

# Engineering and design of holding yards, loading ramps and handling facilities for land and sea transport of livestock

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## Summary

Facilities designed for intensively raised animals trained to lead are not appropriate for handling extensively raised animals unaccustomed to close contact with people. The author provides information on facility design for both intensively and extensively raised livestock. Non-slip flooring in handling facilities is essential for all livestock. Cleats must be spaced on loading ramps for trucks or ships so that the hooves of the animals fit easily between them. Cleats spaced too far apart cause slipping and falling. In developing countries, building stationary ramps for vehicles of differing heights using concrete, wood or steel is recommended. Highly mechanised systems, such as hydraulic tailgate lifts, are not recommended in developing countries due to maintenance difficulties. The holding capacity for livestock shipping and receiving terminals should be designed to hold the largest number of animals handled on the busiest days. To maintain high standards of animal welfare, it is important to train employees to handle animals using methods to reduce stress and to conduct weekly audits of handling using an objective, numerical scoring system to maintain high welfare standards.

## Keywords

Animals, Handling facility, Holding yard, Livestock, Loading ramp, Long distance, Transport, Welfare.

## Studio e progettazione di recinti di contenimento, rampe di carico e mezzi di trasporto per i movimenti via terra e mare di bestiame

### Riassunto

*Gli impianti studiati per l'allevamento intensivo di animali abituati alla cavezza non sono adatti per animali cresciuti in allevamenti estensivi, non avvezzi al contatto ravvicinato con l'uomo. L'autore fornisce informazioni riguardo lo studio di impianti destinati sia ad allevamenti di bestiame intensivi sia estensivi. L'uso di pavimenti antisdrucciolo nei mezzi di trasporto è essenziale per tutti i tipi di bestiame. Le guide per gli zoccoli vanno adeguatamente distanziate sulle rampe di carico sia per i camion sia per le navi così che gli zoccoli vadano ad inserirsi con facilità. Le guide posizionate troppo lontano possono causare sdruciolamenti e cadute. Nei paesi in via di sviluppo sono raccomandabili rampe fisse per veicoli di diverse altezze costruite in cemento, legno o acciaio. Nei paesi in via di sviluppo sistemi tecnologicamente avanzati, come pedane montacarichi idrauliche, sono sconsigliabili a causa delle elevate spese di manutenzione. La capienza dei recinti nei terminal per il carico su nave per trasporto di bestiame nonché quelli nei terminal di approdo dovrebbe essere progettata per contenere il numero più alto possibile di capi per i giorni di maggior movimento. Per mantenere alto il livello di*

*benessere degli animali, è importante addestrare il personale a trattare gli animali adottando metodi atti a ridurre lo stress, e effettuare controlli settimanali utilizzando un sistema oggettivo di indicatori numerici, che aiuti a mantenere gli standard elevati.*

#### **Parole chiave**

Animali, Benessere, Bestiame, Lunga distanza, Mezzi di trasporto, Rampe di carico, Recinti di contenimento, Trasporto.

## **Introduction**

A good transportation system should have well designed and carefully monitored facilities for loading, unloading, holding and the veterinary care of animals. The system should also have sufficient capacity to promptly unload animals from a transport conveyance. Long waits to unload from trucks or ships are a major cause of death from heat stress. Heat builds up rapidly in trucks or ships without mechanical ventilation to keep animals cool. Multiple unloading ramps may be required to promptly unload multiple trucks or large ships. In some facilities, assembly yards are needed where animals are held for several days prior to transport. Assembly yards must have feeding and watering systems in addition to pens and equipment for loading the animals.

Engineering and design is only half the equation. Well-designed facilities are useless if they are not well managed. A common problem is the failure to train people on how to use and manage new facilities. An essential part of operating an effective system is ensuring it will be managed, maintained and operated by well-trained people.

The recommendations in this paper are based on the author's practical experience with animal handling and transport in both the developed and developing world. Scientific studies relevant to animal handling will also be reviewed. During the last 35 years, the author has observed handling, loading and unloading of trucks and ships in the United States, Canada, Mexico, Europe, Australia, Philippines, Central America, South America, Thailand and South Africa. The author has also

designed livestock handling facilities in most of these countries.

