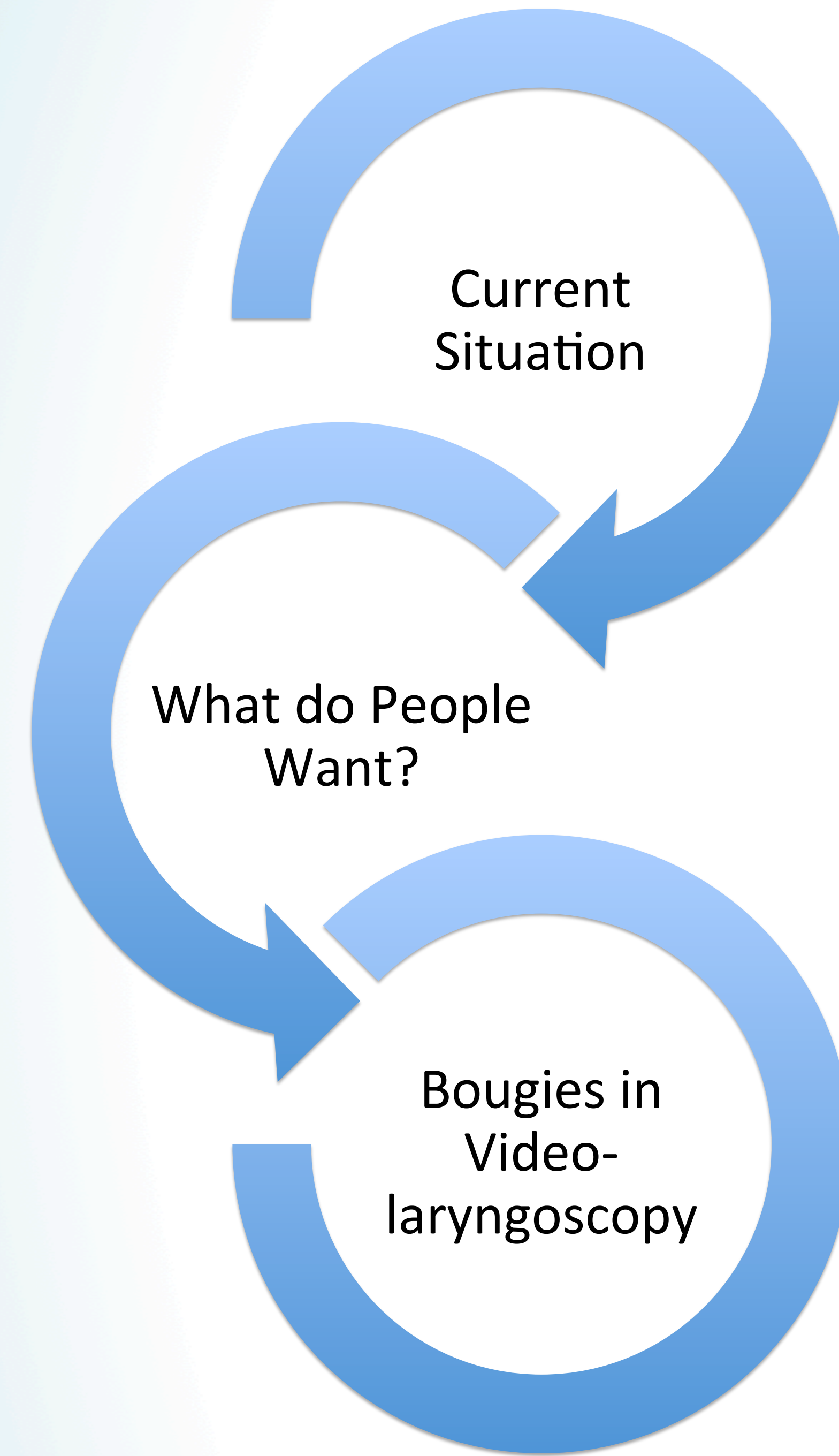


# The development of a novel 'steerable' bougie to assist in airway management

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## Background

Videolaryngoscopy (VL) is increasingly used and has been proposed as a standard of care (BJA Editorial 2015). VL has several important benefits over conventional laryngoscopy. By means of a camera at the distal end of the instrument, the larynx can be visualized even when it is impossible to obtain a straight line of sight and the use of a camera and display facilitates recording and teaching. In some patients, VL allows a good view of the larynx but due to the angles involved intubation itself is still difficult (2)



