

## Newsletter June 2021

## In this edition... 04-05

**Latest Webinars** 

**Fesibility Studies** 

More News

**Coming Soon...** 

**Staff News** 

**Events** 

6-0 **Publications** 

**Recruitment & Partnerships** 

**Brunel** University University of BRISTOL BATH London UNIVERSITY OF CAMBRIDGE THE UNIVERSITY of EDINBURGH University of Glasgow Imperial College London University of Nottingham The University Of Sheffield.

WARWICK





Southampton **glyndŵr** Wrecsam Wrexham

glyndŵr



# Welcome to our summer edition of the Hub Newsletter!

We have had a busy quarter compiling our 2020 - 2021 Annual Report and would like to thank everyone for their contributions. <u>A</u> copy of the report is available to read here.

## Webinars

Following the success of our first project webinar last year, the Hub has continued to host these free-to-attend virtual events. If you missed any of the recent webinars, follow the links below to watch video recordings of each presentation:

## February - Webinar on Automated Fibre Deposition Technologies

#### **Automated Fibre Deposition Technologies**

Dr Thomas Turner, University of Nottingham

youtu.be/97dUoyndEtA

### Fibre Steered Forming Technology

Dr Eric Kim, University of Bristol

youtu.be/mXG\_kjUsyT4

#### Powder-Epoxy Carbon Fibre Towpreg for High Speed, Low-Cost Automated Fibre Placement

Dr Colin Robert, University of Edinburgh



youtu.be/lphdl8bLlUA

#### COMPrinting: Novel 3D Printing of Curved Continuous Carbon Fibre Reinforced Powderbased Epoxy Composites

Dr Dongmin Yang, University of Edinburgh



youtu.be/P\_PITjbErkU

## March/April TexGen Webinars

#### TexGen

The Hub recently supported a 'TexGen' webinar, which gave an overview of the modelling theory, the TexGen GUI and how to create 2D woven textile models.

Dr Louise Brown, University of Nottingham



youtube.com/watch?v=xDYRhVvwd2E



#### **Exporting TexGen Models for Simulation**

The follow-on webinar 'Exporting TexGen Models for Simulation' demonstrated the role of TexGen as a pre-processor with examples of simulations using TexGen models.

Dr Louise Brown, University of Nottingham

#### youtube.com/watch?v=BVME9evj0kc&t=4s





## May Webinar - Optimisation of Fabric Architectures

### **Hub Overview**

Professor Nick Warrior, University of Nottingham



youtu.be/vVZWy9WMsuc

#### **New Manufacturing Techniques for Optimised Fibre Architectures**

Professor Andy Long, University of Nottingham



youtube.com/watch?v=3gLet1RUDnQ

#### **Development of New Manufacturing Techniques for Complex Preforms**

Professor Prasad Potluri, University of Manchester



youtu.be/6FSamn3APF0

#### Numerical Framework for Optimisation of **Fibre Preforms**

Dr Mikhail Matveev, University of Nottingham

youtu.be/thTlwWJR\_VQ

### **Optimisation of 3D Woven T-joints**

George Spackman, University of Nottingham



youtu.be/LAQ2C8AdSTo

#### **Manufacturing of Optimised Preforms: Case Studies**

Dr Vivek Koncherry / Dr Shankhachur Roy, University of Manchester



youtu.be/Zrn\_OKE-IEE



youtu.be/kVliq8zH5wU

## **Events**

## International Mission -German Aerospace Centre

A virtual International Mission took place in May with DLR (German Aerospace Centre). This online event was well attended by over 80 delegates from academia and industry. Members of the Hub and DLR presented research overviews, including project outcomes focusing on Thermoplastics and Automated Dry Fibre Deposition. The Hub is looking forward to discussing potential collaboration opportunities with DLR.

## **Researcher Network Event**

The Researcher Network held a virtual event in April, which enabled researchers affiliated with the EPSRC Future Composites Manufacturing Hub to come together and share their knowledge and facilitate new research connections. The event consisted of several short research presentations and a quiz.

Congratulations to the winning group. The team members were Caroline O'Keeffe (Bristol), Mikhail Matveev (Nottingham), Verner Viisainen (Cambridge) and Matt Collinson (Sheffield), who each received a gift voucher for their achievement.







## **Virtual Conferences**

#### Railway Industry Association (RIA) Innovation Conference 2021



https://www.riagb.org.uk/RIA/Events/RIA\_Innovation\_Conference\_2021.aspx





Dr Mike Johnson and Preetum Mistry from the University of Nottingham presented at the Railway Industry Association (RIA) Innovation Conference 2021. This is an annual Rail Conference that brings together academia, innovation bodies and rail industry professionals to network and share information. This year's conference theme was 'Railway of the Future'.