## **Extensively raised or trained to lead animals**

A facility appropriate for intensively raised cattle trained to lead with a head collar (halter) may cause much distress and injury when used with extensively raised livestock. Extensively raised livestock with a large flight zone become frightened and attempt to escape when people get too close to them. In a small pen, there is not enough room for animals with a large flight zone to move away. They become agitated and rear up which can be hazardous for handlers and may result in injuries to both people and animals. Facilities for animals with large flight zones require more elaborate handling and penning systems than a facility for animals with little or no flight zone. Animals that allow a person to approach them and attach a lead rope have learned to trust humans. Trained animals can be led by handlers to feed and water and can be tied to a simple rail instead of being put in a pen.

## **Lack of loading and unloading ramps**

In developing countries, I have observed a serious lack of good ramps for loading or unloading animals from trucks. I have seen pigs and cattle jump off large trucks because no ramp was available. Economical ramps can easily be built by local people from readily available materials. For instance, dirt can be built up against a simple retaining wall for loading or unloading trucks in remote areas. In facilities that get hard use, concrete, steel or wooden ramps are required. Good ramps can be built locally. Local labour skilled at working with concrete, welding steel, or carpenters using wood can build adequate ramps. It is important for ramps to have non-slip footing. One of the biggest problems observed is slick floors on ramps or in pens that cause animals to fall. For cattle and pigs, a non-slip ramp built on a 20° angle or less is recommended. Sheep can easily move up and down steeper

ramps. The best non-slip footing on concrete ramps is provided by a stair step design (5, 8). Steps are more effective than grooves and provide non-slip footing even when old and worn. Grooves wear down quickly and become slick. Stair steps are a proven design used on many ramps around the world. Figure 1 shows the recommended step dimensions for a concrete ramp for cattle, horses, camels and other large livestock. The recommended dimensions are a maximum 10 cm rise and a 30 cm or longer tread length. Two grooves at least 2.5 cm deep should be made in each step (5). For pigs, a shorter 8 cm rise is recommended.

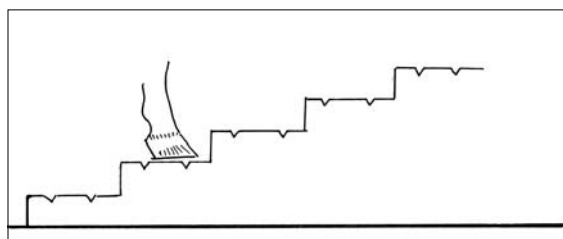


Figure 1  
Concrete stair step for a truck loading ramp  
It has a 10 cm rise and a 30 cm or greater tread length  
Do not build a step rise greater than 10 cm

For ramps constructed from either steel or wood, cleats are normally used. Figure 2 shows the correct and wrong spacing of cleats to provide non-slip traction. Spacing the cleats too far apart is a common mistake and can cause slipping. When cleats are too close together, the hooves slide over the top and provide poor traction. During unloading, cleats spaced too far apart cause dew claw injuries in piglets. The feet of the piglets slide and the dew claws catch on the cleats. For both small and large livestock species, the cleats should be spaced so the hoof of the animal will fit easily between them (Fig. 2). For cattle, 20 cm of clear space between the cleats is recommended. Smaller animals require closer spacing (14, 15, 17). The stair step and cleat spacing recommendations are the same for both animals trained to lead with a halter, and extensively raised animals with a large flight zone.

Cleats can be made from many different materials. On wooden ramps for cattle and other large livestock, 5 cm × 5 cm cleats made from hardwood work well. Use 2.5 cm × 2.5 cm cleats for smaller species. Concrete reinforcing rods make good cleats on steel ramps. Reinforcing rods are readily available in all countries where homes are built from masonry or concrete block. Pipe or square steel tube can also be used.

