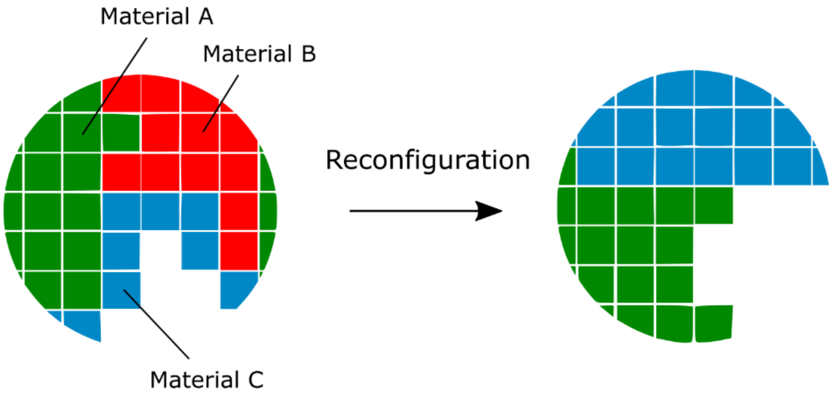
Project 2 : Biased Galton board through shape and stiffness modification of the chip:

Context: *A classical Galton board is a device built to demonstrate the central limit theorem. More specifically, that with sufficient sample size the binomial distribution approximates a normal distribution. We want to modify the chips used in a Galton board to create other distributions. The shape of the chips can be modified, but also their stiffness. Creating other distributions (biased results) can allow to create interesting sorting mechanisms based on the chips shape and stiffness but can also find application in quantum mechanics. Since we want to test a large number of shapes and stiffnesses for the chips, a reconfigurable approach is chosen to design and make the chips. More specifically, the chips will be made out of Diels-Alders polymers. The reversible covalent bonds of this polymer ensure high interfacial strength between different materials while allowing for reconfiguration. The reversible DA bonds allow recovering from macroscopic damage, like cuts and punctures, upon a heat-cool cycle. Therefore, the polymer can be cut and healed back together to reform a single part with full recovery of the initial material properties. By varying the network properties of the polymer, different mechanical properties, ranging from hyperelastic (100 kPa) to hard thermosets (10 GPa) can be obtained leading to multi-material parts with strong multi-material interfaces. By using these polymers, chips can be made of different materials and can be reconfigured to avoid using extra material to create other chips.*



Goal (direction of the whole paper):

Controlled, biased distributions can be created thanks to the drops of chips of specific shape and stiffness on a Galton board.

Problem (what are you trying to solve ?):

A Galton board with a classic chip always results in a normal distribution. However, depending on the application, obtaining other distributions can be useful.

Hypothesis (how are you going to solve this ?/ how are you going to achieve your goal ?):

In order to obtain other distributions, the shape of the chips can be tweaked as well as its material properties.

Proof (what do you need to show to convince the reviewers ?):

Simulations of the Galton board with different shapes and material properties of chips show that different distributions can be obtained. Real-life experiments with reconfigurable chips made of

Diels-Alder polymers (containing reversible DA bonds) show similar results, i.e. that different distributions can be obtained.

Conclusion:

By using Diels-Alders polymers to make the chips, these can be easily reconfigured (see Figure above). This avoid having to manufacture new chips from scratch, which spare time and material. Obtaining different distributions by tweaking the shape and material of the chips used in a Galton board can allow creating new sorting mechanisms. Moreover, this research may find application in quantum physics.

Timeline:

Before coming to Cambridge:

- Test the making of a multi-material chip, check the manufacturing limitations.
- Check the reconfigurability of the multi-material chips.

During Cambridge stay:

	September				October				November			
	1	2	3	4	1	2	3	4	1	2	3	4
WP1: Design & assembly of multi-material chips												
T1.1 Adapt the chip design to the automatic testing board												
T1.2 Manufacturing of the self-healing chip												
T1.3 Test the chips in the automatic testing board and compare with original chip												
WP2: Reconfiguration of the multi-material chip												
T2.1 Design of a support to cut the chip												
T2.2 Design of a reconfiguration method												
WP3: Testing and data acquision												
T3.1 Results acquision of the simulations												
T3.2 Results acquisition of the experimental testing board												
WP4: Writing of the paper												
T4.1 Writing of the introduction and simulations												
T4.2 Writing of the manufacturing technique of the chips and board												
T4.3 Writing of the results & conclusion												