UNIVERSITY OF SURREY

Towards Autonomous Robotic Systems (TAROS)

Conference Programme 2017

Contents

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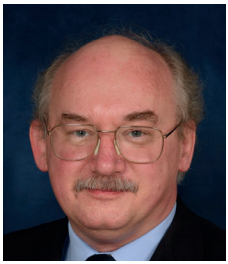
Welcome Notes

Professor Yang Gao FIET FRAeS
TAROS-2017 General Chair

The University of Surrey is very pleased to be hosting the 18th TAROS, the longest-running UK-hosted international conference on robotics and autonomous systems. Continuing the tradition and spirit of the event, this year's TAROS will provide a friendly environment for researchers and practitioners in robotics to take stock, share ideas and plan future progress. We warmly welcome participation and contribution to TAROS-2017 from robotics/Artificial Intelligence (AI) researchers, technologists and business entrepreneurs worldwide.



Dr Mark Witkowski
TAROS-2017 Steering Committee & Award Panel Chair

The TAROS Steering Committee is delighted to be able to acknowledge the very best papers and contributions to the Conference with prizes and awards. We are particularly grateful to the sponsors of these awards: the Springer best paper prize, the IET prize for innovation in robotics, and the best poster award supported by the UK-RAS Network. The best student paper is awarded in memory of the late Professor Ulrich Nehmzow on behalf of his family. As always, this is a fitting opportunity for us all to remember Ulrich's commitment and contributions to the science of robotics and to TAROS.

Mr Paolo Bianco
Manager of R&T Co-Operation Engineering at Airbus

Airbus Defence and Space is very pleased to sponsor TAROS-2017, to support the University of Surrey in this endeavour and to welcome all participants. We are certain that the conference will be an excellent opportunity to exchange ideas, network, create new collaborations and plan for new projects. We would like to wish a great success to both organisers and participants.

Programme

Day 1: Wednesday, 19 July 2017

8:30 – 9:00	**Registration**	
9:00 – 9:30	**Opening & Welcome address**	Yang Gao, TAROS-2017 General Chair
9:30 – 10:30	**Day-1 Keynote Lecture**	*Deep Reinforcement Learning for Robotic Control Problems* Nicolas Heess, Senior Research Scientist, Google DeepMind.
10:30 – 11:00	Tea Break & Visiting Exhibitions	
11:00 – 13:00	**Oral Presentation Session 1.1** *Swarm and Multi-Robotic Systems* Session Chair: Saber Fallah	• Tom Bridgwater, Alan Winfield and Tony Pipe. *'Reactive Virtual Forces for Heterogeneous Swarm Exploration and Mapping'* ** • James O'Keeffe, Danesh Tarapore, Alan Millard and Jon Timmis. '*Towards Fault Diagnosis in Swarm Robotic Systems via Characterisation of Robot Behaviour'* ** • Ali Narenji Sheshkalani, Ramtin Khosravi and Mayssam Mohammad. *'Verification of Visibility-Based Properties on Multiple Moving Robots'** • Eric Schneider, Simon Parsons and Elizabeth Sklar. '*Mechanism Selection for Multi-Robot Task Allocation*' • Elisa Donati, Godfried J van Vuuren, Donato Romano, Katsuaki Tanaka, Thomas Schmickl and Cesare Stefanini. *'aMUSSELs: Diving and anchoring in a new bio-inspired under-actuated robot class for long-term environmental exploration and monitoring*' • Juan Nogales, Mauricio Escarpinati and Gina Barbosa de Oliveira. *'Shark-inspired Target Approach Strategy for Foraging with Visual Clues'*
13:00 – 14:00	**Lunch & Networking**	

14:00 – 15:20	**Oral Presentation Session 1.2** *Human-Robot Interaction* Session Chair: Saber Fallah	• Guido Bugmann, Dominic Cassidy, Paul Doyle and Khushdeep Singh Mann. *'An Open-Source Tele-Operated Mobile Manipulator: CHAP V1'* • Junshen Chen, Marc Glover, Chenguang Yang, Chunxu Li, Zhijun Li and Angelo Cangelosi *'Development of an Immersive Interface for Robot Teleoperation'** • Edwin Daniel Oña Simbaña, Alberto Jardón Huete and Carlos Balaguer. *'The Automated Box and Blocks Test: An Autonomous Assessment Method of Gross Manual Dexterity in Stroke Rehabilitation'* • Robert Wortham, Andreas Theodorou and Joanna Bryson. *'Robot Transparency: Improving Understanding of Intelligent Behaviour for Designers and Users'*
15:20 – 15:40	**Tea Break & Visiting Exhibitions**	
15:40 – 17:00	**Oral Presentation Session 1.3** *Robotic Learning and Imitation* Session Chair: Saber Fallah	• Jens Lundell, Murtaza Hazara and Ville Kyrki. *'Generalizing Movement Primitives to New Situations'** • Mark Baxendale, Martin Pearson, Mokhtar Nibouche, Emanuele Secco and Tony Pipe. *'Self-adaptive context aware audio localization for robots using parallel cerebellar models'* • Joe Watson, Josie Hughes and Fumiya Iida. *'Real-Time Robotic Grasping with Convolutional Neural Networks and externally collected training data''* • James Gillespie, Inaki Rano, Nazmul Siddique and Jose Santos. *'Learning Bio-Inspired Target Seeking using Reinforcement Learning'*
17:00 – 18:00	**Day-1 Wrap-Up & Panel Discussions**	
18:00 – 19:00	**Ice Breaker Reception @ Conference Venue**	
19:00 – 20:00	**IET Public Lecture (open to both TAROS participants and the Public)**	*First European Mars Rover - ExoMars Rover: Engineering for the Red Planet* Abbie Hutty, Principle Engineer, Airbus

