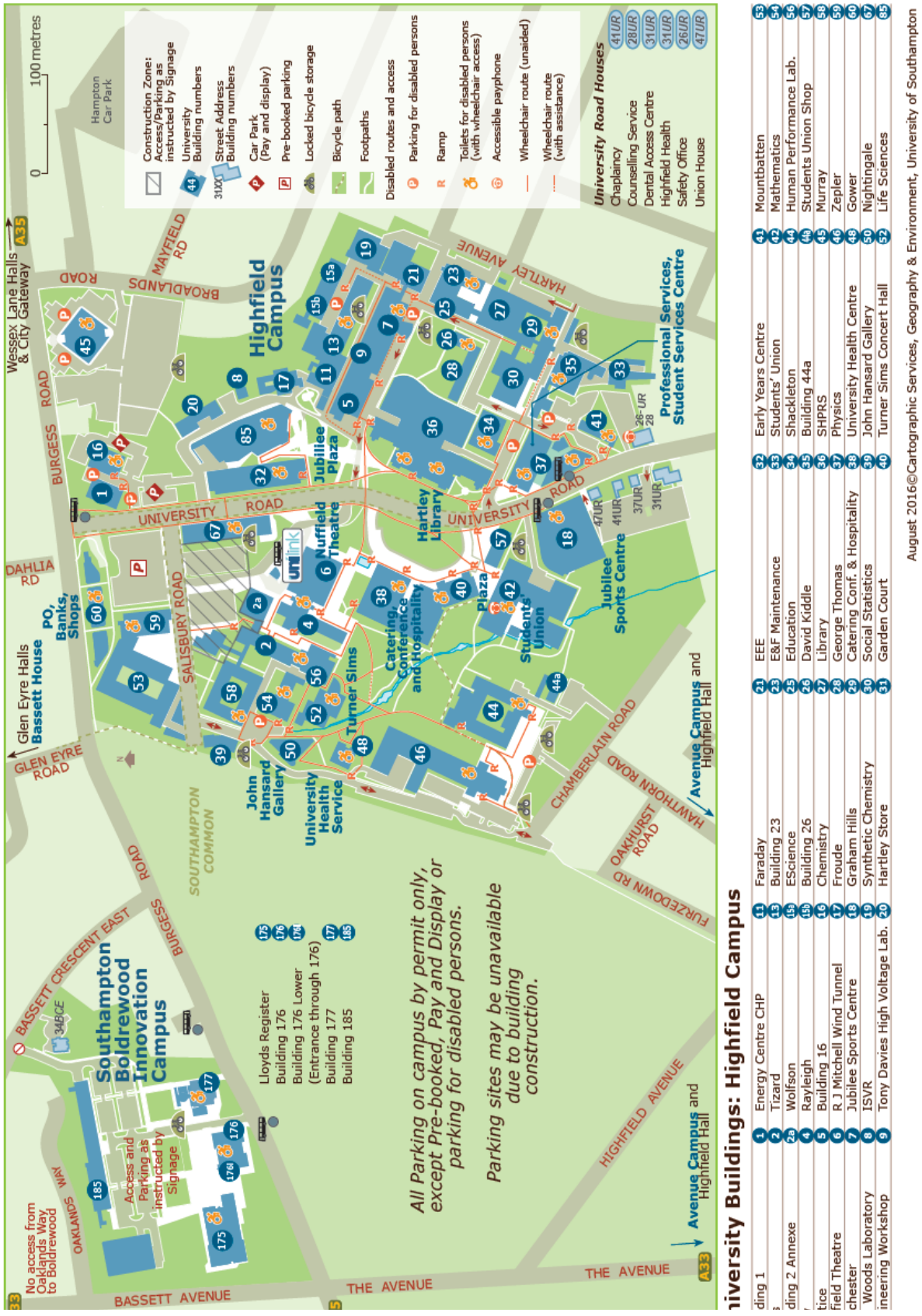
Fast trains from London and Bournemouth/Weymouth stop at Southampton Central and Southampton Airport Parkway. Trains from Portsmouth and Bristol/South Wales stop at Southampton Central. There are also regular trains from major airports such as Gatwick and Heathrow to Southampton Central. You can find details of routes and timetables on the National Rail website.

Highfield Campus is three miles from Southampton Central, and two miles from Southampton Airport Parkway. You can get the unilink bus: U1 from either of these stations to Highfield Campus.

Coach

National Express provides regular coach services to Southampton from central London, Heathrow, Birmingham, Bournemouth and the north. Southampton Coach Station is at Western Esplanade, in the city centre. Some coach services also stop at Highfield Campus.
From Southampton Coach Station you will need to walk to the nearby Civic Centre, where can continue your journey to Highfield Campus using our own unilink bus U1 or taxi. The unilink bus fare is £2 for a single or £3.50 for an all-day pass. Taxi fares from the city centre are usually £6-10.

