Design for AM NETWORK

Engineering and Physical Sciences Research Council

Brunel University London

Design for Additive Manufacturing for Education

13th July 2021. 12pm – 4.30pm (BST)

Event Programme

DfAM for Education

In partnership with Dr Eujin Pei and Brunel University London, the EPSRC DfAM Network are pleased to host the next event in their series, DfAM for Education.

The event will host presentations from experts in the field, with talks covering different aspects of the education spectrum, and focusing on the development of DfAM in educational settings. The event will investigate where DfAM is in the area, as well as highlight ideas, challenges and questions on the future of Design for Additive Manufacturing in education.

Design for AM NETWORK

CONTENTS

Welcome to the DfAM Network

The purpose of the EPSRC Design for AM Network is to connect the wider UK Design for AM academic research community alongside those in industry that are experienced practitioners of additive manufacturing technologies, such that we can benefit from sharing knowledge, developing research themes and working collaboratively to ensure that Design for AM is given the best platform possible.

By bringing together the Design for AM community, the network aims to reach out to the widest possible audience that might benefit from Design for AM research; identify future research directions and facilitate larger and more adventurous research collaborations.

See more information at www.designforam.ac.uk

Agenda

Time	Activity
12.00pm	Welcome from Dr Eujin Pei, Brunel University London
12.10pm	Introduction from Dr Patrick Pradel, Loughborough University, about the DfAM Network
12.15pm	Keynote speaker – Prof Alain Bernard, Ecole Centrale de Nantes “Key Considerations for AM development and approaches – An Educational Perspective”
12.45pm	Dr Connor Myant, Imperial College London “Starting a multi-departmental DfAM Elective module for engineering students”
1.00pm	Michael Mead, Create Education “The Development of Additive Manufacturing skills in young people”
1.25pm	Martin Dury, The Manufacturing Technology Centre (MTC) “Creating a pipeline of AM skilled workforce via apprenticeships”
1.40pm	Interactive sessions Exploring the Grand Challenges in DfAM for Education Feedback

Agenda (continued)

Time	Activity
2.40pm	Prof Christopher Tuck, University of Nottingham “A cohort-based PGR training programme in Additive Manufacturing and 3D Printing”
3.00pm	Prof David Rosen, Georgia Institute of Technology “Perspectives on Additive Manufacturing Education Pedagogy“
3.20pm	Tony Ryan, Design & Technology Association ”Providing context for learning – Positioning design and technology to be a catalyst for change”
3.40pm	Keynote speaker - Adelaide Almeida, European Federation for Welding, Joining and Cutting “Developing the Additive Manufacturing Workforce Skills of Today and Tomorrow”
4.10pm	Martins Obi & Dean Grierson, PhD Students - DfAM Student Poster Competition results
4.20pm	Feedback & Summary
4.25pm	Future DfAM event updates from Jonathan Rowley, Advanced SLS and Ajit Panesar, Imperial College London
4.30pm	Prof Allan Rennie, Lancaster University - Close

Dr Eujin Pei

Brunel University London

Eujin is the Director for Postgraduate Studies and Programme Director for the BSc Product Design Engineering Course at Brunel University London. The programmes are among the top 100 in the world to undertake research and study design by the Quacquarelli Symonds (QS) 2021 World University Ranking by Subject (Art and Design).

He is a Chartered Engineer (CEng) and a Chartered Technological Product Designer (CTPD) with the Institution of Engineering Designers. Within the institution, he leads the Additive Manufacturing and 4D Printing Research Group and is the Editor-in-Chief for the *Progress in Additive Manufacturing* Journal (SpringerNature). In the UK, he chairs the British Standards Institute BSI/AMT/8 committee for Additive Manufacturing.

At an International level, he chairs the International Organization for Standardization ISO/TC261/WG4 committee that develops Standards for Additive Manufacturing Data and Design; and also chairs ISO/TC261/JG67 for Functionally Graded Additive Manufacturing. He is a Full Member of the EPSRC Peer Review College, and a member of the Member of EPSRC Early Career Forum in Manufacturing.

