# Final report

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## A.TEC.0087 – ScribeAssist

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# Abstract

This report outlines and analyses the potential of using the knowledge gained from the HookAssist project to develop and design an intelligent scribing device (ScribeAssist). The report includes background information about the HookAssist project and design considerations for the proposed ScribeAssist project. The report addresses issues with the current methods of processing and proposes a solution with the use of an Intelligent Assist Device (IAD). The devise design and specifications are outlined and a prototype design is illustrated.

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# 1 Background

This project aims to use the knowledge acquired in the HookAssist (HA) project to build an assist device (ScribeAssist) to perform beef scribing. Beef Scribing, is the strategic cutting of the spine and ribs of a beef carcase side to allow identification and removal of specification cuts.

The strategic cuts segment and separate the carcase to allow the operator visual identification of required meat specifications. Currently the cuts are made manually with a powered handheld saw device.

ScribeAssist (SA) is aimed at intelligently assisting the scribing processes in meat processing plants around Australia. SA can take advantage of the knowledge gained through the HookAssist (HA) project to piggyback the development of a new Intelligent Assist Device.

## 1.1 HookAssist Project Summary

**Figure 1 – HookAssist production prototype**

The HookAssist project was divided into 3 (three) phases:

### 1.1.1 Phase 1 – Establish Preliminary Requirements

This required measurements and observations to be recorded about certain arduous and laborious tasks at meat processing sites. These recordings were then analysed in order to identify the required task performance criteria. This criterion was then used to create mock-up prototype designs and from these, a final design was selected.

### 1.1.2 Phase 2 – Build A Fully Functional Assist Device.

The chosen design was then built and the lab prototype was used as a non-production test-bed, allowing researchers, ergonomists and engineers to perform functional tests and thereby be able to optimise the design for a production prototype.

### 1.1.3 Phase 3 – Build Production Prototype

Phase 3 (three) involved building the phase 2 (two) agreed upon production prototype, to be trialled in production at an Australian beef processor.

# 2 Introduction

The scribing process involves cutting a beef carcase side in 4 (four) places in the order illustrated in Figure 2.