Garden Court is building number 40 on the below Campus Map



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Official Programme

09:30 - 10:00		**Registration & coffee**
10:00 - 10:05		Welcome - Prof. Paul Kemp
10:05 - 10:30		Key note speaker – Dr. Dhivya Puri
10:30 - 11:00		Water presentations
	10:30	Dr Ian Williams
	10:45	Diego Panici
11:00 - 11:20		Coffee break
11:20 - 12:20		Water presentations cont.
	11:20	Daniella Montali-Ashworth
	11:35	Nick Flores Martin
	11:50	Marwan Khan
	12:05	Questions
12:20 - 13:20		Lunch and poster presentations
13:20 - 14:50		Transport Presentations
	13:20	Ioannis Kaparias
	13:35	Richard McIlroy
	13:50	Dr Madhusudhan Murthy
	14:05	Dr Craig K. Allison
	14:20	Hamad Almujibah
	14:35	Amanda Haylett
	14:50	Questions
15:00 - 15:20		Coffee break
15:20 - 16:50		Energy Presentations
	15:20	Prof. Patrick James
	15:35	Fernando Arenas
	15:50	Maria Ramos Suarez
	16:05	Lara Eggbert
	16:20	Tom Bryden
	16:35	Questions
16:50		Closing remarks - Prof. Paul Kemp

Keynote Speaker

Exploiting the potential of AD in a UK bio-refinery from residual waste

Presenter: Dhivya Puri*

Other contributors: Stefano Gandolfi**, Sonia Heaven**, Charles Banks**;

*Fiberight Ltd,

***Faculty of Engineering and the Environment, University of Southampton*

Absrtact

Fiberight has developed a circular economy solution for residual municipal solid waste (landfill bound MSW) where mixed waste is processed to recover recyclables, energy and Industrial Biotechnology (IB) building blocks. As part of the process the food waste component of residual waste is solubilised and this organic rich liquid stream is fed into high rate anaerobic digestion to produce biomethane and a clean effluent which is recycled back into the process.

The Fiberight process utilises thermo-mechanical treatment and washing to solubilise the food-waste fraction of the MSW. Clean lignocellulosic fibre is then extracted from this washed waste and hydrolysed to sugar via enzyme hydrolysis. The process was originally developed on US MSW which contains a lower foodwaste to paper waste ratio than UK MSW. Due to this key difference in waste composition the current study aimed to increase foodwaste solubilisation of UK MSW in order to obtain a resultant fibre akin to US fibre. A design of experiments (DOE) study was carried out on the wash step to test the effect of process variables, including; time, temperature and additive concentration, on the solubilisation of organic matter.

The analysis of the built model for the MSW washing indicated that the temperature, additive type and concentration up to 1% w/v were the main factors that affected organic matter solubilisation in the washwater. Moreover, the interaction between temperature and additive concentration was observed as important. Compared to water washing, the use of additive B and A resulted in an organic load increase of about 2 and 3-fold respectively. A preliminary study on the additive toxicity showed that additive B is well tolerated by anaerobic granular sludge at any of the concentrations used. Conversely, the increase of additive A led to higher organic strength in the washwater but when this compound was used at over 0.1% w/v an inhibition effect was observed on biogas production. Extraction of the fibre from waste washed in the DOE showed slight differences in the hydrolysability of the resultant fibre.

Keywords: Anaerobic digestion (AD), Municipal solid waste (MSW), Enzymatic hydrolysis, Bio-methane

Biography

Dhivya Puri is the Senior Technical Lead in Research and Development for Fiberight Ltd, an innovative waste-to-IB products company. Dhivya has worked with the UK and US based start-up for the past 7 years and her current role involves developing and overseeing a number of R&D activities within the company.

Dhivya has worked in biotechnology related fields over the last 10 years, this has involved roles in academia, the sugar industry and the waste industry. Dhivya obtained her PhD from the University of Southampton, UK and a Masters in Chemical Engineering and Bachelors in Science (Genetics) from the University of Melbourne, Australia.

Water & The Environment Invited Speaker

Applying circular economy thinking to industry: a case study for southern water

Presenter: I.D. Williams*

Other contributors: K.P. Roberts*, P.J. Shaw*, B. Cleasby**

* *International Centre for Environmental Science, Faculty of Engineering and the Environment, University of Southampton, Highfield Southampton, Hampshire, UK, SO17 1BJ*

** *Southern Water Services Limited, Southern House, Yeoman Road, Worthing, UK, BN13 3NX.*

Abstract

Collaboration between universities and external organisations offers opportunities for multiple and mutual benefits. Academics at the University of Southampton's International Centre for Environmental Science have, over a long period, developed, initiated, and delivered activities that involve collaboration between university students and staff with external organisations. These activities have multiple aims, including:

- Generating new knowledge relating to case studies that exemplify the implications and impacts of resource-related research across a range of spatial scales;
- Providing students with real-world, *in situ* experiences as a means to enhance their skills with regard to problem-solving, sustainability, team-working, consultancy and employability;
- Providing mutual benefits to external organisations, universities and students, through sharing of resources to extend their value and impact.

This presentation outlines the educational approach taken and research results achieved when under- and post-graduate students were tasked with working with a water supply and waste water treatment company (Southern Water; SW) with the aim of identifying opportunities to apply circular economy thinking to SW's operations at a waste water treatment plant (WWTP) in England. The students were presented with a "real world" consultancy task to identify and evaluate the water and waste streams within the WWTP process and produce options for their reduction, recovery and reuse without hindering operational effectiveness. The mutual benefits of this collaborative venture were demonstrated via: i) the utility of students' recommendations and SW's desire to participate in and fund follow-up activities, including academic consultancy, MSc and PhD projects; ii) positive feedback from SW and the students;

and iii) the quality of the exercise as a vehicle for academic learning and development of professional and employability skills. Active learning approaches to education in waste and resource management incorporating consultancy-style work of this nature are strongly recommended.