Mike and Preetum presented their research on the '**Fatigue Performance of Scaled Composite Railway Axles**'. This is part of the new partnership of the Composites Hub with the UKRRIN Centre of Excellence in Rolling Stock.

#### Bristol Composites Institute Researchers win best poster prize at CompTest 2021

CompTest is a series of conferences which brings together academics and industrial communities working on modelling and characterisation of composite materials and structures. CompTest 2021 was the 9th event in the series, organised by ONERA, which took place online 18–20 May.

The best poster prize was won by Dr Irene Jimenez Fortunato, Professor Ole Thomsen and Professor Janice Barton from the Bristol Composites Institute, and their co-author Dr Daniel Bull from the University of Southampton.



Irene was recently awarded her PhD and is an active member of the Hub Researchers Network. The presentation was entitled '**Determining the Source of the Thermoelastic Response of Laminated FRP Composite Materials Using DIC**'.



youtube.com/watch?v=83zbVxDn21M

## **2021 Q2 Publications** (1/2)

Take a look at some of the recent publications produced by Hub members in 2021.

Mistry, P.J., Johnson, M.S., Li, S., Bruni, S., Bernasconi, A. 2021. Parametric Sizing Study for the Design of a Lightweight Composite Railway Axle

Composite Structures, 113851. https://doi.org/10.1016/j. compstruct.2021.113851



The full length pre-manufactured tube axle design concept annotated with the five key areas of research covered by the NEXTGEAR 'wheelset of the future' work package to include: (1) Detailed structural design and optimisation, (2) Bonded joint optimisation, (3) Impact analysis, (4) SHM & NDT considerations and (5) Wheelset dynamic effects

Budwal, N., Kasper, K., Goering, J., Ward, C. 2021. Flexible, Low-cost Tooling Solutions for a One-shot Resin Infusion of a 3D Woven and Multi-textile Preform

Procedia Manufacturing. https://doi.org/10.1016/j. promfg.2020.10.120 Gandhi, N., Rose, R., Croxford, A., Ward, C. 2021.

Developing a Highfidelity Knowledge Base for Improvements in the Non-destructive Testing of Advanced Composite Material Products Procedia Manufacturing.

https://doi.org/10.1016/j. promfg.2020.10.049 Nguyen, S., Millereux, A., Pouyat, A., Greenhalgh, E.S., Shaffer, M.S.P., Kucernak, A.R.J., Linde, P. 2021. **Conceptual Multifunctional Design, Feasibility and Requirements for Structural Power in Aircraft Cabins** Aerospace Research Central. https://doi.org/10.2514/1. C036205

O'Keeffe C., Pickard L.R., Cao J., Allegri J., Partridge I.K., Ivanov D.S. 2021. Multi-material Braids for Multifunctional Laminates: Conductive Through-thickness Reinforcement

Functional Composite Materials. https://doi.org/10.1186/s42252-021-00018-0



Data flow for creating FE model of braided thread: **a** geometrical model of flat textile produced with WiseTex software [43], **b** solid model of thread created by geometrical transformation of the flat model with superimposed image of the mesh, c cross-section of the braid model after the "rolling" transformation, **d** voxel-like mesh of the reinforcement showing periodicity vector d->

## **2021 Q2 Publications** [2/2]

Yousaf, Z., Withers, P. J. & Potluri, P. 2021. Compaction, Nesting and Image Based Permeability Analysis of Multi-layer Dry Preforms by Computed Tomography (CT) Composite Structures, 263 (): 113676. https://doi.org/10.1016/j. compstruct.2021.113676



3D rendering of the tows isolated from the tomograph showing bothwarp (green) and weft (gold) tows

Street, G.E., Mistry, P.J., Johnson, M.S. 2021. Impact Resistance of Fibre Reinforced Composite Railway Freight Tank Wagons Journal of Composites Science. https://doi.org/10.3390/ jcs5060152 Willicombe, W., Elkington, M., Hamerton, I., Ward, C. 2021. **Development of Novel Transportation Shells for Rapid, Automated Manufacture of Automotive Composite Parts** Procedia Manufacturing.

https://doi.org/10.1016/j. promfg.2020.10.115 Yu, F., Chen, S., Harper, L.T., Warrior, N.A. 2021. Double Diaphragm Forming Simulation using a Global-to-local Modelling Strategy for Detailed Defect Detection in Large Structures

Composites Part A: Applied Science and Manufacturing Volume 147 (2021), 106457. https://doi.org/10.1016/j. compositesa.2021.106457

A full list of publications can be found on our website at https://cimcomp.ac.uk/publications/