*Best Paper Nominees
**Best Student Paper Nominees
***Best Poster Paper Nominees

Day 2: Thursday, 20 July 2017

9:00 – 10:00	**Day-2 Keynote Lecture**	*On-orbit Assembly of Large Space Telescope with Autonomous Robotic Systems* Qingwen Wu, Professor, Changchun Institute of Optics, Fine Mechanics and Physics (CIOMP), Chinese Academy of Sciences.
10:00 – 10:30	**Tea Break & Visiting Exhibitions**	
10:30 – 12:30	**Oral Presentation Session 2.1** *Robot Navigation, Planning and Safety* Session Chair: Alan Winfield	• Stefan Schubert, Peer Neubert and Peter Protzel. *'Towards camera based navigation in 3D maps by synthesizing depth images'** • Pedro Proença and Yang Gao. *'Probabilistic Combination of Noisy Points and Planes for RGB-D Odometry'*** • Stefan Edelkamp, Baris Secim and Erion Plaku. *'Surface Inspection via Hitting Sets and Multi-Goal Motion Planning'* • Silvain Louis, Karen Godary-Dejean, Lionel Lapierre, Thomas Claverie and Sébastien Villéger. *'Formal method for mission controller generation of a mobile robot'* • Sing-Kai Chiu, Dejanira Araiza-Illan and Kerstin Eder. *'Risk-based Triggering of Bio-inspired Self-Preservation to Protect Robots from Threats'* • Alan Winfield and Marina Jirotka. *'The Case for an Ethical Black Box'**
12:30 – 14:00	**Lunch & Networking**	
14:00 – 15:20	**Poster Sessions** Session Chair: Tina Lekakou *A: Humanoid & Bio-inspired Robots*	• Christopher Wallbridge and Guido Bugmann. *'Recovery of a Humanoid Robot from a Destabilising Impact'* • Vaibhav Gandhi, Ganesh Kumar Kalyani, Zhijun Yang and Tao Geng. *'Using Robot Operating System (ROS) and Single Board Computer to Control Bioloid Robot Motion'* • Matthew Hale, Jonathan L Du Bois and Pejman Iravani. *'A Comparison of Analytical and Empirical Controllers for the SLIP Hopper'* • Zhanye Yang, Pejman Iravini, Andrew Plummer and Min Pan. *'Investigation of Hardware-in-the-Loop Walking/Running test with Spring Mass System'* • Ryan Draper, Jane Sheard and Matt Troughton. *'Soft Robotic Snake with Variable Stiffness Actuation'*

	B: Mobile Robots & Vehicles	• Steffen Müller, Thanh Q Trinh and Horst-Michael Gross. *'Local real-time motion planning using evolutionary optimization''* • Mark Witkowski and Vince Gallo. *'The Virtual Beehive'* • Víctor H Andaluz. *'Mobile Manipulators for Cooperative Transportation of Objects in Common'* • Víctor H Andaluz. '*Navigation and Dynamic Control of Omnidirectional Platforms* • Víctor H Andaluz. *'Dynamic Unified Control of Omnidirectional Robots'* • Anastasia Stone and Ildar Farkhatdinov. *'Robotics Education for Children at Secondary School Level and Above'*
	C: Robot Design & Testing	• Emily Ingham, Shuhei Miyashita and Dana Damian. *'Elastomeric Spring Actuator Using Nylon Wires'* • Rodrigo D. Solis-Ortega, Abbas A. Dehghani-Sanij and Uriel Martinez-Hernandez. *'Characterization of kinetic and kinematic parameters for wearable robotics'* • Alex Watts and Constantina Lekakou. *'A Robot Gripper with Sensor Skin'* • Josie Hughes and Fumiya Iida. *'3D Printed Sensorized Soft Robotic Manipulator Design'* *** • Shuai He, Zhenbang Xu and Xiaoming Wang. *'Design and Testing of a Parallel Manipulator for Space Micro-vibration Simulation'*
	D: Detection & Recognition	• Rebecca Allday, Simon Hadfield and Richard Bowden. *'From Vision to Grasping: Adapting Visual Networks*' • Steven Balding and Darryl Davis. *'Simple anchoring model for robotic colonies'* • Thomas Wright and Barry Lennox. *'Algorithmic Approach to Planar Void Detection and Validation in Point Clouds'*
	E: Learning & Adaptive Behaviours	• Thomas Lowndes, Alexander Phillips, Catherine Harris, Eric Rogers, Bing Chu and Ekaterina Popova. *'Evaluating the capabilities of the EcoSUBμ to perform emergent and adaptive behaviours using simulation'* • James Finnis. *'Homeostatic robot control using simple neuromodulatory techniques'*