Biography

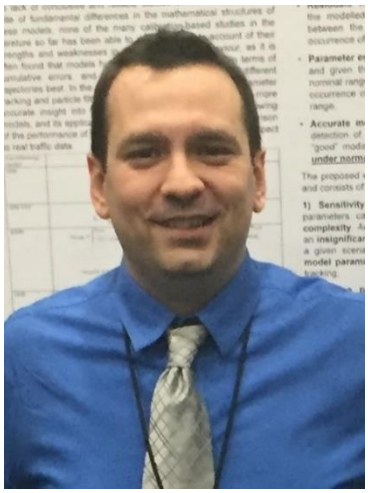
Ian Williams is Professor of Applied Environmental Science and Associate Dean (Enterprise) in the Faculty of Engineering and the Environment at the University of Southampton, UK. He has an established track record in the field of waste/resource management and extensive experience of leading and managing research and commercial projects. Ian has published two books and over 170 peer-reviewed journal papers on waste and environmental issues, as well as over 100 commercial project reports. He has a long track record of holding positions as an External Examiner for taught and research degrees, service on external bodies, sitting on the scientific and organizing committees of several international conferences, working on national and international task groups.

Transport Invited Speaker

Monitoring cyclist trajectories in urban environments using an instrumented bicycle

Presenter: Ioannis Kaparias

Transportation Research Group, University of Southampton



Absrtact

Cycling is an increasingly popular mode of travel in cities due to the great advantages that it offers in terms of space consumption, health and environmental sustainability, and is therefore favoured and promoted by many city authorities worldwide. The large number of recently introduced schemes in many cities (such as the Santander Cycle Hire scheme and the Cycle Super-Highways in London) demonstrates this trend. Yet, the relatively low perceived safety of cyclists from the users' side presents itself as a major hurdle to the desired uptake of cycling as a viable alternative to the private car, with a particular source of hazard appearing to originate from the interaction of cyclists with motorised traffic at low speeds in urban areas. Accident numbers, unfortunately, confirm this perception as reality: in 2015 there were 100 cyclist fatalities in the whole of Britain, and this number is only a small part of a staggering total 18,845 cyclist casualties, 80% of which occurred on 30 mph roads. A typical collision pattern observed involves cyclists being "crushed" by turning motorised vehicles, due to their presence in the so-called "blind spot", which is to the left of the vehicle in the UK and to the right in countries with right-hand traffic. Thus, the research reported here involves the development and testing of an innovative technological solution for accurately localising and tracking cyclists in such situations using a low-cost micro-electromechanical systems (MEMS) sensor configuration on an instrumented prototype bicycle system, called "iBike". Recent results from field tests in Central London have shown that the iBike achieves considerably better localisation accuracy compared to, not only mainstream satellite positioning systems (GPS), but also high-specification experimental equipment, such as Inertial Navigation Systems (INS). This makes the iBike an ideal platform for collecting vast amounts of microscopic cyclist-safety-related data from urban environments, enabling the formulation of behavioural and predictive accident models, for use in active and passive safety systems' development, as well as in road safety policy-making. This presentation gives an overview of the iBike system, reports the results of the field tests carried out so far and explores avenues for further research and development.

Keywords: Cycling; road safety; positioning; instrumented bicycle

Dr Ioannis Kaparias graduated with a Master of Engineering (MEng) degree in Civil Engineering from Imperial College London in 2004. He then joined the Centre for Transport Studies of Imperial for his PhD research on the topic of "Reliable Dynamic In-vehicle Navigation", which he completed in 2008, and continued as a post-doctoral Research Associate in the same institution for a period of four years, working on a wide range of transport research projects. From 2012 he held a Lecturer position at School of Engineering of City University of London, and in 2016 he joined the Transportation Research Group of the University of Southampton as a Lecturer in Transport Engineering. His research interests include traffic engineering, modelling and simulation, Intelligent Transport Systems (ITS), network reliability, travel demand, Operations Research, travel behaviour, and transport and public realm, and his work has led to several journal publications and presentations at international conferences. He is also Honorary Lecturer at the Centre for Transport Studies of Imperial College London, as well as an independent expert for the European Commission in research and innovation activities.

Energy & Infrastructure Invited Speaker

Future Cities and Disruptive Technologies.

Presenter: Prof. Patrick James

Professor of Energy and Buildings, Energy and Climate Change Research Group, University of Southampton.

Biography

His research is based on understanding energy use in the built environment whether this is at home, at work or at a broader urban scale. He is a specialist in micro-generation technologies including solar thermal, photo-voltaics, micro-wind and micro-CHP (see www.energy.soton.ac.uk).
Current major research projects span Energy for Development (rural electrification in Africa), future urban environments (liveablecities) and household energy use (energy and community, intelligent agents, energy and census data). He is the Principle Investigator of APERIO, an EPSRC funded study looking into the use of cameras for facade management in non-domestic buildings.
He is the Director of Programmes for postgraduate taught energy, overseeing the (i) MSc Energy and Sustainability, and (ii) MSc Sustainable Energy Technologies programmes. He is an Associate Editor of the IET Renewable Power Generation Journal and an energy based research assessor for several national funding agencies.
He specialises in energy in the built environment, where he teaches modules related to (i) energy performance assessment, (ii) climate change and settlements, (iii) energy resources and (iv) bioclimatic design.

