LIVESTOCK HANDLING PRE-SLAUGHTER

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Good pre-slaughter handling procedures and facilities offer five important benefits – bruising is reduced, meat quality and animal welfare are improved, labour costs are reduced and employee safety is improved. Concern about animal welfare has heightened the need for proper stunning procedures, but pre-slaughter handling should not be neglected.

The Australian beef industry loses the equivalent of 1 per cent of its total export earning to bruising (Marshall, 1977). Fifty percent of all bruises are caused by rough, careless handling (Grandin, 1983). Facility improvements will also greatly reduce bruising. Livestock are most likely to bruise when they hit an object with a sharp edge such as an angle iron or the side of a truck door and horned cattle have higher levels of bruising (Meischke et al., 1974).

Dark cutting (DFD) meat can be reduced by gentle handling, keeping groups of strange animals separated and by provision of adequate feed and rest for cattle and sheep which have travelled long distances.

Careful, gentle handling and resting will reduce PSE and improve meat quality in pigs (Grandin, 1986; Barton Gade, 1985; A. Fortin, 1988, personal communication). Hot, overheated pigs are more likely to have either DFD or PSE meat (Gariepy et al., 1987). The following procedures will improve meat quality in pigs:

* quiet handling and restricted electric prod usage,
* prompt unloading and resting for 1 to 4 hours prior to stunning,
* showering in the yards during warm weather,
* no mixing of strange pigs from different fattening pens, and
* an 8 to 12 hour fast prior to stunning.

All species of livestock should have access to clean water prior to slaughter.

REDUCE STRESS

Animal welfare and meat quality are improved when stress is reduced. Electric prodding will cause an animal's heartrate to increase each time it is prodded (Van Putten and Elshof, 1978). Loud noise is highly stressful to animals and equipment that bangs and clangs will cause balking. Sheep slaughtered in a small, quiet research abattoir had lower cortisol (stress hormone) levels compared to sheep slaughtered in a large noisy commercial abattoir (Pearson et al., 1977).

The use of dogs to move sheep in meat works should be discouraged. They are unnecessary in properly designed facilities. Sheep which had been bitten by a dog had higher cortisol levels than sheep which had been chased (Kilgour and DeLangen, 1970). Leader sheep can be easily trained to draw other sheep (Bremner and Kilgour, 1980). The lead sheep draws the others into the forcing pen and then returns through a flap door for a feed reward. I have observed Judas goats leading sheep in a U.S. meat works. They were very efficient.

Physiological measurements indicated that washing sheep is one of the most stressful of all pre-slaughter handling procedures (Kilgour, 1978) and yet it only reduces carcass contamination in very dirty sheep (Glover and Davidson, 1977). Washing relatively clean sheep does not reduce contamination but it increases bruising (Petersen, 1977). It seems therefore that the practice of washing relatively clean cattle and sheep should be eliminated. Canadian and some U.S. meat inspectors forbid wetting cattle shortly prior to stunning. They state that wet cattle have increased carcass contamination.

CONFINEMENT PIG PROBLEMS

Some confinement reared pigs are extremely difficult to move at the abattoir and they often become stressed during handling. There are three causes of hard to drive, confinement reared pigs: understimulation during rearing, improper flooring in the fattening pens and weak hindquarters. Pigs with weak hindquarters will often fall down and do the 'splits'. The Landrace breed is most likely to have this problem but it can be corrected by changing the breeding programme.

Pigs reared during the final fattening stage on metal mesh will often balk and be difficult to drive on concrete. Many have excessively long hooves. Pigs reared during the final fattening stage on concrete will be easier to drive than pigs fattened on mesh. Pigs reared in dimly illuminated buildings with little contact with people may become hyper-excitable during handling. Sensory restriction and a lack of stimulation causes hyper-excitability (Melzack, 1954). Playing a radio in the barn and a person entering the fattening pens for just five minutes once a week will reduce excitability. Fattening pigs which had access to hanging rubber hoses to chew and a little extra contact with people in their pens were less excitable and easier to drive (Grandin et al., 1987). Entering the pens or walking fattening pigs in the aisle will not reduce weight gains if it is done gently and carefully. The effect of these treatments on meat quality and pig drivability will vary due to genetic factors, husbandry differences and handling procedures at the abattoir.