Dr Patrick Pradel

Loughbrough University

Dr Patrick Pradel is a Lecturer in Product Industrial U ser-Centred Design at the Loughborough School of Design and the Creative Arts, and a member of the Design for Digital Fabrication Research Group (D4DF). His research focuses on Design for Additive Manufacturing, Technology-Inspired Design, and Design Education. Patrick is the PI for the EPSRC UK Design for AM Network, reviewer for different scientific journals and Associate/Review Editor for Frontiers in Manufacturing Technology. He has more than twelve years of teaching experience in product and industrial design.

Prof Allan Rennie

Lancaster University

Allan is a Professor of Manufacturing Engineering at Lancaster University and Director of the Lancaster Product Development Unit within the Engineering Department. His interests are widespread in the area of additive manufacturing, a field he has been involved in since 1995, particularly related to design and industrial applications of the technology.

Allan has secured funding in excess of £20M+ and delivered a wide range of projects over the last 20 years, with partners and collaborators in the UK and overseas.

Recognising his work in supporting industry, Allan was appointed as a Fellow at Wollongong University (Australia) in 2017. He is an Editor for the *Rapid Prototyping Journal* (Emerald), Associate Editor for the *International Journal of Rapid Manufacturing* (Inderscience) and lead for the *Rapid Design, Prototyping and Manufacturing* Conference in the UK.

Allan is Co-Investigator for the EPSRC Design for Additive Manufacturing Network.

Prof Alain Bernard

Ecole centrale de Nantes

Professor Alain Bernard graduated in 1982, PhD in 1989, was associate-Professor, from 1990 to 1996 in Centrale Paris. From 1996 to 2001, he was Professor in CRAN, and leads the “Integrated Design and Manufacturing” team. Since 2001, he has been Professor at Centrale Nantes and Dean for Research from 2007 to 2012. He was a researcher in LS2N laboratory (UMR CNRS 6004), former head of the “Systems Engineering – Products-Processes-Performances” team. His research topics are KM, PLM, information system modelling, enterprise modelling, systems performance assessment, virtual engineering, additive manufacturing.

He has supervised more than 40 PhD students, published more than 150 papers in refereed international journals and books. He is the vice-President of France Additive (French Association on Additive Manufacturing) since 1993, vice-chairman of WG5.1 of IFIP (Global Product Development for whole product lifecycle) and fellow member of CIRP. In 2018, he was elected Fellow member of the French National Academy of Technologies.

Prof Alain Bernard

Ecole centrale de Nantes

Keynote Speech

Key Considerations for AM development and approaches – An Educational Perspective

This talk will address the fact that design vision has to change with respect to AM capabilities. Designers have to consider the new opportunities offered by AM and they have also to consider a real integrated Part/ Process/Material/Post-treatment approach because AM efficiency needs a real systemic approach. This presentation will discuss an educational perspective towards teaching and learning for Design for AM. It will also share some insights about future challenges, educational approaches to fully embrace and take advantage of digital manufacturing.

Dr Connor Myant

Imperial College London

I am a Senior Lecturer (Assistant Professor) and Group led in the Advanced Manufacturing Group, ICL, in the Dyson School of Design Engineering. My general research interests include: Design for Additive Manufacture, mass customisation, development of 3D Printing technology, and Tribology. I am currently module leader for Solid Mechanics 2 (Core 2nd yr module), and Design for Additive Manufacture (3rd/4th yr elective). Prior to starting my lectureship I worked in the ICL Tribology Group, where I held a Junior Research Fellowship studying synovial fluid lubrication of artificial articular joints. I gained my PhD from Imperial College London in 2010 on the development of experimental techniques for investigating lubricated, compliant, bearing contacts. I graduated from the University of Exeter in 2006 with a Bachelors (BEng) in Mechanical Engineering.

Dr Connor Myant
Imperial College London

Presentation

Starting a multi-departmental DfAM Elective module for engineering students

It is vital that the next generation of engineers and designers are equipped with the knowledge and skills necessary to harness the full potential of Industry 4.0. Part of this new industrial revolution is Additive Manufacturing; an exciting and fast developing area of digital manufacturing. That is why we started a DfAM module for all Faculty of Engineering MEng students at Imperial College London.