Speaker Abstracts & Biographies

Water & The Environment

Daniella Montali-Ashworth

Fish passage design for guaging weirs

[1] *Water and Environmental Engineering research group, University of Southampton, UK*

Abstract

Longitudinal river connectivity is of significant importance for maintaining or improving population sustainability and diversity of riverine flora and fauna. Gauging weirs act as barriers to longitudinal river connectivity, often preventing fish species from moving between different habitats for spawning and feeding, which can lead to population decline. The success of non-salmonid species in particular has been neglected as the majority of fish passage designs currently available are more effective for salmonids. Here, a fish pass design is proposed which seeks to alter the hydraulic conditions at gauging weirs so that non-salmonid fish can surmount them. A low cost method of modifying flow on the downstream face of Crump weirs to facilitate fish passage is presented where a staggered array of cylindrical bristle clusters create flow resistance, increasing water depth and decreasing velocity. Different array densities (0.05, 0.1 and 0.15m spacing and 0.03m diameter clusters) were investigated and fish passage compared to with an unmodified weir (control). Experimental work demonstrated that upstream passage efficiency (defined as the percentage of fish passing of those that attempted) for roach (*Rutilus rutilus*) was 0 and approximately 30% for the unmodified control and treatments respectively. Passage efficiency was similar between treatments. Fish were observed bursting to the area immediately behind bristle clusters as they ascended the weir, suggesting the utilisation of the low velocity zones created in the wake of the clusters to pass upstream even when bulk flow velocities were greater than burst swim speeds. In addition to this, a range of staggered cluster array densities (0.05, 0.1 and 0.15m spacing and 0.03, 0.05 and 0.07m diameter clusters) $\varphi = (\mathrm{d}^2\mathrm{Nc})/\mathrm{D}^2)$ were analysed to obtain a greater understanding of impacts to the hydraulic environment at the weir. A relationship between array density and drag was determined. Array configurations using larger diameters produced the greatest bulk drag. Further, velocity reduction and depth increase were accomplished without compromising weir gauging accuracy. Following promising experimental results, the efficiency of the fish pass was evaluated in the field (using 0.17m spacing and 0.05m diameter clusters). Upstream passage of a number of coarse fish species including chub (*Leuciscus cephalus*) and roach (*Rutilus rutilus*) was monitored using Passive Integrated Transponder (PIT) telemetry

during Spring 2017 at a 7 m long, 1.2 m wide Crump weir. A relationship was found between fish passage and design installation, with the majority of fish passing only when the fish pass was in place.

Biography

Studied Civil Engineering to Masters level (2010-2014) at the University of Southampton. Progressing to an iPhD seeking to develop a low-cost fish pass solution utilising fundamental hydraulic theory. My research interests are largely in the field of hydraulic engineering and its practical applications to fish passage. I am currently investigating a fish passage design for gauging weir retrofit utilising an array of cylindrical bristle clusters. These clusters, placed on the downstream weir face, will reduce flow velocities in their wake and may be utilised by fish which burst between them. Such a design may result in successful fish passage even when average velocities are higher than burst swim speeds.

Diego Panici

Understanding woody debris jams at bridge piers

[1] *Water and Environmental Engineering research group, University of Southampton, UK*

Abstract

Woody debris accumulations at bridge piers have historically represented a source of additional hazard for flood risk and pier scour. These accumulations reduce the flow area and can significantly increase upstream water levels as well as exerting lateral loads on the pier and exacerbating local scour, which might result in a bridge failure. Although the negative effects of debris accumulation have been widely experienced in both modern and historical bridges, the process by which these jams are formed has yet to be studied. Furthermore, attempts to investigate this problem did not systematically analyse the main factors involved in the formation and growth of large wood debris jams.

The aim of this study is to experimentally analyse the potential size of woody debris accumulations at bridge piers. Extensive experiments were conducted at the Hydraulics lab flume of the University of Southampton. Accumulations were tested varying debris size, shape and flow conditions. Debris were modelled using natural sticks, which were individually introduced into the flume upstream of the pier position.

Results showed that accumulation growth follows a three-phase process: unstable – the jam grows at a fast rate but debris elements are likely to be removed, stable –

accumulation is formed and grows at a slower pace, critical – the jam oscillates about the pier and fails. The experiments have unveiled that the critical stage is reached when the jam displays its maximum size. Furthermore, the debris Froude number Fr_L reveals a significant influence on the maximum size that a jam could achieve: at low Fr_L, the jam is superficial and wide, whereas with increasing Fr_L the jam becomes narrower and deeper.

Keywords: Large Wood Debris (LWD), Flood risk, Bridge pier, Afflux, Bridge blockage

Nicholas Flores Martin

The impact of vibrating needle-injected bubble clouds on cyprinid behaviour.

Abstract

Mitigating the environmental impacts of river, estuarine and coastal infrastructure and the accidental introduction of invasive species is an important engineering challenge. Passage through turbines can cause injury and mortality to fish due to blade strikes and barotrauma, whereas left uncontrolled invasive species will increasingly jeopardize native species, communities, and ecosystems.

A multitude of stimuli have been used to attract, repel and guide fish and responses vary by species, life stage and physiological state. Often, data are contradictory if inadequate testing has been performed. Bubble screens were developed in an attempt to overcome the need for expensive mechanical screens. Sound is generated by bubbles as they detach from the diffuser which results in low frequency (<1000 Hz) sound emissions. Acoustic deterrents appear to have particular promise for species with specialised hearing abilities like Common Carp (Cyprinus carpio) and related species such as Asian carp.

It is commonly thought that reducing the diameter of the hole used to introduce a bubble into a medium will generate smaller bubbles, but this is not so because without vibration the smaller bubbles remain close to the hole and coalesce with successor bubbles, and the bubble which eventually travels into the liquid is large. No previous study has taken this phenomenon into consideration when comparing streams of fine bubbles with streams of coarse bubbles. The present study uses a curtain of fine bubbles, generated by vibrating injection needle using attached encapsulated motors. Passage rates and behaviour of common carp (Cyprinus carpio) to four treatments (control, vibrating motors only, standard bubble generation, fine bubble generation) was investigated.