*Best Paper Nominees
**Best Student Paper Nominees
***Best Poster Paper Nominees

Day 2: Thursday, 20 July 2017

	F: H&R, R&R Interaction	• David Cameron, Samuel Fernando, Emily Cowles-Naja, Abigail Perkins, Emily Collins, Abigail Millings, Michael Szollosy, Roger Moore, Amanda Sharkey and Tony Prescott. *'Children's age influences their use of biological and mechanical questions towards a humanoid'* • Erwin Lopez, Guido Herrmann and Ute Leonards. *'Drivers' Manoeuvre Classification for Safe HRI'* *** • Tsvetan Zhivkov, Eric Schneider and Elizabeth Sklar. *'Measuring the Effects of Communication Quality on Multi-Robot Team Performance'* • Luke Hickton, Matthew Lewis and Lola Canamero. *'A Flexible Component-Based Robot Control Architecture for Hormonal Modulation of Behaviour and Affect'*
15:40 – 16:00	**Tea Break & Visiting Exhibitions**	
16:00 – 17:00	**Oral Presentation Session 2.2** *Soft and Reconfigurable Robots* Session Chair: Tina Lekakou	• Constantina Lekakou, Seri Mustaza, Tom Crisp, Yahya Elsayed and C.M. Saaj. *'A Material-based Model for the Simulation and Control of Soft Robot Actuator'* • Thomas Collins and Wei-Min Shen. *'Integrated and Adaptive Locomotion and Manipulation for Self-Reconfigurable Robots'* • Alexander Thorn, Dorukhan Afacan, Emily Ingham, Can Kavak, Shuhei Miyashita and Dana Damian. *'Low-power and Low-cost Stiffness-variable Oesophageal Tissue Phantom'*
17:00 – 18:00	**Day-2 Wrap-Up & Panel Discussions**	
19:00 – 21:00	**Conference Dinner @ Harbour Hotel Guildford (See Appendix for location map)**	

Day 3: Friday, 21 July 2017

9:00 – 10:00	**Day-3 Keynote Lecture**	*Towards zero manual intervention* Rob Buckingham, Director of Remote Applications in Challenging Environments (RACE), UK Atomic Energy Authority
10:00 – 10:30	**Tea Break & Visiting Exhibitions**	
10:30 – 12:30	**Oral Presentation Session 3** *Service and Industrial Robots* Session Chair: Rob Buckingham	• Zhuoling Huang, Sam Wane and Simon Parsons. *'Towards automated strawberry harvesting: Identifying the picking point'* • Andreas Grünauer, Georg Halmetschlager-Funek, Johann Prankl and Markus Vincze. *'The Power of GMMs: Unsupervised Dirt Spot Detection for Industrial Floor Cleaning Robots'* • Ola Ringdahl, Polina Kurtser and Yael Edan. *'Strategies for selecting best approach direction for a sweet-pepper harvesting robot'* • Seyedmohammadhadi Sadati, Seyedeh Elnaz Naghibi, Ali Shiva, Ian D. Walker, Althoefer Kaspar and Thrishantha Nanayakkara. *'Mechanics of Continuum Manipulators, A Comparative Study of Five Methods with Experiments'* • Jelizaveta Konstantinova, Senka Krivic, Agostino Stilli, Justus Piater and Kaspar Althoefer. *'Autonomous Object Handover using Wrist Tactile Information'* • Chris Harris. *'Autonomous Vehicle Decision-Making: Should We Be Bio-Inspired?'*
12:30 – 13:00	**Award Ceremony** Session Chair: Mark Witkowski	• Best Paper Prize sponsored by Springer • Best Student Paper Prize in memory of the late Professor Ulrich Nehmz • Best Poster Prize sponsored by UK-RAS Network • Best Robotics Demonstration Prize sponsored by IET
13:00 – 14:30	**Lunch & Networking** **Closing Remarks**	

*Best Paper Nominees
**Best Student Paper Nominees
***Best Poster Paper Nominees

Keynotes & IET Public Lecture

'Deep reinforcement learning for control - algorithms and architectures'

Nicolas Heess
Google DeepMind

Enabling an embodied agent to interact with the physical world in an autonomous and sophisticated manner based on raw sensory input is one of the long-standing challenges of artificial intelligence. Deep learning based approaches are playing an increasingly important role in efforts to achieve this goal. In his talk, Nicolas Heess will give an overview of algorithms and architectures for continuous control, and discuss applications both in simulation and towards real robotic arms.