The module aims to provide students with the platform needed to solve future industry challenges, get the most out of 3D printing technology and ultimately find the optimal design solution. It explores advanced CAD plugins for manufacture, optimisation and generative design purposes. This presentation will cover how we started this module with the key concept of delivering a DfAM education for all FoE students, its core curriculum, the employed examination processes, and what we have learned along the way.

Michael Mead

Create Education

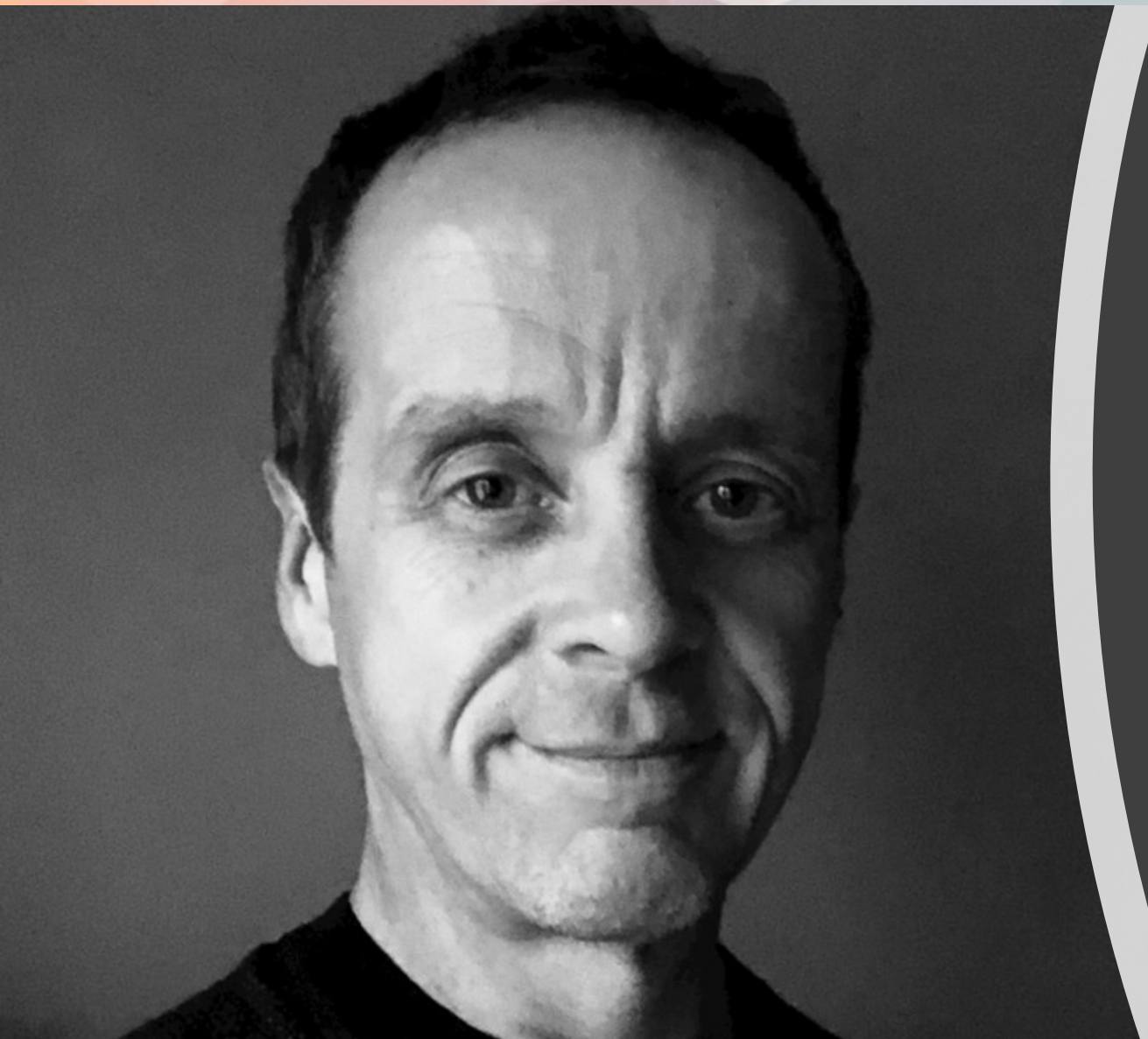
I worked at two leading universities in the Northwest of England - Lancaster and the University of Central Lancashire working to help the universities reach out to businesses and engage them with new technologies that could help change the way they work. This started in IT and Comms before moving to industry 4.0, engineering and manufacturing. During that time i was an ambassador for CREATE Education - helping pass on the 3D printing knowledge I had to schools. I moved full time to CREATE 3 years ago and am now the leading expert for Meltio metal additive systems in the UK and specialise in working with universities.