Future studies will incorporate behavioural tracks relative to plots of the particle velocity component of the sound field. Improved knowledge on the reactions of fish to certain stimuli will in turn help develop better guidance systems for fish.

Keywords: fish, behavioural deterrent, bubbles, renewables

Biography

Nicholas graduated from the University of Malta with a BSc (Hons) in Chemistry and Biology (2004 – 2008), and earned a Master's in Oceanography (2010 – 2011) at the University of Southampton.

He worked for the Maltese Department of Fisheries and Aquaculture (2013 – 2015) co-ordinating fisheries data collection efforts to meet EU obligations under the Data Collection Multi-Annual Programme (DC-MAP), and managed Malta's Gap 2 case study on trawler fisheries management.

He is currently working on developing behavioural deterrents for fish using bubble walls, being particularly interested in whether particle motion plays a role in detection and avoidance of bubble curtains by carp.

Marwan Khan

Faculty of Physical Sciences and Engineering: Department of Electronics and Computer Science

Absrtact

Agricultural sector uses 70 % of all fresh water that is use globally, however up to 95 % in the developing countries to meet with the challenges of growing demand of 70 % more food for estimated population of 9.1 billion in 2050. It is also estimated that 14 % more fresh water will be needed to withdrawn for agriculture purposes in the next 30 years. It is evident from literature that precision irrigation systems outperformed the traditional/ surface irrigation system and save water up to 50 %. In this report NRCS has been used and a two farm scenario has been considered in two different watersheds at the slope level which has sprinkler irrigation system installed, water shed A is a higher ground level and water shed B is at lower ground level. As the sprinkler irrigation event happens water will flow from farm A through an outlet point/ gateway to the farm B it must be learnt and predicated before going to inlet stream of farm B's sprinkler irrigation system. Multiple wireless sensors on farm A has been suggested to extract data for input parameters which are irrigation depth, soil moisture and crop stage (CN) and time of concentration and two separate regression models has been generated for estimation of runoff volume (inches) and total runoff time (hrs). Several state of the art algorithms for regression has been considered which are multiple linear regression, Artificial neural network (regression), Decision tree (regression) and support vector machine (regression) for the learning and predication purposes . Six bench

mark performance parameters are considered which are Mean square error (MSE), Root mean square error(RMSE), R square(R 2) , Relative root mean square error (RRMSE) , Normalized root mean square error (NRMSE) and Mean absolute error (MAE). A part from this Cross validation is performed for different folds on the data from the database that has been extracted from a well written script in matlab on the basis of Tom Davis hydrograph source code package available online. Then impact of different input variables on the two separate models have been investigated. Multiple experimentations have been performed on the basis of holdout method and cross validation method and finally the results are concluded in tabulated forms specifying the algorithms performance and it is suggested that which algorithm will be ideal to deploy in real world on the sensor node level or on the gateway level on the wireless sensor network of the farm. Further the future work is explained in a brief.

Transport

Richard McIlroy

Encouraging Eco-Driving: The Case for Vibrotactile Information

Presented Through the Accelerator Pedal

Abstract

The close-to-five years of research that was required to complete the project with the above title was initially motivated by two broad factors; a belief in the society wide need to reduce global resource consumption, and an interest in Ecological Interface Design (a particular human factors method). At the beginning of the research journey the low carbon vehicle domain (e.g., hybrid and electric vehicles) was chosen as an appropriate field within which to address these two factors; however, focus soon changed. A broader eco-driving perspective was taken, across not only low carbon vehicles, but road vehicles of any type. One ultimate aim was to shed further light on this increasingly-studied topic via the use of a variety of Human Factors methods; as will be seen, some of these methods were more enlightening than others.

With regard to the theoretical motivation to the research, rather than attempt to apply the full Ecological Interface Design method to in-vehicle interface design, the focus was narrowed to include only a small subset of its core principles. This led to the exploration of the theoretical justifications for the use of in-vehicle haptic (in this case, vibrotactile) stimuli for the support of certain in-vehicle behaviours. A relatively in-depth discussion of the theory behind the Ecological Interface Design methodology was provided; however, theory was not the be all and end all of the project. Far from it; there was a distinctly practical aim as well. To provide those working in the automotive vehicle industry with advice on how to help drivers make the most out of their vehicle's energy reserves, in whatever form that energy may be stored. To this end an argument was provided for the support of anticipatory behaviours in the vehicle, the uptake of which would not only be beneficial for fuel economy (the focus of this work), but also for safety.

In short, this presentation provides a brief overview of how one gets from not knowing what on earth to do with all the time provided, to frantically trying to get as many participants into a driving simulator as quickly as possible in order to get enough data for one's statistical analyses before one's funding runs out, and what happens after.

keywords: Eco-driving, In-vehicle information, Haptic feedback, Driving behaviour, Driving simulator

Biography:

Rich C. McIlroy received the B.Sc. (Hons) degree in psychology and the M.Sc. degree in research methods in psychology from the University of Southampton in 2008 and 2009 respectively. He was recently awarded his Engineering Doctorate by the same university, having been based in the Transportation Research Group, Faculty of Engineering and the Environment. He has published over 16 articles, across a variety of topics, including eco-driving and the effect of in-vehicle information on driving behaviour and fuel use, the effect of multi-sensory information on responding, the general utility of Ecological Interface Design, the link between expertise development and verbal reporting, the use of non-intrusive verbal reporting for information acquisition, and the ability of Cognitive Work Analysis, and its various components, to support decision making and system design in a variety of domains, from rail transport to system requirements specification.

