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To whom it may concern,

Re: Reference for Mr Max Vergé-Kemp

It is my pleasure to write a reference letter for Max, who I have known since September 2023 when he started a research project under my supervision as part of his MEng degree in Aerospace Engineering at the University of Bristol. The degree of Aerospace Engineering has a long heritage at Bristol, being the first of its kind in the UK and consistently ranked as one of the best in the UK and Europe. During the four-year MEng degree students must complete a research project in the third year, and outstanding students are invited to extend their research in a second project during their final year. Max was one of a handful of these outstanding students.

Max's project investigated the nonlinear behaviour of kirigami sheets, usually a thin elastomeric film that has been perforated by a matrix of parallel cuts. When tensioned these structures exhibit interesting buckling behaviour whereby the material between the cuts deforms out of the plane. In this buckled state, the kirigami sheet can undergo very large axial deflections at a predictable stiffness and, for this reason, kirigami sheets have been considered as potential ultra-lightweight suspension elements for large satellite structures, *e.g.* the CalTech space solar project. An interesting feature of these kirigami structures is that they can buckle into two possible modes with significantly different stiffnesses. If individual cells of material between cuts could be controlled to buckle into either of these modes across the sheet, the axial stiffness of the sheet could be modulated and controlled in-situ to create a tunable spring.

During his third- and fourth-year projects, Max explored the technical feasibility of this approach by attaching piezo-electric actuators onto a kirigami sheet to influence the buckling mode. To control the piezo-electric actuator Max had to design and build a custom driver that would step up a small voltage (the order of a Volt) to the much larger voltages (order of a thousand volts) required by piezo-electric actuators. In order to investigate the effectiveness of controlling the deformation mode and stiffness of the kirigami sheets using piezo patches, Max conducted detailed experiments involving tensile testing machines and digital image correlation (a first for kirigami sheets). To run these experiments, he designed and manufactured a test fixture using rapid prototyping and rationalised his experimental observations using analytics and advanced finite element simulations. The high standard of the research produced by Max is reflected in the first-class mark he received for both phases of the project.

Especially striking about Max's work was his maturity and independence in thought and analysis. I was particularly impressed by Max's ability to learn new concepts that he had not yet covered in lectures (piezo-electrics, non-linear finite element analysis) while at the same time applying the knowledge and skills that he had previously covered in his course at Bristol. Throughout the research project, Max also had the opportunity to present the findings of his research to his peers and members of staff, for which he received a prize for excellence in technical communication.

I have no reservations in recommending Max to your organisation as an excellent engineer with a positive work ethic, great communication skills and an individual of outstanding character. Should you have any further question, please do not hesitate to reach out.

Yours sincerely,



Dr Rainer Groh MRAeS CEng