Nicolas Heess is a senior research scientist at Google DeepMind. He has published papers on aspects of reinforcement learning, unsupervised learning, probabilistic models, and inference. His research focuses on applications of these techniques at the intersection of control and perception. Before joining DeepMind Nicolas was a postdoctoral researcher at the Gatsby Unit (UCL), working with Yee Whye Teh and David Silver. He did his PhD under the supervision of Chris Williams at the University of Edinburgh, working on generative models of structure in natural images. During that time he also paid several extended visits to Microsoft Research (Cambridge, UK) where he worked with John Winn.

'Towards Zero Manual Intervention'

Rob Buckingham
Remote Applications in Challenging Environments (RACE), UK Atomic Energy Authority

RACE represents an extreme use case: zero manual intervention into a complex industrial facility for 10 years – a fusion reactor. This means it is necessary to think about the design and operation of the end-to-end system that will rely completely on robotic intervention. Rob Buckingham's talk will explore some of the issues, look at progress to date, and outline the future R&D strategy for RACE.

Dr Rob Buckingham (FREng) is a Director of the UK Atomic Energy Authority (UKAEA) and the first Head of RACE, the new centre for Remote Applications in Challenging Environments. Rob was a lead author of the UK's Robotics and Autonomous Systems 2020 Strategy. Before joining the UKAEA, Rob co-founded and was Managing Director of OC Robotics. He is a Fellow of both the Royal Academy of Engineering and the Institute of Engineering and Technology.

'On-orbit Assembled Space Telescope using Autonomous Robotics '

Professor Qingwen Wu
Changchun Institute of Optics, Fine Mechanics and Physics (CIOMP), Chinese Academy of Sciences.

Space telescopes of greater than 10m aperture can significantly enhance the resolution and detection limit for imaging and space science. However, there are still barriers for space telescopes imposed by launch vehicle and large aperture mirror manufacture limitations. Professor Qingwen Wu will present a new approach called 'On-orbit Assembled Space Telescope (OAST)', which involves designing and manufacturing modules on the ground and launching them using one or multiple launches. Autonomous robotics is the key technology behind OAST. Space robots play an important role in the procedure, enabling the identifying, carrying, assembling, locking & docking, and aligning of the telescope modules automatically and intelligently. The OAST program is currently being implemented in China.

Professor Qingwen Wu specialises in space robotics, mechanics design and thermal control for space optics remote sensors. He has taken part in and completed more than 20 space projects since 1994. Most of the projects are focused on the design and manufacturing of space optics, remote sensors and space robots. As a professor, he has supervised more than 40 Masters and PhD research students.

'ExoMars Rover: Engineering for the Red Planet'

Abbie Hutty
Airbus

ExoMars is Europe's first Rover mission to Mars – a mission in search of life, past or present, to answer one of mankind's big questions: are we alone in the Universe? Abbie Hutty, Platform Delivery Manager for the Rover, will talk about the mission's aims and objectives, some of the major challenges and design drivers of a mission to Mars, and how the team are engineering solutions to meet those challenges.

Abbie Hutty joined Astrium at Stevenage, now Airbus Defence and Space, as a Mechanical Engineer in 2010, moving to the ExoMars Rover team as a Spacecraft Structures Engineer in 2012. She spent five years as the lead structures engineer for the Rover Vehicle and, following successful delivery of the first full structure, has recently taken on the role of Platform Delivery Manager for the Rover. In this role she is responsible for all the subsystems on the Rover Platform being delivered, tested and integrated together to create the first build of the Rover.

Paper Prize Nominees

Congratulations to the following papers submitted to TAROS-2017 which have been nominated by the International Program Committee (IPC) based on the peer-review results:

Nominees for Best Paper Prize sponsored by Springer

- Junshen Chen, Marc Glover, Chenguang Yang, Chunxu Li and Zhijun Li. 'Development of an Immersive Interface for Robot Teleoperation'
- Jens Lundell, Murtaza Hazara and Ville Kyrki. 'Generalizing Movement Primitives to New Situations'
- Ali Narenji Sheshkalani, Ramtin Khosravi and Mayssam Mohammadi. 'Verification of Visibility-Based Properties on Multiple Moving Robots'
- Alan Winfield and Marina Jirotka. 'The Case for an Ethical Black Box'
- Stefan Schubert, Peer Neubert and Peter Protzel. 'Towards camera based navigation in 3D maps by synthesizing depth images'