Dr Madhusudhan Murthy

Role of Soil Characterisation and Behaviour in Transport Infrastructure Problems

Abstract

Soil behavior plays vital role in solving infrastructure problems. Routine soil characterisation and analysis is not sufficient in all transport infrastructure projects especially for problematic ground conditions and often affects the economic cost and long term performance. Predicting the mechanical response in terms of stiffness, strength and deformation/volume change is key to model the behaviour of soils for a sustainable design in light of environmental degradation and geohazards. This presentation will highlight some of the challenges in understanding and characterizing problematic soils important to transport infrastructure projects.

Biography

Dr Madhusudhan Murthy is a Geotechnical Engineer and has obtained his PhD from Indian Institute of Science, Bangalore in 2012. He is a Research Fellow at University of Southampton, U.K since 2014. He has primarily developed skills in experimental geomechanics for more than 10 years which aids him to work on both scientific and engineering research projects such as NERC 'Landslide-Tsunami' and EPSRC 'Track 2 the Future'. His recent and current research themes are Mechanical properties of hydrate-bearing sediment, offshore geohazards, ground improvement and railway geomechanics. Before moving to U.K, he worked as a post-doctoral researcher at University of Hong Kong. e-mail: mbnm1f13@soton.ac.uk;
url: https://www.southampton.ac.uk/engineering/about/staff/mbnm1f13.page

Dr. Craig K. Allison

G-ACTIVE – Green Adaptive Control For Future Interconnected Vehicles

Other contributors: K. Allison & Prof. Neville A. Stanton

Abstract

There has been a growing acceptance of the role of man-made emissions play in climate change. One significant source of greenhouse gas emissions is transport, currently the second largest source of GHG emissions in the EU, after electricity generation. Of this, road transportation, primarily automobiles, is the biggest contributor, accounting for approximately 75% of the total transport GHG emissions. Finding ways to reduce the GHG emissions of driving is a key concern for the immediate future, and is a topic currently being tackled at Southampton. The Green Adaptive Control for Future Interconnected Vehicles project (G-ACTIVE) is a collaboration between the University of Southampton and Imperial College London and targets a significant reduction in fuel consumption, carbon dioxide (CO_2) emissions and nitrogen oxide (NO_x) emissions in road vehicles.

To achieve these goals the project seeks to develop new engine management systems, which optimize vehicle energy use and needs, based on both the requirement of the vehicle systems, but also exploits the upcoming environment, road events and traffic conditions. Additionally, the system will act to teach the driver to be more fuel-efficient, promoting the use of eco-driving techniques designed to reduce fuel use not by the changing of vehicular systems but by modifying drivers' behaviors, encouraging a more refined driving style characterized by gentle acceleration and braking.

With optimised vehicle energy management systems in place, less fuel will be required by vehicular systems. Combined with drivers possessing a greater knowledge of upcoming road events, enabling them to react to events earlier than they are currently able will act to encourage a more refined driving style, reducing the amount of fuel consumed each trip. Although the relative saving of such actions are small for each driver, consistently repeated across all drivers, fuel use and subsequent NOx and CO_2 emissions could drop significantly.

Keywords: *Road Transport; Eco-Driving; Automobiles; Energy Management; Human Factors*

Biography

Dr. Craig K. Allison, is a Research Fellow, working in the Human Factors Engineering team, part of the Transport Research Group, University of Southampton. Craig was awarded his PhD in Web Science (Psychology) from the University of Southampton in 2016. Craig received his M.Sc in Web Science from the University of Southampton in 2011, and his B.Sc in Psychology in 2009, also from the University of Southampton. Since joining the Human Factors team in October 2015, Craig has worked on both aviation and automotive projects. Craig's current research focus is developing in-vehicle interfaces encouraging drivers to behave in a more fuel-efficient manner, supporting the G-Active project

Hamad Almujibah

A Comparison between High-Speed Ground Transportation Technologies, including HSR, Maglev and Hyperloop.

Transportation Group, University of Southampton.

Abstract:

High-Speed Ground Transportation (HSGT) is a transport mode that has been used in the world since the Shinkansen began circa in 1964. It includes an upgrading of the infrastructure of an existing railroad to support train-set to transport passengers in a speed over 125mph. it is also a critical component to transport passenger vehicle to a speed greater than 250kph (160mph), in terms of developing the infrastructure to support the magnetic levitation technology. HSGT has been designed to be competitive with existing congested transport modes, such as automobile, bus, aircrafts, conventional train, etc., and provide an alternative transport mode for passengers to travel between heavily populated cities, looking at a greater distances than 500 miles apart. In summary, this paper will focus on a comparison between three main forms of HSGT systems that have drawn great attention from operators and decision makers worldwide, including high-speed rail, magnetic levitation, and Hyperloop. First, HSR has become an important technological achievement and a symbol of efficiency, besides being a new transportation mode for passengers in the second half of the 20th century. Second, The Maglev is a highly advanced technology to move vehicles without any contact to the ground and it is considered as a solution for transportation needs at the current and future times of the world. Third, Hyperloop is called the fifth transport mode, which was proposed by the CEO of Tesla and SpaceX, Elon Musk and his team to transport passengers through reduced pressure tubes, at a top speed of 760 mph (1200 km/h) and average speed of 600 mph. However, HSR and Maglev are high-speed transportation systems, but they are essentially different

in the technology used, while Hyperloop is determined as a faster, cheaper new alternative transport mode to HSR that will consist of passenger pod travelling between cities through a vacuumed-sealed tube.