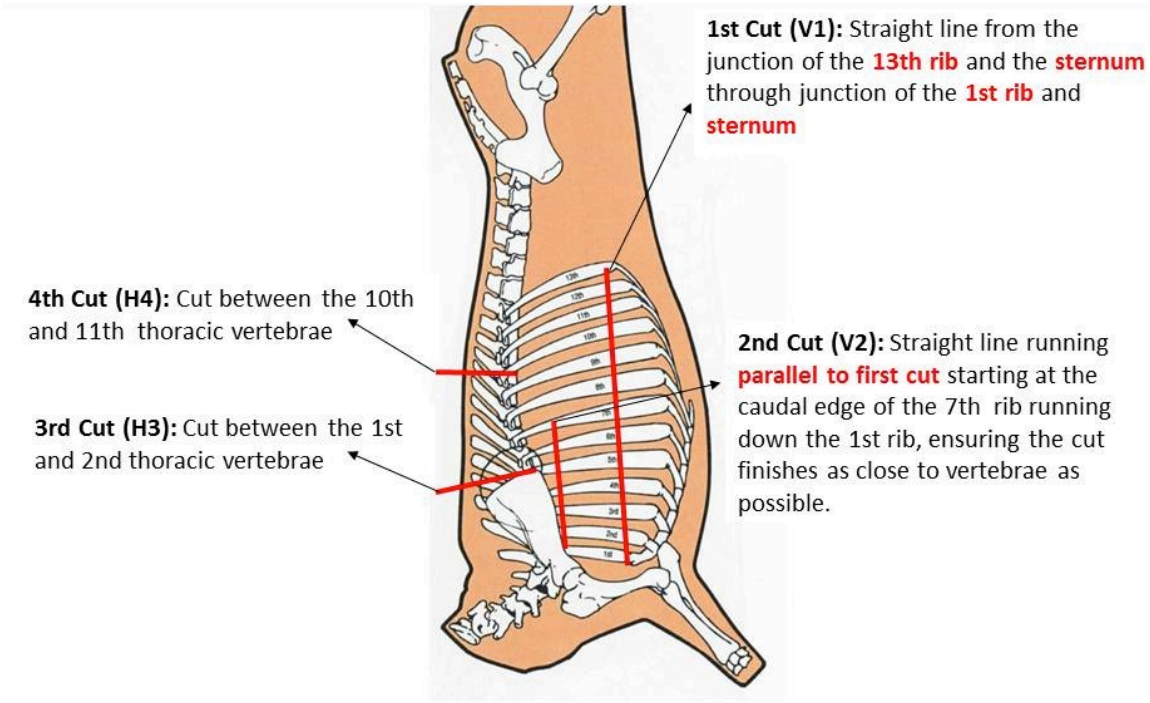


**Figure 2 – Overview of scribing process**

## 2.1 Overview/Deficiencies of Current Scribing Process

The current method has many unavoidable issues; Measuring the accuracy of the vertical cutting lines and the method used to measure accuracy of horizontal cutting line.

Deficiencies of current process include, but are not limited to:

### 2.1.1 Saw Weight:

The weight of the saw is counter balanced, however the balancers only assist in supporting the mass of the saw and the operator has to balance all the forces associated with maneuvering the saw.

### 2.1.2 Operating Forces:

The operator must also provide all the cutting forces for the processes. This includes, but is not limited to, pushing through dense bone(s). During the cutting process, the operator must also

resist all the reaction forces created by the spinning blade. This includes pitch, roll and yaw moments.

### 2.1.3 Safety Issues:

With the current systems in place, the operator has the ability to run the saw using a single hand; this increases the possibility of the operator injuring their non-operating hand. Figure 3 illustrates the issues associated with the current process.

### 2.1.4 Dynamic/Yield Processing:

As the chain carrying the carcasses is constantly moving, the operator is forced to work against a swinging carcass, which adds to the difficulty of the process. These ergonomic issues, coupled with the dynamic nature of the process lead to operator fatigue, which has a negative effect on the yield. Figure 4 illustrates the yield costs per cutting.