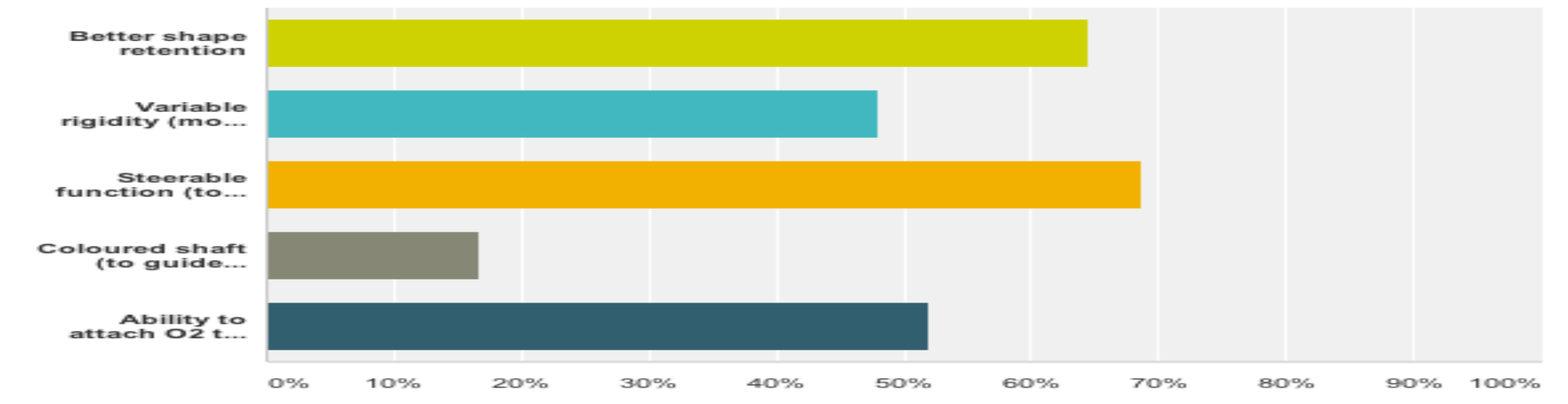
- The traditional bougie, being long, flexible, narrow and having some intrinsic memory can often be placed within the trachea when the view is limited. They do, however, have **limitations** – the shape retention is often short lived and there is **no ability to 'steer'** the tip, so directional control in-situ is limited. This can be frustrating for clinicians, and potentially dangerous for patients (3)

- We started by creating an on-line survey asking anaesthetists what additional **physical or functional properties** a new bougie would have. We have created a wordle of their responses (fig 1)

- We designed a second survey to look at Anaesthetists use of video-laryngoscopy, and their experience with aids for intubation. **75 % recognised the situation of good view, unable to intubate**. When asked about desirable properties of a new aid, the responses can be found in graph 1.



Figure 1: (Above) Wordle of physical and functional properties of a new bougie. Largest and mostly central words reflect the most frequent responses



Answer Choices	Responses
Better shape retention	64.58% 31
Variable rigidity (more flexible tip)	47.92% 23
Steerable function (to allow shape change with device in situ)	68.75% 33
Coloured shaft (to guide insertion depth)	16.67% 8
Ability to attach O2 to the bougie	52.08% 25