Nominees for Best Student Paper Prize in memory of Professor Ulrich Nehmzow

- Tom Bridgwater, Alan Winfield and Tony Pipe. 'Reactive Virtual Forces for Heterogeneous Swarm Exploration and Mapping'
- Pedro Proença and Yang Gao. 'Probabilistic Combination of Noisy Points and Planes for RGB-D Odometry'
- James O'Keeffe, Danesh Tarapore, Alan Millard and Jon Timmis. 'Towards Fault Diagnosis in Swarm Robotic Systems via Characterisation of Robot Behaviour'

Nominees for Best Poster Prize sponsored by UK-RAS Network

- Erwin Lopez, Guido Herrmann and Ute Leonards. 'Drivers' Manoeuvre Classification for Safe HRI'
- Josie Hughes and Fumiya Iida. '3D Printed Sensorized Soft Robotic Manipulator Design'

The IPC's Award Panel will further evaluate the presentations given by the shortlisted candidates during the conference and announce the winners at the Award Ceremony.

Sponsor Profiles

Airbus is a global leader in aeronautics, space and related services. It is Europe's Number 1 defence and space company and the world's second largest space company. In 2016, it generated revenues of €67 billion and employed a workforce of around 134,000. Airbus offers the most comprehensive range of passenger airliners from 100 to more than 600 seats. Its defence and space technologies enable governments and institutions to protect natural resources, societies and individual freedom. The aircraft, satellites and services help to monitor climate and crops, and to secure borders. Its portfolio also ensures communication, mobility, the expansion of knowledge and the safeguarding of the environment. In helicopters, Airbus provides the most efficient civil and military rotorcraft solutions worldwide.

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The Changchun Institute of Optics, Fine Mechanics and Physics – Chinese Academy of Sciences (CIOMP-CAS) is the premium sponsor of TAROS-2017. The company was founded in 1952 focusing on luminescence, applied optics, optical engineering, and precision mechanics and instrumentation. CIOMP has been involved in many important national projects, such as the "Two bombs, One Star" and manned space projects. CIOMP has made great contributions to China's defence construction, economic development, and social progress.

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The Institution of Engineering and Technology (IET) is the sponsor of TAROS for public lecture and prize. IET's vision is to engineer a better world and its mission is to inspire, inform and influence the global engineering community, supporting technology innovation to meet the needs of society.

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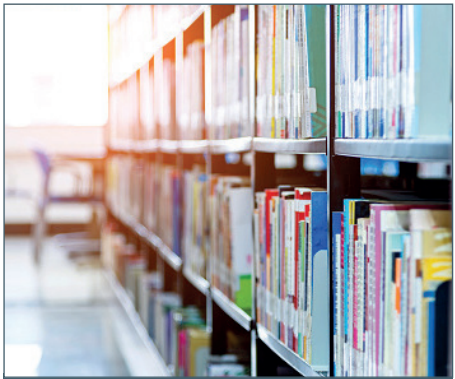

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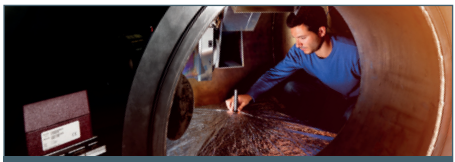
UK-RAS NETWORK
ROBOTICS & AUTONOMOUS SYSTEMS

The EPSRC UK Robotics and Autonomous Systems Network (UK-RAS Network) was established in March 2015 with the mission to provide academic leadership in Robotics and Autonomous Systems (RAS), expand collaboration with industry and integrate and coordinate activities at eight Engineering and Physical Sciences Research Council (EPSRC) funded RAS capital facilities, four Centres for Doctoral Training (CDTs) and partner universities across the UK. The Network is expanding to include broader stakeholders including key national laboratories in the UK and leading international collaborators in both academia and industry. It has already received strong support by major industrial partners, the Science Museum and the UK's major professional engineering bodies including Royal Academy of Engineering, IET, and IMechE. The Network organises a wide range of activities including network and strategic roadmap events such as the UK Robotics Week, symposia and focused workshops, public engagement and exhibitions. It also has extensive online engagement activities using social media, web and user forums. The Network aims to strengthen the relationship with industry by supporting interdisciplinary mobility and industrial secondment, developing proof-of-concept (PoC) projects and running design challenges. There is also a strong emphasis on government policy and high-level engagement with international stakeholders.

hamlyn.doc.ic.ac.uk/uk-ras/about-us/facility



UNIVERSITY OF SURREY

The University of Surrey is one of the leading universities in the UK (ranked 10th by the Guardian University Guide 2018, 13th by the Complete University Guide 2018, and 11th by the Times and Sunday Times Good University Guide 2017). It was named The Times and Sunday Times Good University Guide 2016's University of The Year. Surrey is home to many world-renowned departments and research institutes, several of which have made notable R&D contributions to the field of space robotics, computational intelligence and connected autonomous systems. These include the STAR (Surrey Technology for Autonomous systems and Robotics) Lab which is a leading research lab in space robotics and autonomous systems within the Surrey Space Centre. Its expertise includes sensing, perception, GNC, autonomy and biomimetic mechanisms. STAR Lab has been involved in developing many real-world space robotic missions such as ESA's ExoMars, Proba3 and LUCE, UK's MoonLITE and MoonRaker, and Chinese Chang'E. It is also active in technology transfer to non-space sectors like nuclear and agriculture.