FLIGHT ZONE AND HERD BEHAVIOUR

Understanding the animal's flight zone will improve handling efficiency. An animal will start to move away when the handler penetrates the edge of the flight zone. It will stop moving when the handler retreats from inside the flight zone. The size of the flight zone is determined by the wildness or tameness of the animal. Completely tame animals no longer have an effective flight zone. Sheep confined in a small enclosure will have a similar flight zone to sheep confined in a larger enclosure (Hutson, 1982).

Cattle often rear up in races if the handler leans over them and invades the flight zone. If an animal rears, the handler should back up and remove himself from inside the flight zone. Livestock being driven down an alley will often attempt to turn back if the handler deeply penetrates the flight zone. The handler must back up and remove himself from inside the flight zone when the animals give the very first indication of turning back. Livestock will often refuse to approach if they can see people up ahead of them. The installation of shields for handlers to stand behind may facilitate livestock movement. Powered gates which can be operated by remote control can help keep handlers out of the flight zone of approaching animals. More information on livestock behaviour during handling is in Grandin, 1980, 1987, and Grandin and Kilgour and Dalton, 1984, Kilgour, 1971.

An isolated animal which has been left behind after its herdmates have walked up the race may become highly stressed and agitated. A lone sheep left in a pen after its herdmates had left had decreased glycogen levels (Shorthose, 1978). Excited, isolated animals are more likely to have poor meat quality. Many serious cattle handling accidents occur when handlers get inside a confined space with a frantic lone animal. The best way to move an excited animal is to put other animals in with it.

DON'T OVERCROWD

Handlers must be careful not to overload the forcing pen with too many animals. Overloading the forcing pen is a common handling mistake. Inexperienced handlers often push the crowd gate too tightly against the animals. As animals enter the single file race the crowd gate should follow the animals and make the pen smaller. The animals need room to turn. Handlers must also avoid prodding an animal that has no space to move into. They should wait until the stunning pen door is open before prodding an animal. If an animal balks once, it is more likely to balk a second or a third time. When the single file race is being refilled, the handler should wait until it is half empty to take advantage of natural following behaviour.

PRINCIPLES OF FACILITY LAYOUT AND DESIGN

Well designed yards and races with solid sides will improve efficiency and reduce labour costs. A curved race system will require fewer people to move cattle (Grandin, 1984). Figure 1 illustrates a cattle handling system with long narrow diagonal pens on a 60 degree angle, a round crowd pen and a curved race.

The 3m (10ft.) wide curved holding lane leading up to the round forcing pen facilitates livestock movement. The advantages of long narrow diagonal pens include one way traffic flow and elimination of sharp ninety degree corners (Figures 1 and 2). Long, narrow, diagonal pens work well for all species. The pen

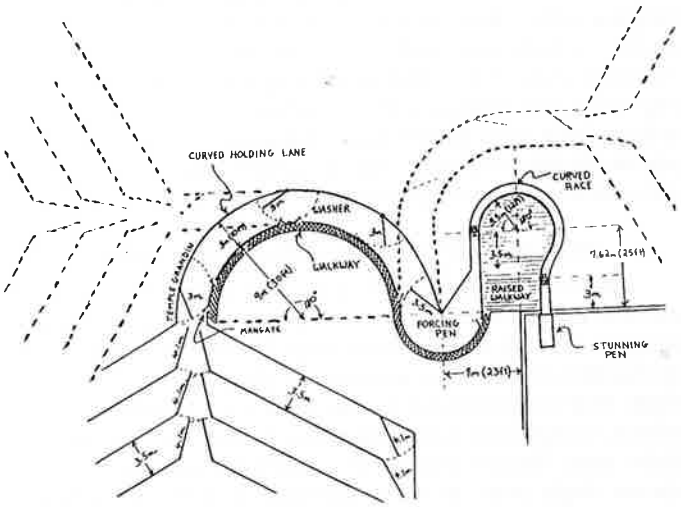


Figure 1. High efficiency curved cattle layout. Raised walkway reduces walking distance for the handler. The dotted lines show alternate layouts utilizing the same basic design.

gates should be slightly longer than the width of the drive alley so they open on an angle. Layout and design mistakes will ruin efficiency and stress the animals. The layout principles outlined below apply to all species of livestock. Automation should never be used as a substitute for good basic design.