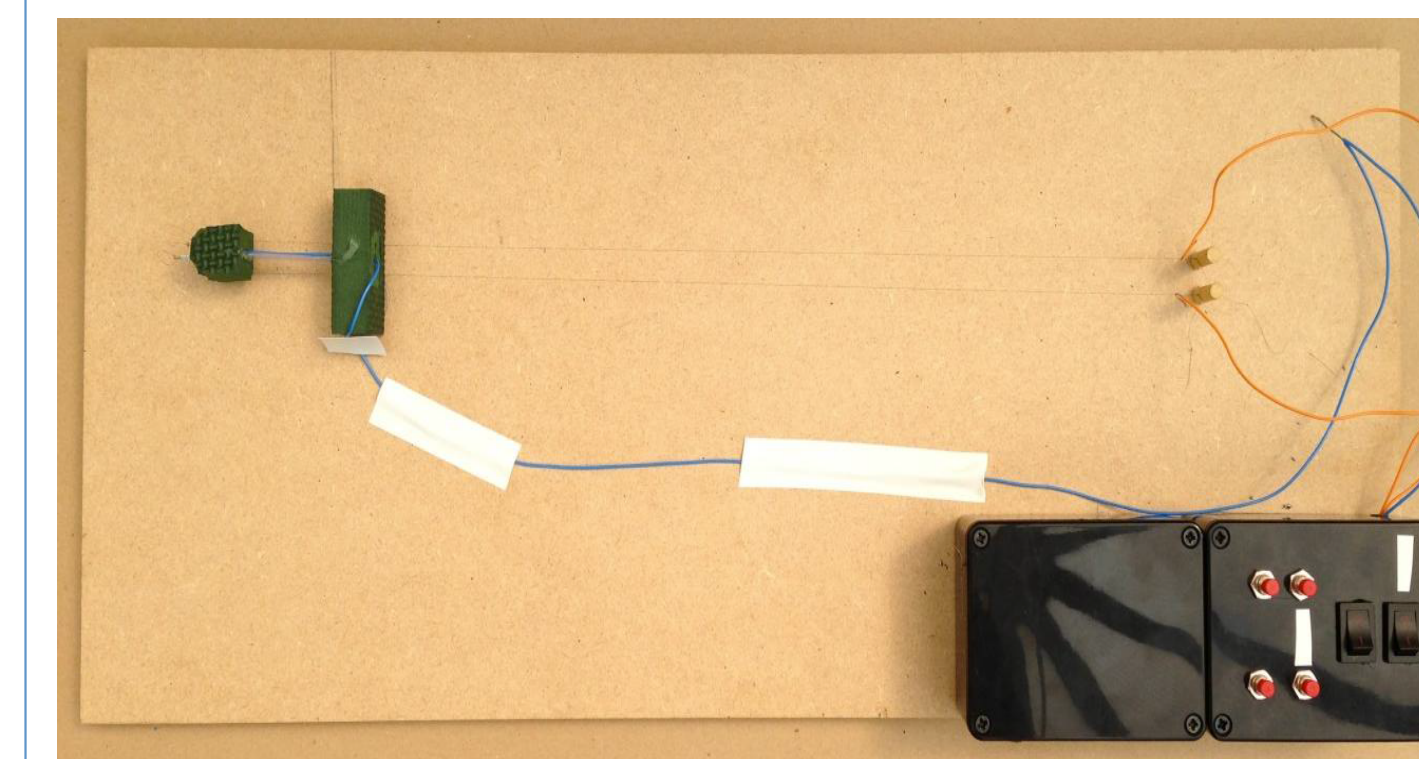
Graph 1 (Above): the desirable functions of a new bougie to aid with intubation, as desired by Anaesthetists who commonly use video-laryngoscopy in their practice.

## Design brief

The design brief called for a flexible proximal section, with good shape retention with a 'steerable' tip, flexible enough to allow for 120 degree curvature in two planes, within one second of activation. The device would work alone as a standard bougie, but could be connected to a control device to activate the steering function while the device was in situ. Connection of controller to bougie would need to be quick and easy to achieve to enable single-handed operation and remove the need to pre-load the endotracheal tube on the device

## Proof of concept

Working in conjunction with Nottingham Trent University (NTU) an initial proof of concept model was created (picture 2)