## Feasibility Studies (1/2)

#### COMPrinting: Novel 3D Printing of Curved Continuous Carbon Fibre Reinforced Powder-based Epoxy Composites

#### Dongmin Yang, University of Edinburgh (recently finished)

This study addressed the Hub themes of 'high rate deposition and rapid processing technologies' and 'design for manufacture via validated simulation'. A novel 4-axis rotational printing system, together with a customised printer nozzle, has been developed to process fibre reinforced prepreg filaments produced by a novel electrostatic deposition process. Printing of the thermoset filament on the rotational printing system demonstrated excellent fibre positional control for both straight and curved printing paths. The developed filament was used to produce an open-hole composite coupon, which was compared against a composite with a drilled hole. Uniaxial tensile tests of the printed open-hole composites were carried out with the assistance of DIC. It was demonstrated that the printed composite with identified fibre paths has much uniform distribution of strain around the hole. As expected, the drilled composite (printed with straight fibre paths) has strain concentration on both left and right edges of the hole. Markforged Two printed composite has a quasi-isotropic lay-up with additional fibres placed around the hole, and the principal strain is concentrated on the +/- 45 degrees leading to a shear failure.

The load bearing capacity is improved by 58% (on average) on the open-hole composite coupon compared to the drilled composites. Very consistent stiffness is achieved as a result of the identified fibre paths. Loading strain Eyy is improved by 26% (on average), and Maxi-principal strain is improved by 120% (on average) around the hole just before the failure. The Markforged Two printed composites have a much low failure strength and stiffness, although more ductile failure behaviour is found due to the PA6 thermoplastic.

One challenge was the unavailable access to high-resolution X-ray micro-CT due to COVID19, therefore the failure mechanisms and 3D imaging of fibre alignment has not been fully understood yet. We have planned to do this as soon as we gain the access.







Rotational 3D printing of continuous carbon fibres along identified stress trajectories.

#### For more information on this project:

cimcomp.ac.uk/research/comprinting-novel-3d-printing-of-curved-continuous-carbon-fibre-reinforcedpowder-based-epoxy-composites/

## **Feasibility Studies** [2/2]

#### Joint Feasibility Call Now Live - Closing Date Thursday 22<sup>nd</sup> July 2021 (17:00 BST)

The Hub launched its' latest Feasibility Study Call in May 2021. Partnering with three other Hubs; Electrical Machines, Metrology and Photonics, funding of up to £900k is available to support a number of Studies at TRL 1 to 3.

The Composites Hub is encouraging applications to address the sustainability challenges of fibre reinforced composites. Sustainability is a global priority requiring a huge drive for change, with demanding zero-carbon legislation targets to meet across all industries, in a bid to reduce environmental impact.

#### The full call document, and details of how to apply, can be viewed here:



<u>cimcomp.ac.uk/wp-content/uploads/2021/05/Future-Manufacturing-Hubs-Joint-Call-for-Feasibility-</u> Studies-2021.pdf



## **Staff News** (1/2)

Hub Research & Business Development Manager **Dr Richard Gravelle** is leaving the University of Nottingham in June. The Hub would like to thank Richard for his contribution to the Hub and wish him the very best with his new role.

**Dr Marco L. Longana** has been appointed to the position of Lecturer in Composites Design and Manufacturing at the University of Bristol. He has a background in Aerospace and Material Engineering, with a BSc and MSc from the Politecnico di Milano. He started his research career as a visiting student at Cranfield University with a research project on Z-Pin pull-out. He then obtained an MSc by Research in Nanotechnology and Microsystems, developing an Energy Harvesting device that exploited piezoelectric materials and bi-stable beams, from Cranfield University.



Marco was awarded his PhD from the University of Southampton with a thesis on full field strain measurement techniques for the characterisation of composites tensile behaviour at intermediate strainrates. He has been a researcher at the Bristol Composite Institute since March 2014, working on the HiPerDiF (High Performance Discontinuous Fibre) Technology, aimed at the manufacturing of highly aligned discontinuous fibre tapes. He is looking forward to establishing new interactions with Hub stakeholders over the next two years.





## Staff News (2/2)

After receiving first prize at the IMechE Future of Rail Competition 2021-Midlands Centre Local Heats earlier this year, **Preetum Mistry, EngD Research Engineer at University of Nottingham** went on to compete in the National finals in May and was awarded runner up in the virtual competition.



events.imeche.org/ViewEvent?e=7327



There were seven finalists from across the UK who presented their work on the theme of the 'Future of Rail' with a focus on technological development and innovation.

Preetum presented his research into the **'Design and Development of a Lightweight Composite Railway Axle'**. The panel of judges comprised of distinguish Railway Engineers and IMechE Fellows who commented on the excellent research and professional delivery of the presentation.