surrey.ac.uk/ssc/research/star-lab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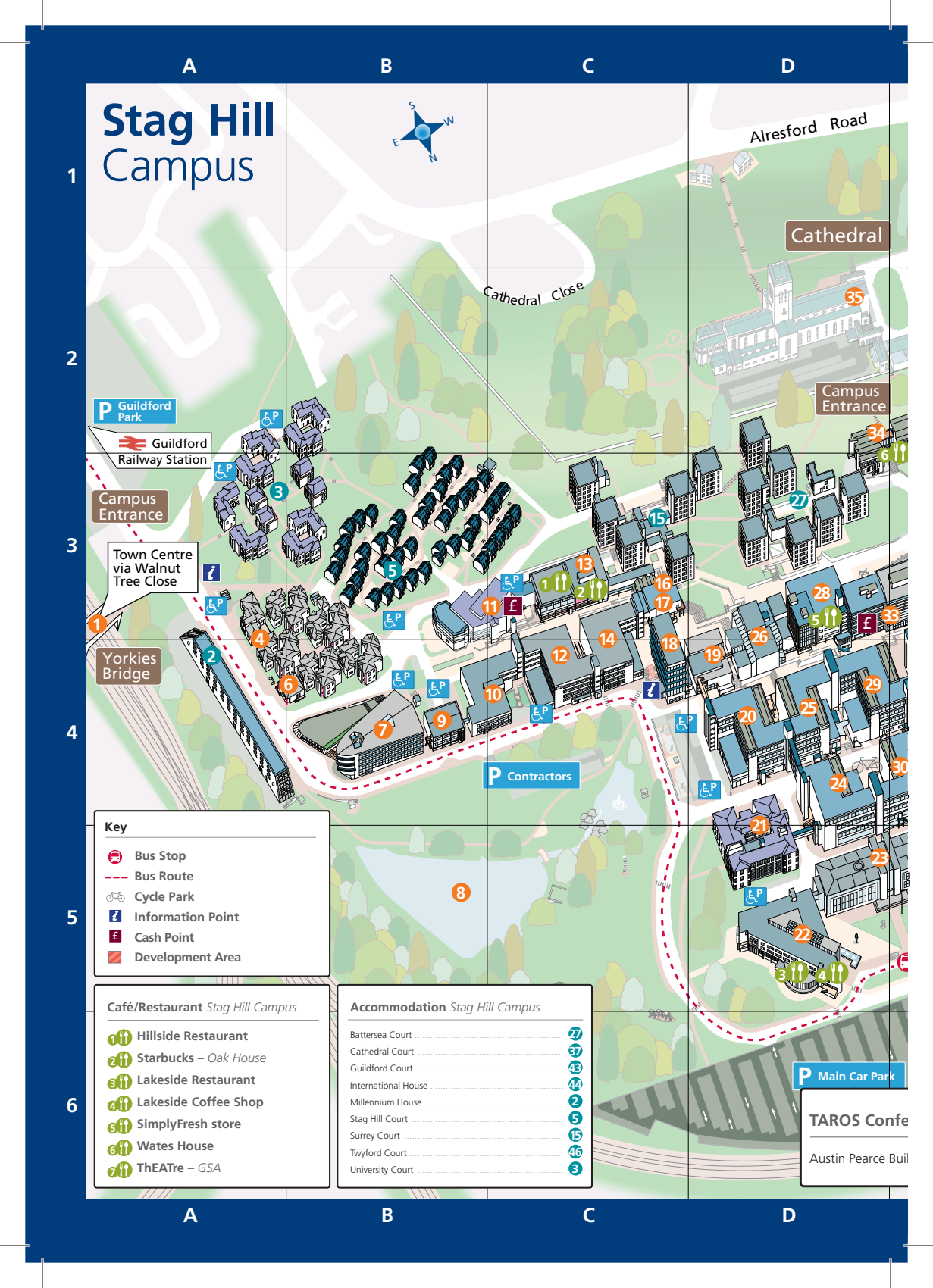
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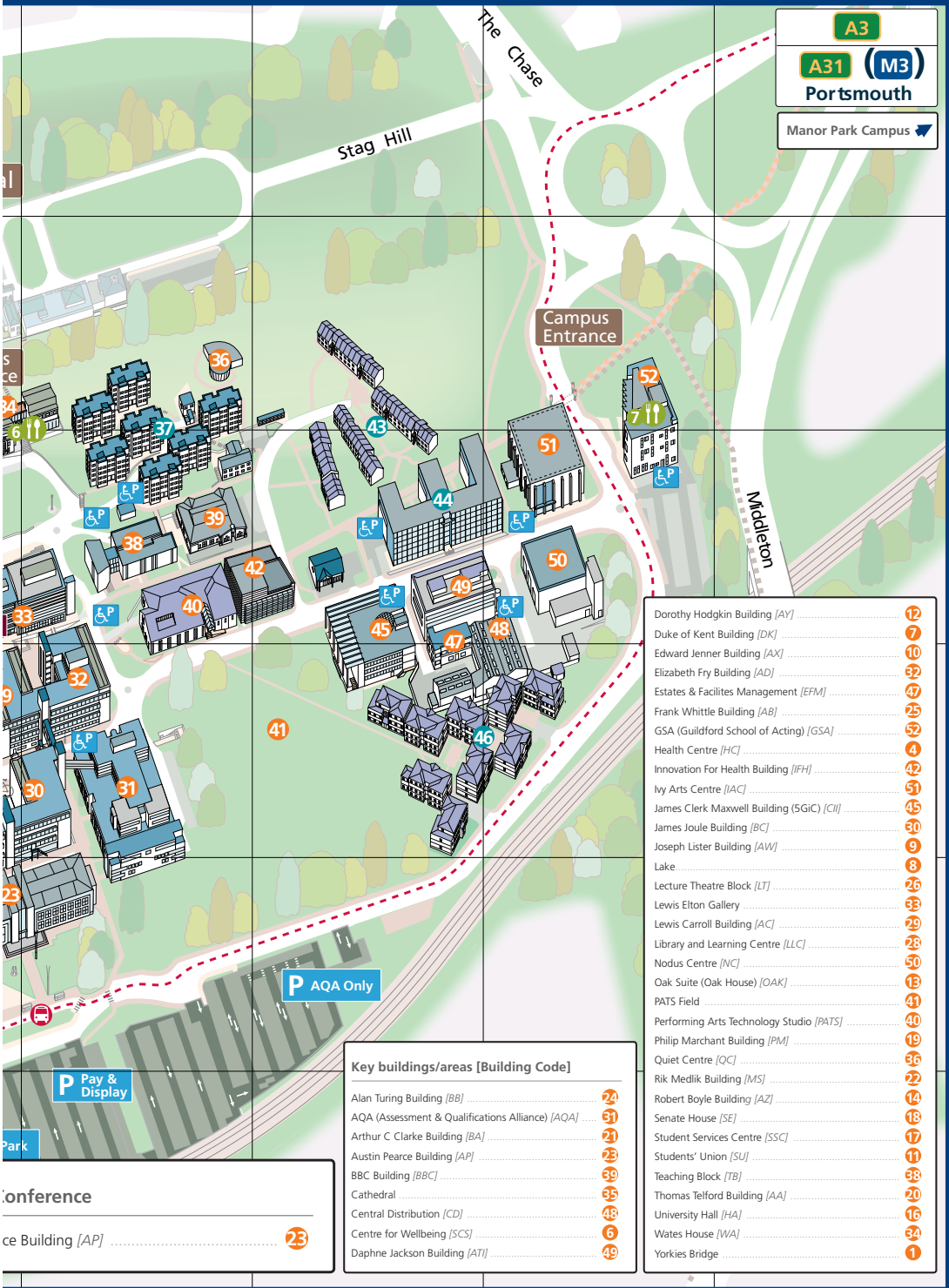
Cycle Park
Information Point
Cash Point
Development Area
Café/Restaurant Stag Hill Campus
1 Hillside Restaurant
2 Starbucks – Oak House
3 Lakeside Restaurant
4 Lakeside Coffee Shop
5 SimplyFresh store
6 Wates House
7 ThEATre – GSA
Accommodation Stag Hill Campus
Battersea Court 27
Cathedral Court 37
Guildford Court 43
International House 44
Millennium House 2
Stag Hill Court 5
Surrey Court 15
Twyford Court 46
University Court 3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Manor Park Campus
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Campus Entrance
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P Pay & Display
Park
Key buildings/areas [Building Code]
Alan Turing Building [BB] 24
AQA (Assessment & Qualifications Alliance) [AQA] 31
Arthur C Clarke Building [BA] 21
Austin Pearce Building [AP] 23
BBC Building [BBC] 39
Cathedral 35
Central Distribution [CD] 48
Centre for Wellbeing [SCS] 6
Daphne Jackson Building [ATI] 49
Dorothy Hodgkin Building [AY] 12
Duke of Kent Building [DK] 7
Edward Jenner Building [AX] 10
Elizabeth Fry Building [AD] 32
Estates & Facilites Management [EFM] 47
Frank Whittle Building [AB] 25
GSA (Guildford School of Acting) [GSA] 52
Health Centre [HC] 4
Innovation For Health Building [IFH] 42
Ivy Arts Centre [IAC] 51
James Clerk Maxwell Building (5GiC) [CII] 45
James Joule Building [BC] 30
Joseph Lister Building [AW] 9
Lake 8
Lecture Theatre Block [LT] 26
Lewis Elton Gallery 33
Lewis Carroll Building [AC] 29
Library and Learning Centre [LLC] 28
Nodus Centre [NC] 50
Oak Suite (Oak House) [OAK] 13
PATS Field 41
Performing Arts Technology Studio [PATS] 40
Philip Marchant Building [PM] 19
Quiet Centre [QC] 36
Rik Medlik Building [MS] 22
Robert Boyle Building [AZ] 14
Senate House [SE] 18
Student Services Centre [SSC] 17
Students' Union [SU] 11
Teaching Block [TB] 38
Thomas Telford Building [AA] 20
University Hall [HA] 16
Wates House [WA] 34
Yorkies Bridge 1
conference
ce Building [AP] 23