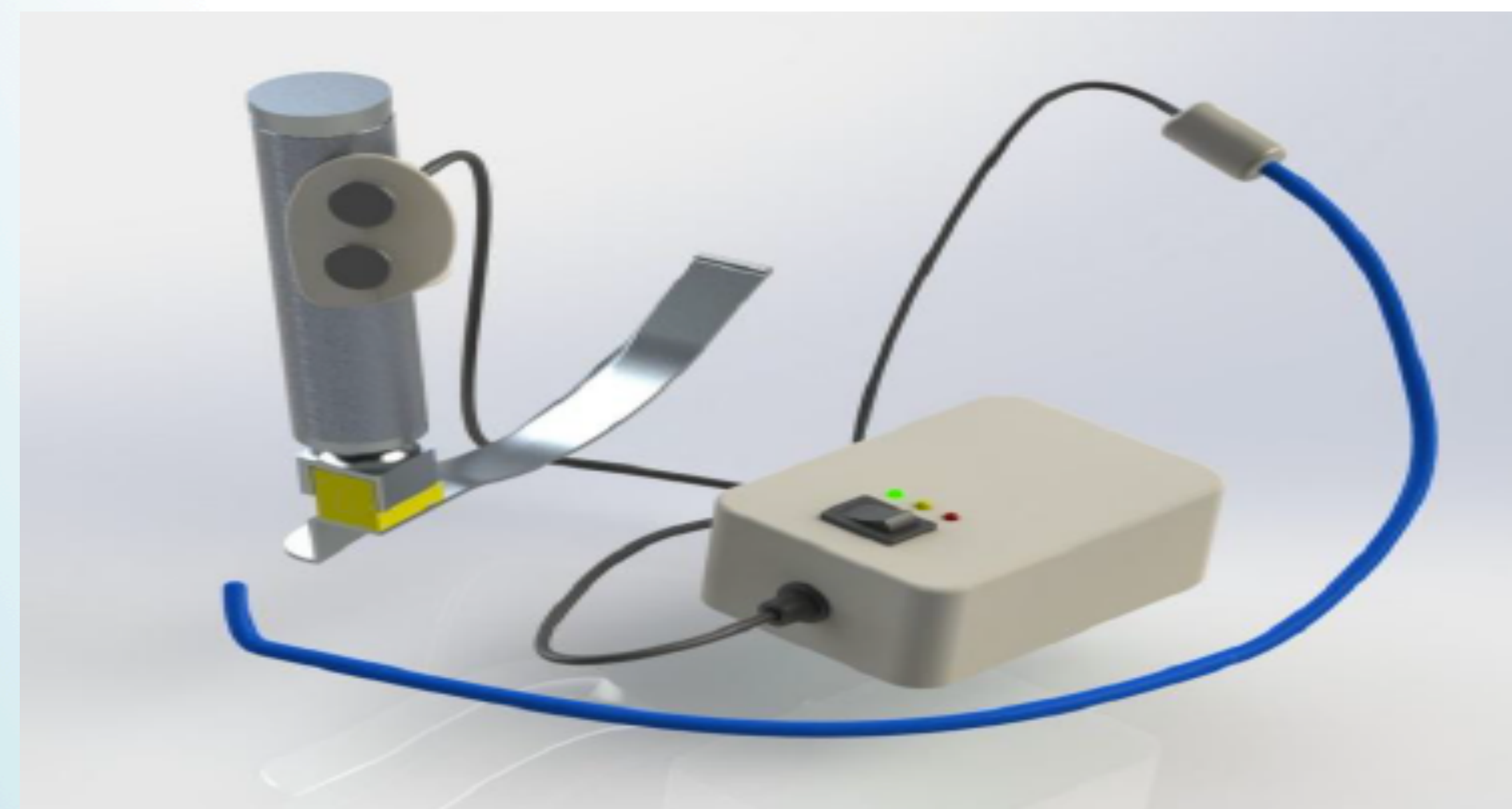


Picture 2: Proof of concept of steerable bougie

## Funding for Prototype

A successful grant application was secured for Ten thousand pounds from Nottingham University Hospitals (Grant reference PP-K INKPIN-APR15) . Working in collaboration with Nottingham Trent University, we set about creating a new bougie.

Over several months, we researched the materials, actuation mechanism, internal mechanisms, tip design and control mechanism to best allow us achieve a working prototype (Picture 3).



Picture 3: original prototype of steerable bougie

## Results and Future work

The resulting prototype (picture 3, left) is a design centered on the use of Flexinol®, a nickel-titanium shape memory alloy that is used as an artificial muscle. Two antagonistic Flexinol® wires are situated in the disposable bougie casing, and when heated via an electric current it shortens, enabling the flexible tip to be steered via a detachable controller. We have successfully produced 'proof of concept' prototypes and our ongoing work is focused on improving design ergonomics and anthropometrics, with the aim of production of the final device later this year.

### References

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# Summary slide

- Current Bougies have limitations which restrict their use and application when managing a difficult airway, especially when used in conjunction with Videolaryngoscopy
- Local surveys highlighted that additional functionality, such as steerability, would be a useful feature of a redesigned and modified bougie
- Using locally obtained Grant money for R+I, we have been working in collaboration with Nottingham Trent University to design a steerable bougie
- A working prototype has been made, and ongoing work with manufacturing and improving the device is underway