1. **Solid Fences**
   The curved holding lane, single file race and forcing pen should have solid fences. Mangates must be installed for efficiency and safety. Solid fences in these areas facilitate animal movement because they prevent animals from seeing distractions outside the fence with their wide angle panoramic vision. The crowding gate in the forcing pen must also be solid to prevent animals from turning back towards the pens they just left.
2. **Don't Deadend the Race**
   A curved single file race will work more efficiently than a straight race, but it must not appear to be a deadend (Figure 3).

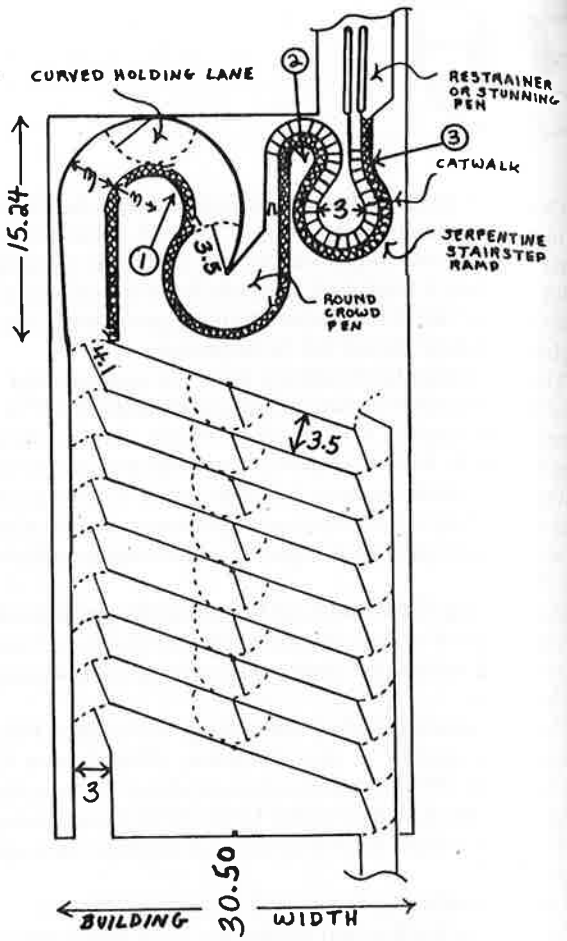
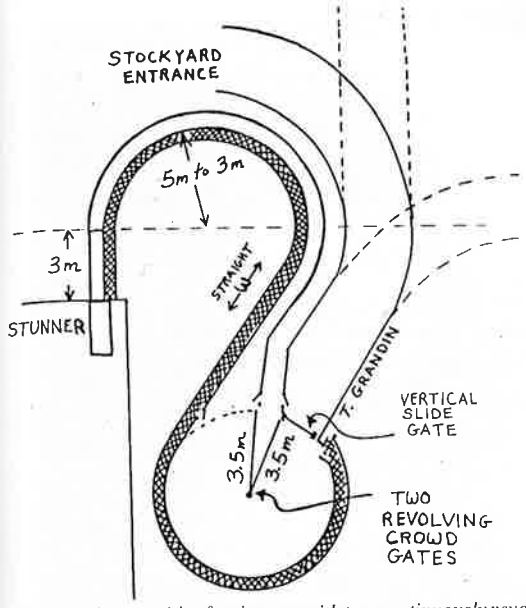


Figure 2. Compact serpentine cattle layout which will fit inside a rectangular building. The handler should stay in Position 2 and Position 3 as much as possible to take advantage of the animal's tendency to circle around the handler.

Figure 3. A curved race with a walkway which runs alongside the inner radius is more efficient than a straight race. All races should have solid fences.

Animals standing at the entrance to the single file race must be able to see a minimum of two to three body lengths up the race. If space permits, the recommended inside radius for a curved race is 3 m (10 ft.) to 5 m (16 ft.) (Figures 1 and 4). Serpentine designs with very tight 1.5 m (5 ft.) bends will work very efficiently. There must be a minimum of three animals body lengths of straight race before the animal encounters the first tight bend (Figure 2.) Livestock will readily move around the tight bend after they are inside the single file race. Curved races with an inside radius of less than 3 m (10 ft.) must be built in a smooth continuous curve.