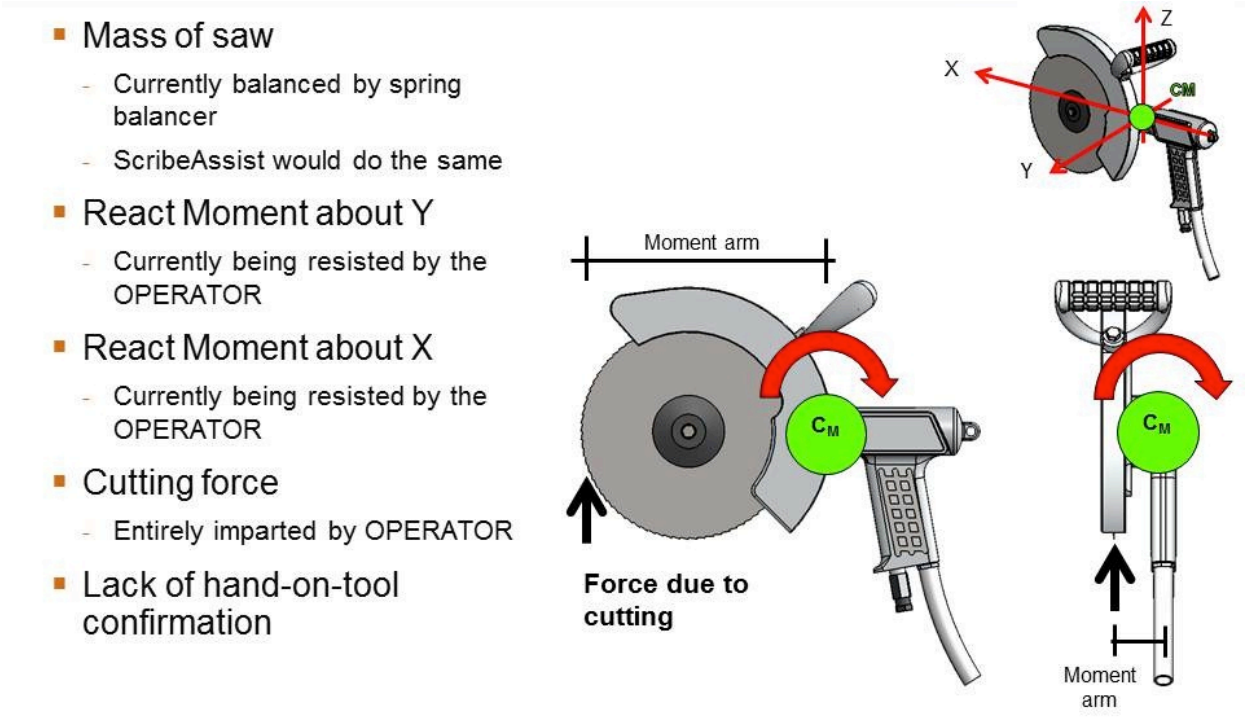


**Figure 3 – Summary of current issues**

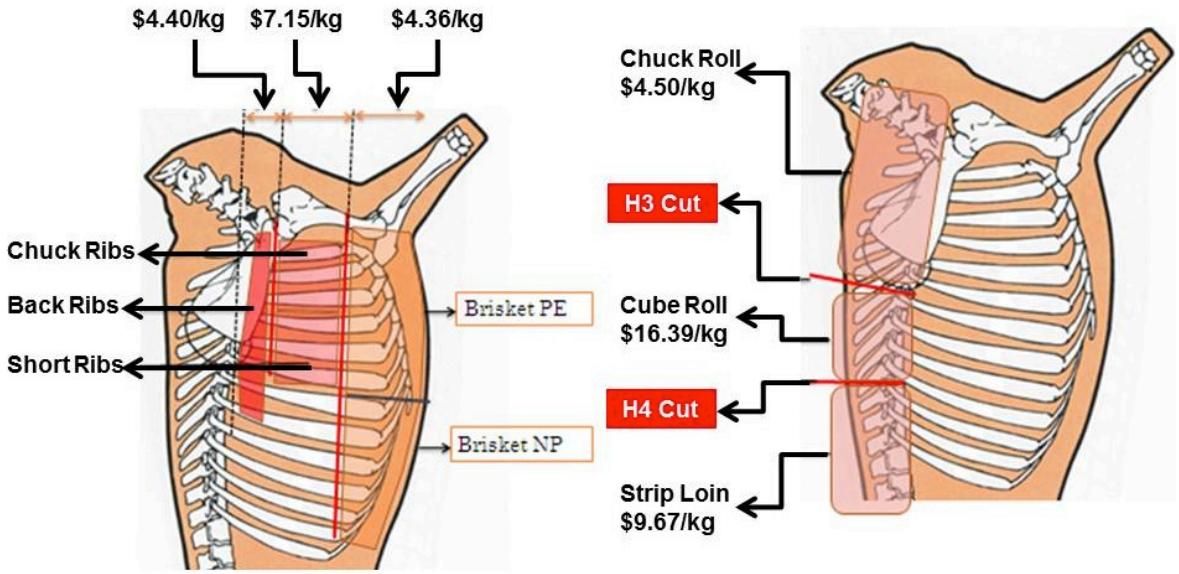


**Figure 4 – Illustrative financial outline of yield**

# 3 Project objectives

The overall project outcome will be the incorporation of a typical powered scribing circular handsaw to the HookAssist platform. This merger of two pieces of equipment is designed to take all the strain, vibration and heavy lifting required to operate the saw, away from the operator, utilising the >350kgs lifting capacity of the HookAssist platform to take the weight of the saw during its operation.

The system will eliminate the arduous component of this task and allow the operator to focus all of their mental and physical energy into guiding and placing the saw in the optimum position on the beef carcase side.

The objectives of this project are (as contracted):

1. Data collection and onsite process analysis.
2. Concept analysis and brainstorm session with industry representatives.

# 4 Methodology

## 4.1 Data collection

A survey was conducted with three (3) Australian meat processing sites in order to identify industry needs in terms of: machine assisted scribing and cutting, cutting line improvements, line precision and yields. Hence leading to options for a ScribeAssist functional specification. Some data on estimated costs and expected benefits were also collected.

The real life data was gathered and passed onto design engineers who hypothesised preliminary designs and specifications. These preliminary designs allowed feasibility for development of a prototype device with an option for further development.

## 4.2 Concept analysis

An industry workshop was organised and the findings of the data collection and process analysis phase were presented. This included the functional specifications and design options for a potential device. The brainstorm discussed, industry needs, benefits and expected costs, the future of the assist technology in Australian meat processing and the path moving forward.