Michael Mead Create Education

Presentation

The Development of Additive Manufacturing Skills in Young People

It’s no secret that additive manufacturing is a skill that is permeating the job market. Its presence is being noted in more and more industry areas from food and medicine to manufacturing and engineering. For the last five years CREATE Education has worked to develop a community which has a shared objective to develop these required additive skills and create and eco system in which 3D printing skills are not only taught to young people but are built into the fabric of education. I'm going to speak about our journey, the successes and the barriers to uptake from primary school children through to high level university research.



Martin Dury

The Manufacturing Technology Centre (MTC)

Martin is the Head of Future Skills at the Manufacturing Technology Centre (home of the National Centre for AM). Responsible for disrupting the under-served sector of workforce development, through the creation and piloting of new future-proof academic and training programmes that support UK manufacturing.

Martin Dury
The Manufacturing Technology Centre (MTC)

Presentation

Creating a pipeline of AM skilled workforce via apprenticeships

This session will take you through the ‘skills value chain’ – MTC’s process for addressing future workforce requirements. It will provide detail on how this was applied to additive manufacture and the progress made relating to pump-priming a UK additive apprenticeship programme, proving access to AM skills to employers via their apprenticeship levy.

Prof Christopher Tuck
University of Nottingham

Chris Tuck gained his BEng (Hons) in Materials Science and Engineering from Brunel University in 1998 before going on to complete an Engineering Doctorate (EngD) with the Sensors and Composites Group at Cranfield University in Novel Manufacturing Methods of Optical Fibre Sensors. During his EngD Chris undertook the part of the Cranfield Executive MBA programme. He joined AM Research Group at Loughborough University in 2003 as a Research Associate principally working in the supply and business effects of AM on some DTI, EU FP6 and EPSRC funded projects.

In 2008 Chris became a Lecturer at Loughborough University and Senior Lecturer in 2011 & in 2016 became a Professor of Materials Engineering in the University of Nottingham's Faculty of Engineering.
Chris was Deputy Director of the EPSRC Centre Of Innovative Manufacturing in AM to 2018, and currently runs a number of projects based around the manufacture of multi-material and multifunctional inkjet printing, nano-scale additive manufacturing systems, and the development of metallic AM systems for use in industry. Chris has been Director of the EPSRC Centre for Doctoral Training in AM and 3D Printing, a training and research programme for 66 PhD students co-sponsored by industry since 2014. Chris was an Executive Member of the ASTM F42 AM standards committee and a participant in the BSi initiative of AM standards development and is a regular presenter at international conferences, a panel member for EPSRC and a reviewer for European and US funding agencies including NASA. Chris is Associate Pro-Vice Chancellor for Research and Knowledge Exchange in the Faculty of Engineering.

Prof Christopher Tuck
University of Nottingham

Presentation

A cohort-based PGR training programme in Additive Manufacturing and 3D Printing

Additive Manufacturing (AM) has been acknowledged as a potential manufacturing revolution. AM has many advantages over conventional manufacturing techniques; as AM techniques manufacture through the addition of material - rather than traditional machining or moulding methods. AM negates the need for tooling, enabling cost-effective low-volume production in high-wage economies and the design & production of geometries that cannot be made by other means. In addition, the removal of tooling and the potential to grow components and products layer-by-layer means that we can produce more from less in terms of more efficient use of raw materials and energy or by making multifunctional components and products.