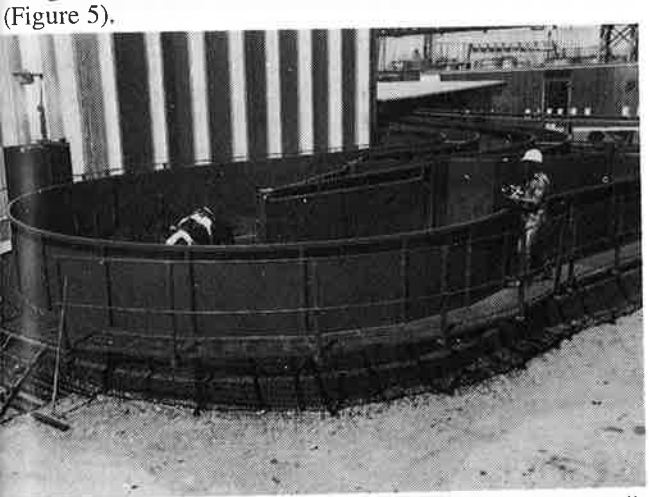
re 4. *Cattle layout with a forcing pen with two continuously revolving crowd s. A smaller version of the forcing pen with 3 m (10 ft.) to 2.4 m (8 ft.) gates work well for sheep. The dotted lines show alternate layouts.*

Crowd Pen Size

Don't make the forcing pen too large. Excessively large forcing pens are likely to increase stress and bruises because handlers over load them. Recommended radius for round crowd pens are:

Cattle – 3.5m (12 ft.)
Sheep – 2.4m (8 ft.)
Pigs – 1.82m (6 ft.)

Round crowd pens can be constructed with either one gate or two gates which revolve continuously in the same direction (Figure 5).



gure 5. Round forcing pens with solid sides are efficient for moving all ecies.

Race Length

The single file race must be the proper length for maximum efficiency and reduced stress. Minimum race length for cattle lines operating at 20 to 75 cattle per hour is 12m (40 ft.) to 16m (50 ft.). For higher production rates, a longer race should be used. For pigs and sheep the minimum race length is 6m (20 ft.). Pig races should not exceed 10.66m (35 ft.) because pigs become stressed while standing in the race.

Ramp Location

Never build a forcing pen on a ramp since the animals will pile up against the crowd gate. Forcing pens should be level except for drainage slope. Never start a ramp at the junction between the single file race and the forcing pen because this will cause balking. Install two to three body lengths of level single file race before the ramp starts. The first one way anti-backup gate should be one to two body lengths from the race entrance.

6. **Wall Rule**
   Never build a wall at the junction between the single file race and the forcing pen. To prevent balking, the single file race must extend a minimum of two to three animal lengths beyond the wall. The animals must be lined up in single file before they pass through a wall.
7. **Lighting**
   Handling facilities should have even diffuse lighting. Dark, dimly illuminated races and crowd pens are less efficient. Sharp contrasts of light or dark and shadows can cause balking but lamps can be used to attract animals into a race. They must never shine directly in the eyes of approaching animals as this can cause balking.
8. **Distractions**
   Eliminate distractions and noise such as hissing air hoses, flapping objects, clanging gates, etc. Puddles on the floor or dripping water can cause balking. A coat or piece of plastic hung over a fence can wreck the efficiency of the best facility.
9. **Floor Surface and Drains**
   All handling facilities must have grooved non-skid flooring. Drains and steel floor plates must be placed outside the areas where animals walk. Livestock will balk at a drain or a change in flooring type or texture. Sheep will balk if they can see light or reflections off water through raised floor gratings. Gratings and battens should be orientated so that sheep walk across the battens. This helps prevent the animals from seeing into the pit as they walk over the grating.
10. **Avoid Overhead Walkways**
    Livestock are more likely to balk if people walk over their heads so walkways should run alongside the race and the forcing pen (Figures 3 and 5).

SPECIES DIFFERENCES

The basic principles of facility design are similar for the three species, but there are some important differences. A funnel shaped transition from the forcing pen to the race with one straight side and the other side on a 30 degree angle will work well for cattle and sheep. This design will not work for pigs since they become jammed in the funnel. One pig will not back up to allow another pig to pass. For pigs, there must be an abrupt transition between the forcing pen and the single file race. A single step shaped fence will allow one pig to step aside and another pig to pass (Grandin, 1982) (Figure 6).