# 5 Proposed Solution

A solution is proposed which addresses and overcomes the current process inefficiencies/issues. An Intelligent Assist Device (IAD) is to be developed, using the knowledge gained from the HookAssist machine, to balance the forces required to manoeuvre the saw in all orientations. To ‘power assist’ in the forward, lateral and vertical directions of cutting and movement. To provide virtual surfaces to control the depth of the cut and to provide visual guidance for the operator, indicating cut position and cut orientation. To provide visual guidance for locating the H3 and H4 cuts and to possibly provide tactile feedback for the operator, warning them of errors and or deviations from the required process.


**Figure 5 - Proposed Solution Summary**

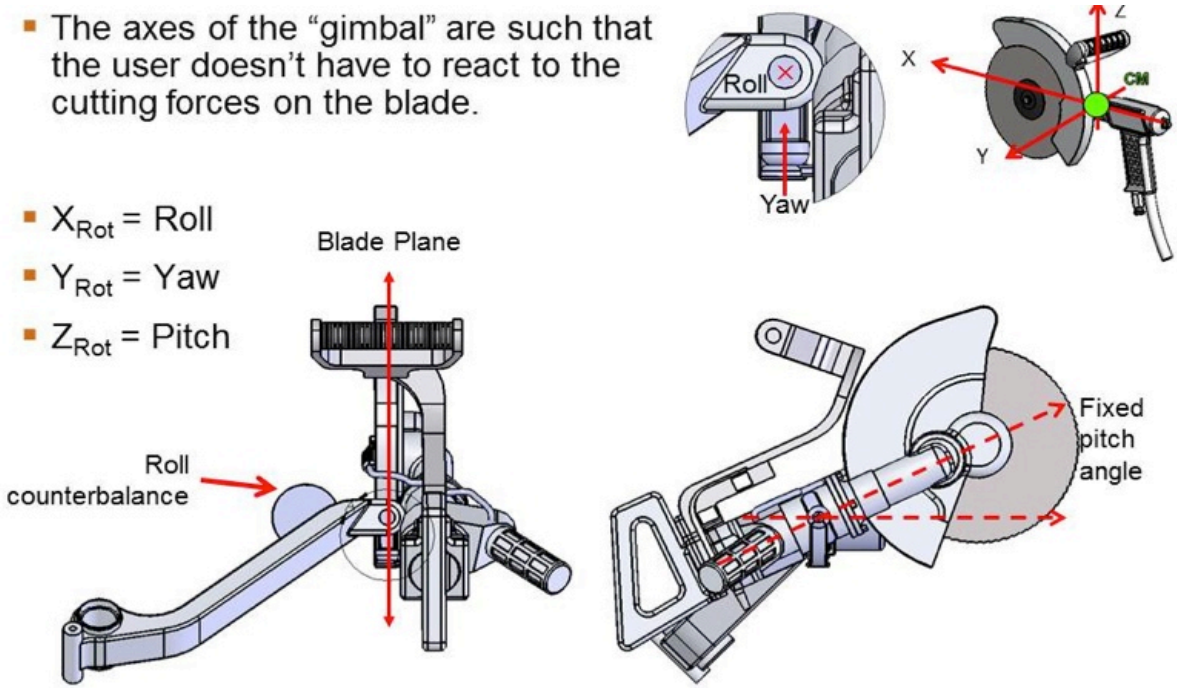


**Figure 6 – Gimbal diagram**

The new design will resolve the forces created in the process by introducing counterbalances and by designing the end effector in such a way that the operator is not required to react to the cutting forces produced. Figure 6 illustrates a possible design for the end effector, which would meet the above requirements.

The improved control of the proposed end effector(s) will minimise cutting errors by giving the operator visual anatomical markers either by laser-line alignments or by anatomical landmarks. The cutting process(es) will be ‘power assisted’ and be aided by predetermined computer calculated depths and angles. Figure 8, Figure 9 and Figure 10 summarise and illustrate the possible horizontal and vertical cutting processes of the proposed design(s). The ‘power assisting’ IAD will decrease operator fatigue and as a result decrease yield losses caused by operator cutting errors.