Keywords: HSGT; Comparison; High Speed Rail; Maglev, Hyperloop

Amanda Haylett

Travel information the smarter way

Transportation group, University of Southampton

Abstract:

Today's wide spread use of Information Communication Technologies (ICT) has introduced public transport travel information into all stages of journey planning (at home, at-stop and on-board). Its purpose is to address specific questions that travellers raise which often relate to the travellers familiarity or lack thereof with the local area.

In fact, travel information must address needs that link to unfamiliarity with public transport provision in the local area to be relevant. Coupled with managing erroneous expectations that are produced when a traveller attempts to pre-plan a journey with reduced local awareness. Thus, future research has to focus on what information itself should deliver before considering other ways to introduce travel information into the public transport environment.

Therefore, this research held a usability study of existing journey planners to measure how well familiar and unfamiliar traveller's travel information needs were met. The results produced specific guidelines that defined the correct flow of travel information to improve information relevancy and interpretability. Enabling future developers of external travel information systems to incorporate all traveller planning types in their design. As well as to open up the debate regarding what travel information in itself should deliver for both the familiar and unfamiliar traveller types.

Energy & Infrastructure

Maria Ramos Suarez

Improvement of fines solubility for enhanced anaerobic digestion

Abstract

Municipal solid waste is often fractionated in waste processing facilities. Here, large recyclables are separated from materials such as organics, grit and small-glass-items. In waste processing, this organic rich fraction is known as the 'fines'. Fines are generated in the first separation step, whose disposal greatly contributes to the overall cost of waste facilities due to the expenses associated with landfilling. Additionally, fines separation is becoming more widespread in many EU countries as a result of policy which is pushing the agenda to achieve zero organic waste to landfill by 2025. Due to their high organic content fines can be used for biogas production through anaerobic digestion (AD). Within the Fiberight process, fines are pulped and washed to obtain an organic rich wash water for high-rate liquid AD. This wash water contains a high soluble organic content and a proportion of total suspended solids (TSS) which have an organic content of 70% on a dry weight basis. The TSS solubility is low and hence difficult for the anaerobic bacteria to degrade in the current system used by Fiberight. To increase solubilisation the literature reports numerous pretreatments for AD of food waste including physical, chemical and biological treatments. Enzymatic hydrolysis is a promising option in terms of cost, energy demand and environmental factors. However, previous studies lack information on biogas yields which would justify the use of enzymes. In addition, the composition of the TSS in this case is unknown and therefore it is hard to predict whether enzymatic hydrolysis is the right pretreatment. The aim of this project was to study the effect of different enzyme pretreatments on these suspended solids as well as a full characterisation of the TSS waste. The study included batch tests to choose the most effective enzymes and optimum operational conditions for solubilisation based on chemical oxygen demand tests (COD). Following this, semi-continuous bioreactors were run on untreated and enzyme-treated material to observe any uplift in biogas yield achieved through enzyme pre-treatment.

Keywords: Bioenergy, biogas, municipal solid waste, anaerobic digestion, enzymatic hydrolysis

Biography

Maria Ramos Suarez did her Bachelor's and Master's degree in Chemical Engineering at The University of Cadiz (UCA), Spain, and specialised in bioprocess engineering. She collaborated with the *Analysis and Design of Processes with Supercritical Fluids*

group (UCA) in two different projects; one about phenolics extraction from mango leaves and the other about biodiesel production under supercritical conditions. During her master's degree she did a research internship within the *Biorefinery Engineering* group at the University of Manchester (UoM) on solid state fermentation. Maria did her dissertation on bioethanol production from sunflower stalks using ionic liquids (UoM/UCA). Currently, she is doing an iPhD in Sustainable Infrastructure Systems at The University of Southampton on *Integrated Biorefinery Products from Wastes and Residues*, a project sponsored by Fiberight Ltd. During the first year of her iPhD, she researched on fuel cell materials recycling for a group project and anaerobic digestion of fines waste for a summer project. Her research interests cover biorefineries and bioprocessing, waste management/recycling and waste water treatment.

Lara Eggbert

Photoelectrochemical characterisation of p-GaP for the photelectric water splitting

Other contributors M. Kurniawan1, O. Supplie1, R. Peipmann1, T. Hannappel1, A. Bund1

Technische Universität Ilmenau, Gustav-Kirchhoff-Str. 6, 98693 Ilmenau

Abstract

Hydrogen is an important energy carrier for renewable energies. By combining hydrogen with oxygen in a fuel cell, it produces electricity, heat and water with almost no pollution. It possesses promising potential as a clean and environmentally friendly energy for future renewable energy resources. Hydrogen is mainly produced by separation process from hydrocarbon through reforming. A new technological approach to produce hydrogen has been developed. This process combines direct solar energy and water electrolysis in a single photoelectrode, which also known as photoelectrochemical (PEC) water splitting.

In this work, a p-type gallium phosphide (GaP) semiconductor (III-V) with an indirect bandgap of 2,3 eV were used as a photoelectrode to investigate the characteristic and the properties of the material for PEC water splitting application. Two types of samples (GaP(100) and GaP(111)) with different crystal orientation were investigated. There are two main electrochemical measurements, linear sweep voltammetry (LSV) and chronoamperometry (CA), that were performed to analyse the photoelectrochemical properties of the GaP. The experiments were done in H2SO4 electrolyte using three electrode configurations, the GaP samples were used as working electrode, a Ag/AgCl electrode as a reference electrode and the counter electrode was platinum. LED light source was prepared and utilized to illuminate the GaP samples during electrochemical measurement for the PEC water splitting experiment. All of the measurements were done in a dark enclosed compartment to eliminate any light interferences from outside.