Curved races are definitely recommended for cattle, and they will work well with sheep and pigs but pigs can also be handled efficiently in a straight race. A double race system with solid outer fences and a 'see through' inner partition works well for pigs. Natural following behavior is encouraged because pigs can see each other in the two adjacent races. A small triangular partition in between the two races at the race entrance will reduce jamming (Grandin, 1982) (Figure 7). To prevent jamming at the race entrance openings, install entrance restrictors so there is only 1 cm of clearance on each side of the largest pig.

RAMP DESIGN

The most efficient handling facilities are completely level with no ramps. Ramps must not exceed a 20 degree angle for cattle and a 10 to 15 degree maximum is recommended for pigs. Slightly steeper ramps will work for moving sheep to the stunning restrainer. Stairsteps are recommended for all species. A 10 cm (3 1/2 in) rise and a 30 cm (12 in) to 60 cm (24 in) tread works well for cattle or sheep. Slightly smaller steps are recommended for pigs.

NEW CONVEYOR RESTRAINER

A new double rail conveyor restrainer system designed by the author has been in operation in a commercial calf and sheep slaughter plant for two years (Grandin, 1986). It is based on

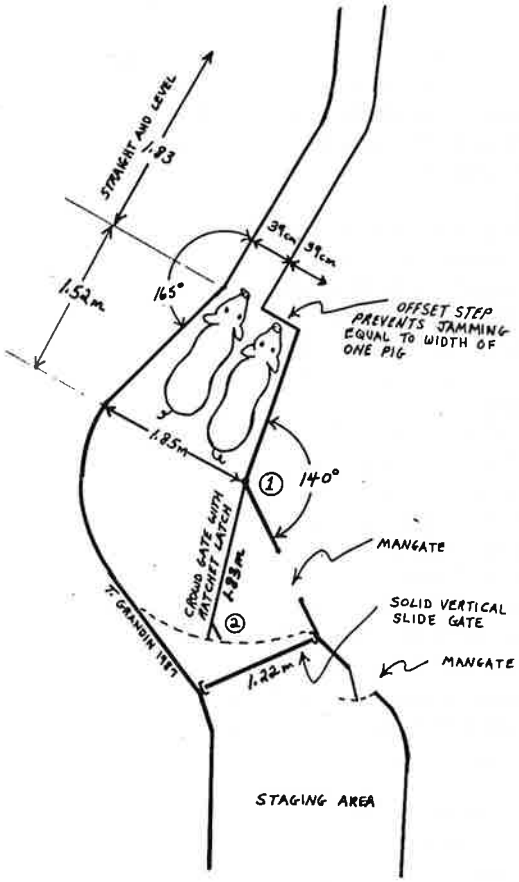


Figure 6. A single step shaped fence will force one pig to step aside to allow another pig to pass. When pigs first enter the forcing pen, the handler stands in Position 1 and directs the leaders into the race. This avoids the problem of pushing pigs from the rear of the group. When the pen is partially empty the handler pushes the crowd gate around to Position 2.

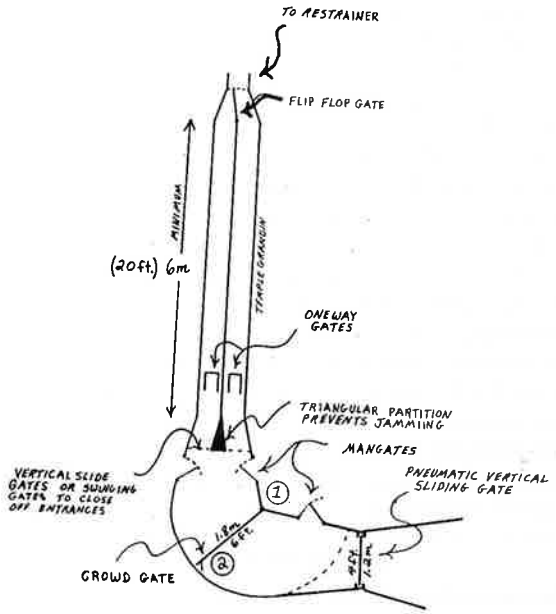


Figure 7. Two races side by side also work well for pigs. The races have solid outer fences and a 'see through' inner partition to promote following. The triangular partition in between the two races reduces jamming.

research by Giger et al. (1977) and it is adjustable for a wide variety of animal sizes. Baby calves, sheep and large 225 kg (500 lb.) calves can all be handled in the same restrainer. A larger unit could be built to handle adult cattle. Standard V restrainer conveyors may cause petechial haemorrhages during electric stunning (Thornton et al., 1979; Lambooy, 1986). There is a possibility that this new system may reduce bloodsplash and speckle in electrically stunned animals (E. Lambooy, 1987, personal communication),

With the double rail conveyor animals are supported under the brisket and belly while straddling the conveyor (Figures 8 and 9) such that even large wild calves will ride quietly. The double rail requires less space than a V conveyor restrainer and it is compatible with existing shackling and bleeding systems.