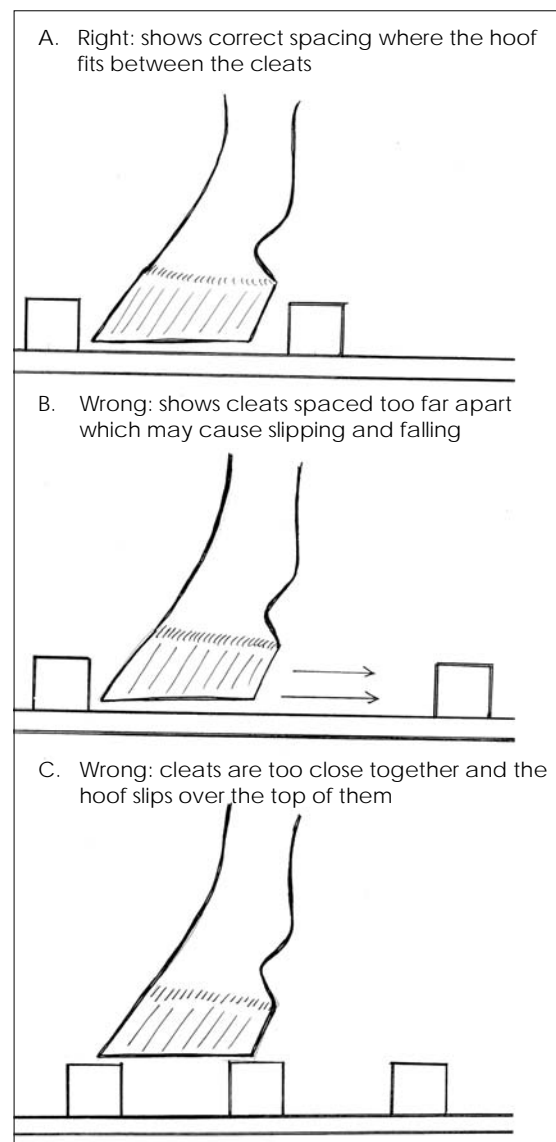


Figure 2  
Cleat spacing for steel or wood ramps

## Non-slip flooring

All concrete floors where animals walk should be non-slip. Smooth trowelled concrete floors cause animals to slip and fall. Broom finished

concrete floors that are made by sweeping a broom over wet concrete also work poorly because the roughened surface wears out quickly and becomes slick. In high traffic areas such as scales, alleys and veterinary facilities, a floor with deep grooves a minimum of 2.5 cm deep is recommended for large livestock, such as cattle. These grooves should be in a 20 cm × 20 cm diamond pattern (Fig. 3). This deep pattern should only be used in handling areas.

It should not be used in pens where animals are housed for several weeks or months because it may cause excessive hoof wear. For sheep and pigs, a good pattern can be made using expanded metal mesh stamped into the wet concrete. Use mesh with a minimum of 3 cm diameter on the short axis of the screen openings. Use a rake to groove the floor if expanded metal is not available.

In existing yards and facilities where a concrete floor is worn and slick, mats constructed from steel rods provide good non-slip footing. Use the mats in areas such as scales, alleys or unloading ramps. Figure 4 shows a well-designed mat of steel rods on a scale. For large livestock such as cattle, heavy rods a minimum of 2 cm in diameter should be used. Rods that are too thin bend and create a space to catch and injure hooves. The rods must never be criss-crossed on top of each other. Criss-crossing rods create a gap where toes can jam beneath, causing injury. The rods must be cut and welded so the mat lies flat against the floor. The recommended spacing is 30 cm × 30 cm squares for large livestock. Smaller squares and much lighter rods can be used for sheep and other small livestock. Concrete reinforcing rods work well and are readily available in all developing countries.