The Centre for Doctoral Training (CDT) in Additive Manufacturing and 3D Printing is training the next generation of leaders, scientists and engineers in this diverse and multi-disciplinary field. The CDT trains cohorts of students in all of the basic aspects of AM, from design and materials through to processes and the implementation of these systems for manufacturing high value goods and services. The CDT also offers specialist training on aspects at the forefront of AM research, for example metallic, medical and multi-functional AM considerations. This means that the cohorts graduating from the CDT have the background knowledge to proliferate throughout industry and the specialist knowledge to become leaders in their fields.

Prof David Rosen

Georgia Institute of Technology

David Rosen is a Professor in the School of Mechanical Engineering at the Georgia Institute of Technology. He is Director of the Rapid Prototyping & Manufacturing Institute at Georgia Tech. Additionally, he is the Research Director of the Digital Manufacturing & Design center at the Singapore University of Technology and Design. He received his Ph.D. at the University of Massachusetts in mechanical engineering.

His research interests include computer-aided design, additive manufacturing, and design methodology, with a specific interest at the intersection of those topics on design for additive manufacturing. He has industry experience, working as a software engineer at Computervision Corp. and a Visiting Research Scientist at Ford Research Laboratories. He is a Fellow of ASME and has served on the ASME Computers and Information in Engineering Division Executive Committee. He is the recipient of the 2013 Solid Freeform Fabrication Symposium, International Freeform and Additive Manufacturing Excellence (FAME) Award and is a co-author of a leading textbook on AM.

Prof David Rosen

Georgia Institute of Technology

Presentation

Perspectives on Additive Manufacturing Education Pedagogy

Additive manufacturing offers a collection of novel manufacturing processes that enable opportunities for customized products, complex geometries, novel design concepts, and new business models. From an educational perspective, these aspects of AM present significant challenges to convey the breadth and depth of AM technologies, capabilities, and opportunities.

To address these challenges, educators at Georgia Tech and across the US have developed a variety of pedagogical approaches, which are summarized in this talk. Then, the design and AM curricula at Georgia Tech are presented in depth to illustrate a variety of approaches that we have implemented. AM and fabrication spaces – that is "maker spaces" – are in important ingredient in delivering both hands-on and minds-on experiences so that students gain competences in AM technology and the application of that technology to solve problems. The integration of our "Invention Studio" at Georgia Tech into our curricula is used to illustrate AM courses and content from Georgia Tech are used to illustrate both technical and action-related competencies.

Tony Ryan

Design & Technology Association

Tony is CEO of the Design and Technology Association an organisation supporting over 23,000 teachers nationally. He joined the organisation in January 2018 following a long career as a secondary headteacher in two large London comprehensives. Tony entered teaching almost by accident having crashed out of school fairly dramatically and then refinding a love of learning through an apprenticeship route as a motor vehicle engineer.

He trained in the last years of the ILEA and qualified initially as a teacher of design & technology, later taking an MA in Educational Studies majoring in the use of information technology and in the process converting to a teacher and leader of information technology and computing. Tony has been a trustee of ASDAN, was on the Education Steering Group for the Princes Teaching Institute, is a Fellow of The Royal Society of the Arts, a member of the IET and is currently on several educational steering groups working with the IET and Royal Academy of Engineering amongst others.

Presentation

Providing context for learning – Positioning design and technology to be a catalyst for change

It is a widely known fact that the number of students nationally opting to study design and technology both at GCSE & A Level has plummeted over the last ten years from a GCSE high of over 270,000 in 2010 to just over 98,000 last year. There are many reasons for this, and I think it is too simplistic to blame the demise solely on the Ebacc and the governments' obsession with promoting an 'academic' curriculum that places little emphasis on developing curious, creative learners. If we have learned anything from the pandemic and the challenges it has presented us both personally and professionally over the last eighteen months, it is that we live in an unequal society where opportunity is not the same for all.

As we emerge from the crisis and start looking at how best to place the UK to economic recovery and growth, I believe that now is the time to take a long hard look at our education system and ask if it can lead the UK towards greater social equity and sustained economic growth. But just as importantly for me, can we create an education system where all students can see what they are learning and connect why they are learning and how this education is relevant to them. I believe that design and technology, working closely with business and industry, can be the catalyst that helps to fuel academic change.