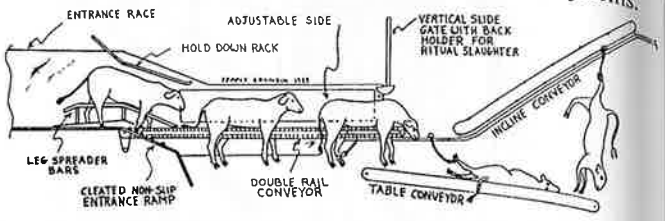


Figure 8. Diagram of double rail conveyor restrainer system for calves and sheep.

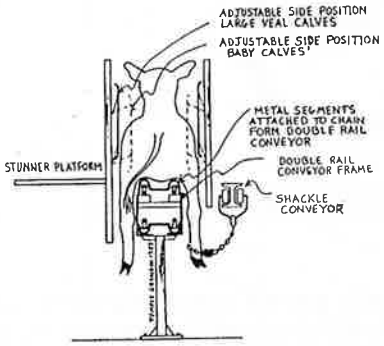


Figure 9. Cross section of double rail restrainer system.

Proper design of the system is essential. The top of the conveyor is level with the floor of the entrance race. The animals walk down a cleated nonslip ramp which is on a 25 degree angle. This same ramp design is also recommended for V conveyor restrainers. The sides of the ramp must be closed-in and animals must not see light coming up through the bottom of the restrainer. A stationary leg spreader bar over the ramp and in the first section of entrance race guides the animal's legs to the correct position. Calves entered this system with less balking compared to a V restrainer. The conveyor is constructed from metal segments attached to a moving chain. Each segment is bent to form the double rail configuration. Total width of the conveyor frame is 21.5 cm (8 1/2 inches). The moving segments are 19 cm (7 1/2 in.) wide with a 7.6 cm (3 in.) space in the middle to accommodate the animals' brisket.

Adjustable sides accommodate different sized animals. The adjustable sides press lightly against the top portion of the animal's body (Figure 10). They are on pivots and the bottom edge of the adjustable side is slightly above the top of the conveyor. This provides room for the animal's leg joints. Pressure on the leg joints causes stress and discomfort. The pivot mechanism simultaneously adjusts the width between the sides and the leg joint space. The width between the adjustable sides can be varied from 51 cm (20 in.) to 25 cm (10 in.). The space between the bottom of the adjustable sides and the top of the double rail is 5 cm (2 in.) when the sides are spread 25 cm (10 in.) apart and 12.7 cm (5 in.) when the sides are spaced 45 cm (18 in.) apart.

MANAGEMENT COMMITMENT

Maintenance of efficient, careful and humane handling procedures requires a sustained management commitment. During visits to hundreds of meat works I have observed that the places with excellent pre-slaughter handling have a manager or an inspector who has made a continuing commitment to maintaining good handling practices. I have observed deterioration of handling procedures with a change in management and I have also observed handling improvements with a change in management. Meat works with rough, cruel handling often have lax management in the livestock department.

Figure 10. Sheep riding on the double restrainer system. Adjustable sides make it possible to handle animals weighing 23 kg (50 lbs.) to 227 kg (500 lbs.).

TREAT ANIMALS WITH RESPECT

Killing animals is an unpleasant task. Employees should rotate between stunning, shackling and driving to help maintain a better attitude.

One advantage of automated stunning and slaughtering for abattoir employees is a less stressful working environment. Employees in several meat works have told me that they like automatic electric stunning and CO2 plants because the machine does the 'ultimate deed'.

To promote better employee attitudes a plaque with the following words has been posted over the race entrance in several meat works. These words were written by a blind girl when she visited a meat works and touched the animals. 'The Stairway to Heaven is dedicated to people who desire to learn the meaning of life and not to fear death. You through respect for these animals can come to respect your fellow man as well.'

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