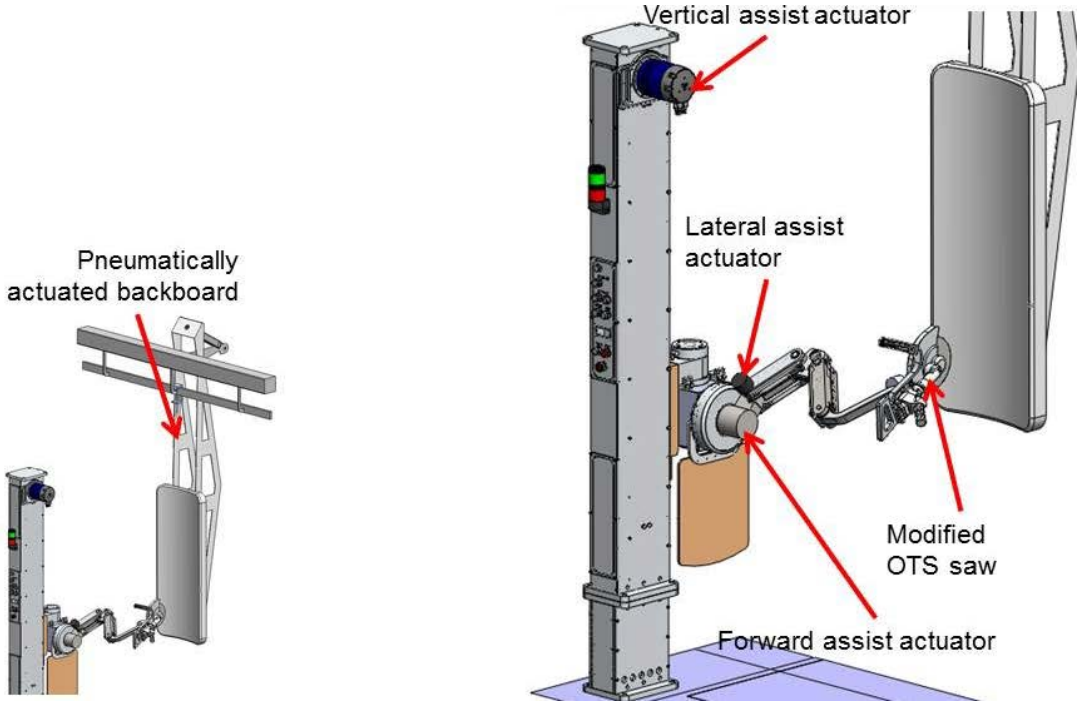


**Figure 7 - Figure Illustrating the backboard support**

## 5.1 Horizontal Cuts

- Roll dof is freed up again
  - Either autonomously or by operator
- Operator orients saw to **H3 location** by,
  - **Visually locates** anatomical landmarks on Side
  - Rolls/yaws the saw so that **Laser-Line aligns** with anatomical landmark
    - And is perpendicular to the bone.
  - **Performs cut** while being power assisted
    - Depth of cut is controlled by the SA
- Operator **translates** vertically locating the **H4 cut**
  - **Yaws** so cut is perpendicular to the bone
  - Performs assisted cut

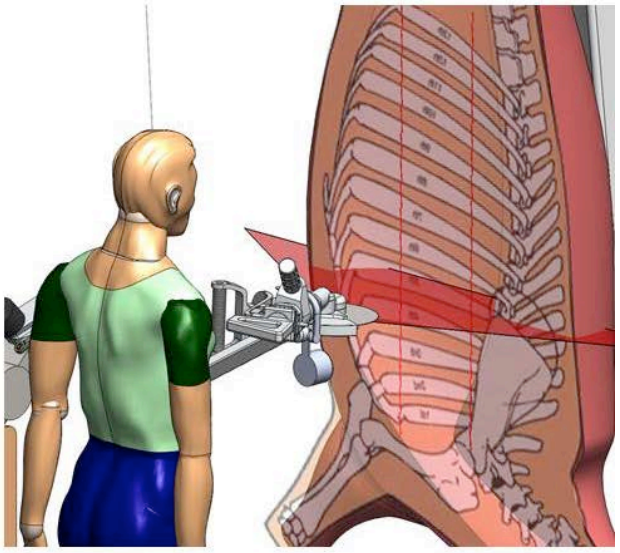

**Figure 8 – Horizontal Cut**

## 5.2 Vertical Cuts

- Operator orients saw to **V1 cut** by,
  - **Visually locating** anatomical landmarks on Side
  - Rolls/yaws the saw so that **Laser-Line aligns** with anatomical landmark
    - And is perpendicular to the bone.
  - Operator **locks-out the Roll** dof
  - **Performs cut** while being power assisted
    - Depth of cut is controlled by the SA
- With Roll orientation **still locked** (to guarantee a parallel cut)
  - Operator **translates** laterally locating the **V2 cut**
  - **Yaws** so cut is perpendicular to the bone
  - Performs assisted cut
  - NOTE:
    - If the separation of the V1 & V2 cuts are known (constant) a **virtual surface** could be implemented.