Tony Ryan

Design & Technology Association

Adelaide Almeida

European Federation for Welding, Joining and Cutting

Adelaide Almeida is the Project Manager in the European Federation for Welding, Joining and Cutting (EWF) since 2016, responsible for several education projects focused on the development of educational programmes and new professional profiles for the manufacturing industry at European Level. Her field of expertise include the development and implementation of projects aiming at developing national and international standards for Vocational Education and Training (VET) and its alignment with European policies and tools, such as the learning outcomes approach (LOs), vocational credit system (ECVET)and European Qualifications Framework (EQF) within EWF Qualification Systems. She holds a master's degree (MSC) in Educational Sciences since 2008 from the University of Coimbra.

Keynote Speech

Developing the Additive Manufacturing Workforce Skills of Today and Tomorrow

In face of the increasing growth of Additive Manufacturing (AM) technologies and consequent requirements for new occupations, skills and knowledge for personnel working in this sector, the first International Additive Manufacturing Qualification System (IAMQS) was launched by EWF in 2018. The IAMQS covers Metal AM Qualifications for Operators, Designers, Supervisors, Inspectors, Coordinators and Engineers, implemented through international guidelines and robust quality assurance system to ensure a harmonised delivery of training in any country and/or region aligned with industrial needs. The qualification system has been implemented through a European-funded project, known as Skills Strategy in Additive Manufacturing (SAM) that also encompasses a European Observatory to identify and anticipate appropriate AM skills and deliver them through a network of European training centres.

Adelaide Almeida

European Federation for Welding, Joining and Cutting

DfAM Student Poster Competition

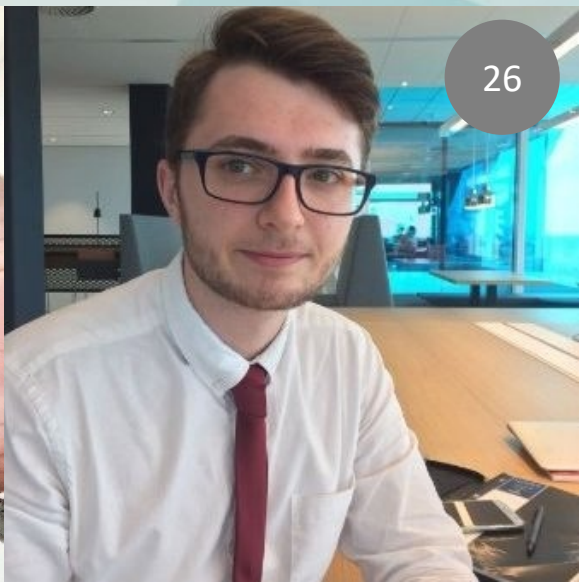
Martins and Dean have organised the competition to support AM students.

The competition aims to help promote the value for students and early career researchers to adopt DfAM in their design practice, and invite students to produce a poster to showcase their work in Design for Additive Manufacturing.

The winners will be announced at the DfAM for Education event.

Martins Obi
Loughborough University

Martins is a Doctoral researcher in DfAM. His research focuses on understanding how to disseminate Design for Additive Manufacturing knowledge by investigating how designers learn and want to learn to DfAM.



Dean Grierson
Lancaster University

Dean is a first year PhD student at Lancaster University studying Functionality Through Design for Additive Manufacturing. His focus in this area is on machine learning enabled/accelerated tools for lattice structure generation.

Activities, feedback and future events

Activities & feedback

The event aims to bring together communities from across the education spectrum to allow for interaction and discussion, and to identify the grand challenges of DfAM in education. These will be addressed through interactive sessions during the event, and the preliminary findings presented at the end.

Ultimately the event outcomes will be brought together in a report.

Future events

The events are based around a key research theme, with specialist leaders. Future events are in their planning stages and will be outlined by the Key Research Theme Leaders at this event.

Contact information:

Email design.for.am@lboro.ac.uk

To join the DfAM Network www.designforam.ac.uk/join-the-network

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