**Preetum commented**: "I am honoured to have received this prize from the IMechE in recognition of my research and novel contribution to rail. It was a great opportunity to present my work and discuss the potential for the use of composite materials in the rail industry. Thanks to Mike Johnson for his full support, guidance and encouragement in this endeavour."





## Recruitment

The University of Nottingham is looking to appoint a Transitional Fellow, to lead innovative research in the area of composites manufacturing and to undertake teaching in the Department of Mechanical, Materials and Manufacturing Engineering. The role offers a progressive pathway from postdoctoral researcher to Assistant Professor over a two-year period. The closing date for applications is **30 June 2021**.

Further information and details on how to apply for the position can be found here:

nottingham.ac.uk/Jobs/CurrentVacancies/ref/ENG162021

## Partnerships (1/2)

In March, the Hub Core Project 'Active RTM' welcomed guest speaker Prof Francisco Chinesta, Professor of Computational Physics at ENSAM Institute of Technology (Paris) and Scientific Director of ESI Group, to present his work on data-driven modelling in a virtual seminar **'Empowering Hybrid Twins from Physics-Informed Artificial Intelligence'**. The webinar was part of a collaboration between ESI Group and the Active RTM project, in developing advanced uncertainty quantification tools for robust simulations of the resin transfer moulding process. The webinar reached an international audience of over 50 people. The recording of the session is available for viewing here:



youtu.be/JrtzxB\_SAJg



## Partnerships (2/2)

The Hub would like to congratulate Industry partner **PAC Group**, Belfast on receiving a Queens Award for Enterprise in Innovation. PAC Group is a leading and innovative provider of high quality and specialist electrical and mechanical engineering solutions and applications. PAC joined the Hub's network in 2020, with the aim of developing solutions to support fundamental research activities, whilst adopting processes and technologies to benefit their customer base.



Darren Leslie, PAC Group Business Development Director, pictured at Stormont with Northern Ireland Economy Minister, Diane Dodds.

Detailed information on this achievement can be viewed here:



pacgroup.co.uk/news/pac-group-celebrates-winning-queens-award-innovation



## More Hub News (1/2)

#### SAMPE Seminar and Media Competition 2021

In March, the Hub supported the Annual SAMPE UK seminar **'Composites – Progressing from the Pandemic'** which was held online. The event welcomed a diverse range of topics and speakers from academia and industry, with one of the keynote lectures given by Hub Spoke representative Dr Dipa Roy, Senior Lecturer at the University of Edinburgh. The event was held over two days and featured a 'Young Engineer and Students' Seminar and Media competition based on the 'Resilience of the composite materials community during the COVID-19 pandemic'.

Congratulations to the Media competition winners; 'Pandemic Preforms' from The University of Nottingham, and 'FAC Technology'. Both teams produced very high quality videos reflecting on the effect of the pandemic on their research. They were awarded prizes and free SAMPE UK and Ireland annual memberships.

The winning videos can be viewed here:

#### 'Pandemic Preforms', University of Nottingham



**Pandemic Preforms commented:** "We wanted to get involved in the SAMPE Media Competition 2021 as it seemed like a great opportunity to work together and showcase our continued resilient efforts to complete our research during the pandemic. The process of filming and creating the video was really fun and we took the approach of filming small snippets to portray our experiences in an entertaining way. The competition allowed us to reflect on our research, talk to each other about our difficulties and motivate each other to continue. We were delighted to win the academic video prize and would like to thank the SAMPE UK & Ireland Team for the generous cash prize!"





## More Hub News [2/2]

#### 'FAC Technology'



**FAC Technology commented:** *"PPE like plastic visors are a world away from the advanced composite materials we work with day to day but we thought we could use the competition to show how agile project management and lean manufacturing approaches learnt from developing composite products could be applied to manufacturing more pedestrian parts. Whilst we are relieved to be back to working with composites, we are proud of the work we did to help the NHS and hope the video shows the problem solving work engineers do in a way that's easily relatable to those considering such a career."* 



youtube.com/watch?v=chPyhhVSNGA



## **Coming Soon**

### Hub Open Day, 19 October 2021

The Hub is delighted to announce that this year's Open Day will take place on Tuesday 19<sup>th</sup> October 2021, it will be hosted by Hub Spoke, University of Edinburgh. The Open Day will be conducted as a virtual event and will be a free to attend. The event will be followed by The International Conference on Manufacture of Advanced Composites (ICMAC 21), which will be hosted by IOM3 on 20<sup>th</sup> – 21<sup>st</sup> October 2021.

More details on this event to follow soon.