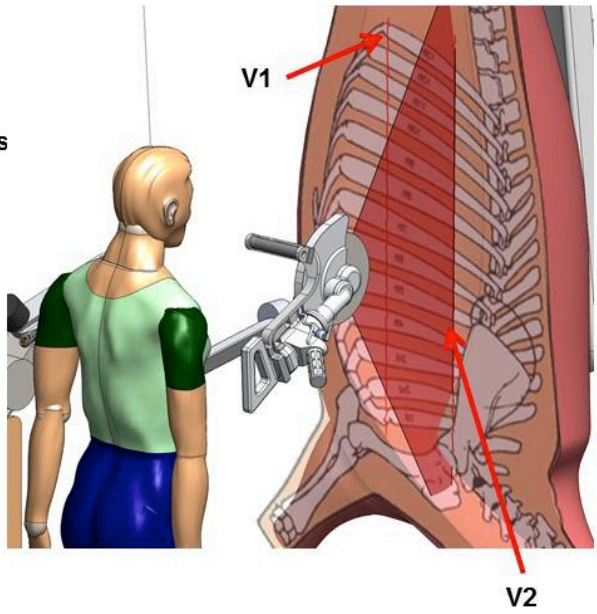


**Figure 9 – Vertical Cut**

### 5.3 Overall Cut Summary

- Laser will project a line on the side of beef
  - Can be used to align the orientation of the saw with the anatomical landmarks on the carcass.
    - i.e. operator can see where the cut would start and end prior to and during the cut.
  - Can potentially also be used to count the ribs for the horizontal cuts.
    - Much like touching with a long finger.
- Less fatigue should also yield less errors.

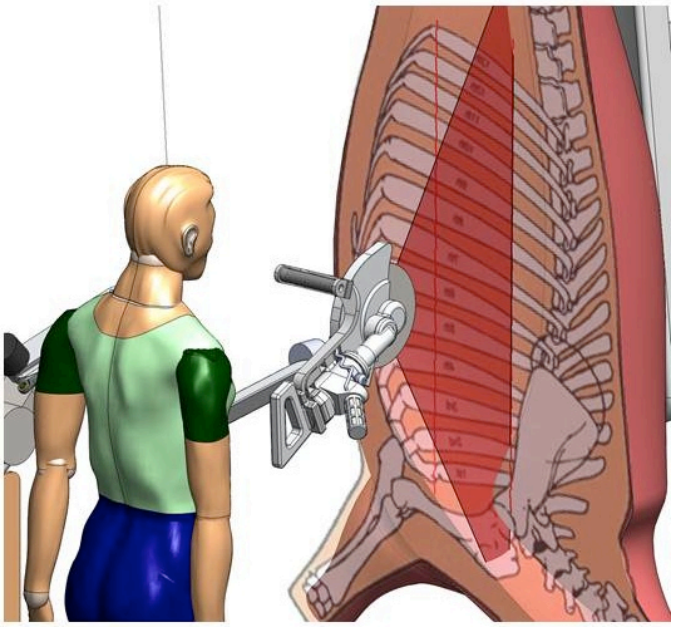

**Figure 10 – Overall cutting summary**

# 6 Conclusion and Recommendation

The proposed design, outlined in section 5, overcomes the issues currently encountered by the scribing process (section 2.1). The design aims to improve yield, safety and accuracy while simultaneously decreasing operator error and fatigue. Furthermore, by utilising the knowledge gained during the HookAssist project, ScribeAssist has the aptitude to progress and become a robust, intelligent and versatile machine. With the developments to date, HookAssist and ScribeAssist have the potential to pave the way for intelligent assist devices to aid operators and increase process efficiencies. It is recommended that a prototype ScribeAssist device be designed and manufactured, to trial on Australian meat processing sites.

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