The results of GaP(100) and GaP(111), shows relatively different characteristic. In the beginning, the GaP(111) sample showed higher current density in comparison to the other sample, but after four hours of stability measurement with CA, the current density has dropped and become relatively similar to the GaP(100). On the other hand, the GaP(100) sample showed good stability than the GaP(111). These findings indicate a strong dependence of the surface crystal orientation to the hydrogen production at the interface.

Biography:

I, Lara Eggert, was born 13.06.1989 in Minden, Germany. I lived on the border to Denmark and was attending for three years at the "Deutsches Gymnasium für Nordschleswig" in Aabenraa, Denmark. I started my undergraduate study in renewable engineering in 2009 at "Fachhochschule Flensburg" in Flensburg, Germany. And graduated in 2014 with the topic of "Development of a device to analyse humidity influence on cycle ability for solid storage" in good cooperation with the "Helmholtz-Zentrum Geestacht". In the same year, I continued to take master program in renewable engineering at "Technische Universität Ilmenau" in Ilmenau, Germny. The topic of my master thesis was "Photoelectrochemical characterisation of p-GaP for the photelectric water splitting". E-Mail: lara.eggert@tu-ilmenau.de

Keywords: Renewable energy, Solar water splitting, Semiconductor, Hydrogen production

Tom Bryden

Fast Electric Vehicle Charging Station with off-Vehicle energy store.

Abstract

Electric Vehicles (EVs) can play an important role in efforts to combat climate change as well as providing health benefits to the population by reducing air pollution, particularly in urban areas. One of the largest barriers to the widespread uptake of EVs is the current slow charging speed. Potential EV owners are used to being able to refill their gasoline vehicles in minutes and worry that in an EV they may run out of energy while on a long distance journey and be delayed for hours while their EV recharges. Currently the fastest EV chargers are capable of providing power up to 120kW to EVs, the equivalent of adding 170 miles driving range in 30 mins. In the future this charging power will increase, with 350kW and 400kW fast charging stations currently being installed.

These high charging powers require a high power electricity grid connection, which limits the available installation locations and may mean expensive electricity grid infrastructure upgrades are required. As charging power and EV penetration increase these problems will be amplified. The solution investigated in this project is to use a stationary off-vehicle energy store at a fast charging station to buffer the energy between the grid and the EV to minimise and control the grid connection power.

The project is split in two, the first part looks at the requirements of the off-vehicle energy store at the fast charging station and the second part looks into the characteristics of potential off-vehicle energy stores. The requirements of off-vehicle energy store are determined by predicting the usage of the fast charging station using GPS gasoline vehicle data and assuming that all the journeys conducted by the gasoline vehicles are conducted instead using EVs. The characteristics of potential off-vehicle energy stores are determined by conducting experiments on Lithium ion, Lead acid and Supercapacitor cells. Both parts of the project are then brought together to answer the research question, what is the optimum type and capacity of off-vehicle energy store to use at the fast charging station?

Biography:

Thomas is currently a PhD student at the University of Southampton at the Centre for Doctoral Training in Energy Storage and its Applications. Thomas is currently entering the fourth year of the PhD programme working on a project entitled "Off-vehicle Energy Store Selection for a High Rate Electric Vehicle Charging Station". Prior to joining the PhD programme Thomas graduated with a Masters in Mechanical Engineering from the University of Warwick and worked for three years as an engineer

in the subsea engineering industry. Thomas has research interests in the challenges associated with the future electricity grid with increasing amounts of renewable electricity generation and electric vehicle ownership.

Keywords: Electric Vehicles, Fast Charging, Electricity Grid Infrastructure, Energy Storage, Electricity Demand

Poster Presentations

Transport

6	Hameed Jehanfo	Addressing the new reality of vehicle automation in highway design.
8	Giacomo Ognibene	Ground support and modelling through railway switches & crossings and transitions.
12	Boniface Hima	Track Noise Mitigation.

Water & The Environment

1	Andrew Bryden	The effect of hydrodynamics on collective behaviour of fish.
5	Georgina Hollands	The impact of ELF-EMF on Bees
7	Mhairi Miller	Development of behavioural deterrents to protect the European Eel at dams and power stations.
9	Freya Radford	Managing emerging pollutants in wastewater systems.
10	Toby Roberts	Ports of the Future.
14	Diego Panici	Understanding the formation of woody debris jams at bridge piers.
16	Marwan Khan	Irrigation Run-Off Modelling – Regression System.
17	Nick Wilding and James Miles	China Group Design project

Energy & Infrastructure

2	David Burn	Leak noise characterisation for buried, fluid-filled pipes.
3	Marie-Salome Duval-Chaneac	Microstructure, properties and fatigue behaviour of Multiple Metallic Material by Additive Manufacturing.
4	David Hoffman	Development of the XSEPT ECR Gridded Ion Thruster.
11	Matthew Robinson	Development of Advanced High Temperature Xenon Resistojet for Spacecraft Propulsion.
13	Cristina Marzo Gago	Utilization of exhausted sugar beet cossettes for the production of bio-productos: Optimization of the hydrolysis step.
15	Theresa Schoetz	The Sustainable Rechargeable Battery based on Conductive Polymers and Aluminium in Ionic Liquids.

Student Chairs

Water section

Chair: Nick Wilding

Transport Section

Chair: Toshan Rampat

Energy Section

Chair: Michael Andrews

CDT-SIS iPhD/ EngD University of Southampton First Year Biographies

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