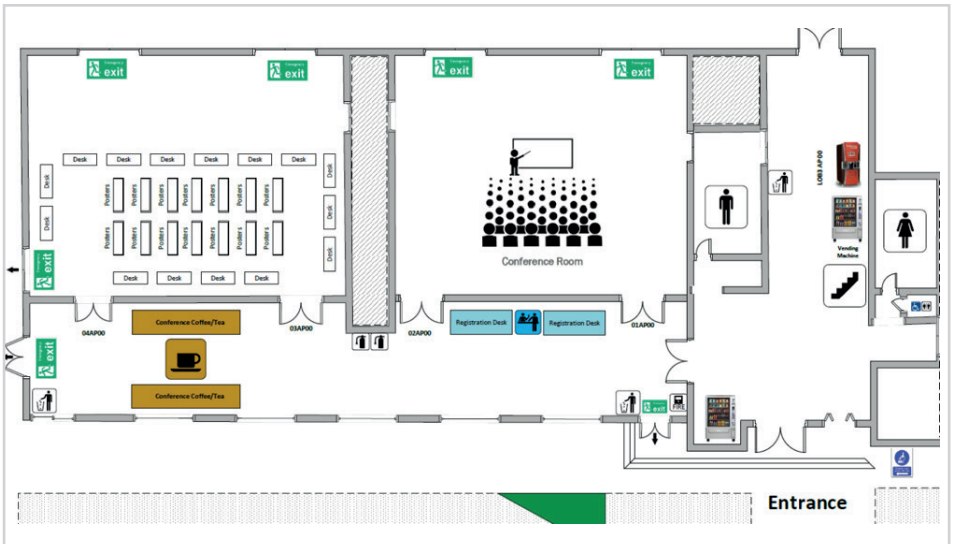
Conference Venue:

University of Surrey – Stag Hill Campus

Austin Pearce Building

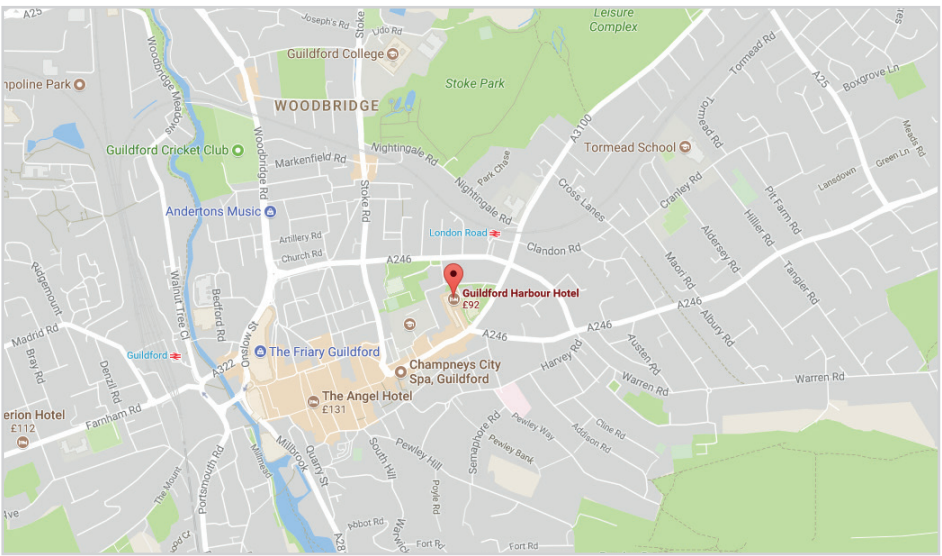
Austin Pearce – Main Entrance

Room 1 to 4 Layout



Dinner Venue:

Harbour Hotel Guildford – 3 Alexandra Terrace, Guildford GU1 3DA
T: +44 (0) 1483 792300



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