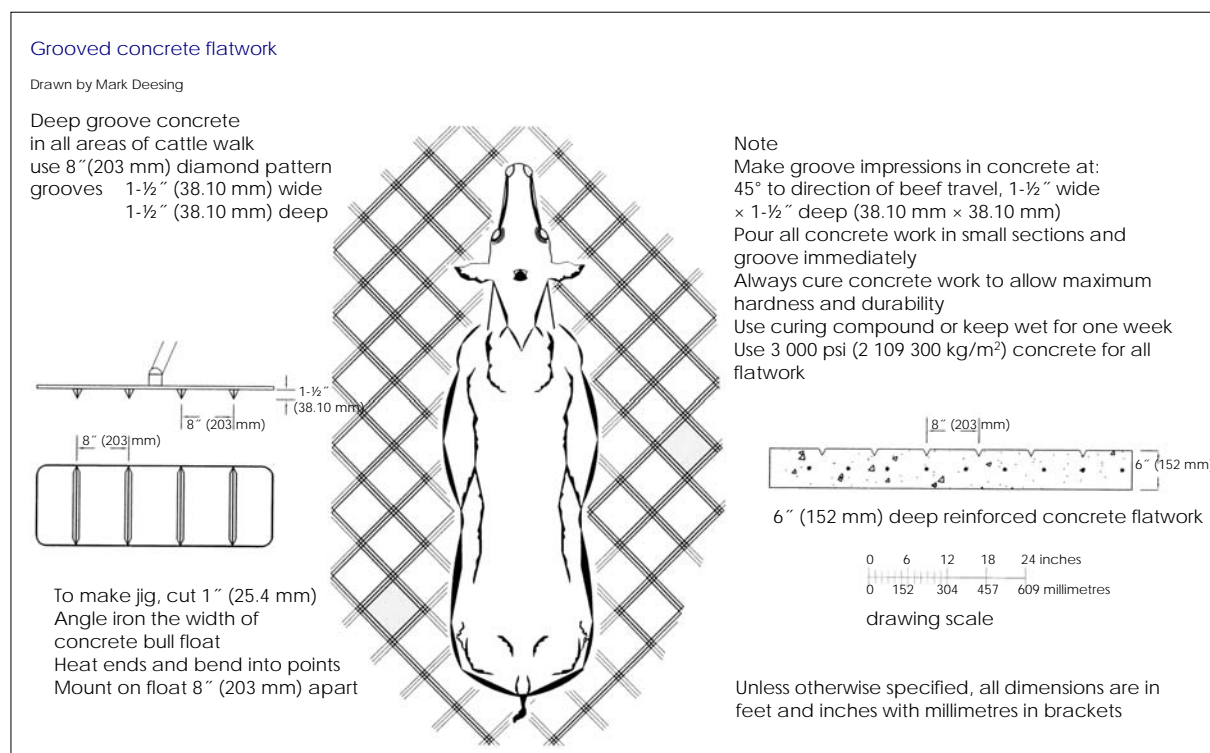


Figure 3

A diamond groove pattern is recommended

The grooves should be oriented as shown in this diagram

For large livestock the grooves should be 2.5 cm deep and 20 cm × 20 cm

For small species, a similar pattern with smaller, shallower grooves and smaller diamonds can be used





Figure 4  
A mat of welded steel rods can be used to provide a non-slip surface on scales and other high traffic areas with worn out slick floors. The bars must never be criss-crossed; they must be cut so they will lie flat on the floor.

## Appropriate equipment in developing countries

All of the ramp and floor recommendations in this paper can easily be constructed in developing countries. Curved handling systems for extensively raised cattle can be constructed by local people who are skilled at welding and concrete work. No highly specialised skills or materials are required. Most can be built from basic construction materials. More information is available on facilities for cattle, sheep, deer and pigs in the book *Livestock handling and transport* (8).

Many durable non-slip floors in the United States and Europe are surfaced with either rubber mats or specialised epoxy coatings. These surface materials provide excellent traction but are only recommended for use in highly developed countries. In developing countries, they may be too expensive, or local people might be unable to repair and maintain the surface. Specialised materials are not recommended where the material is not readily available.

Many pieces of equipment used in developed countries are not recommended for use in the developing world. Excellent hydraulic tailgate lifts commonly used in Europe may be too difficult and expensive to maintain in a developing country. I have observed many pieces of broken or discarded equipment that was too expensive for local people to maintain.

Another example is European-style truck tailgates that are lowered. They are seldom used in the developing world because the heavy springs for raising the gate have to be imported. The advantage of stationary ramps described previously is that local people can easily build and maintain them.

A portable ramp on a trailer is another piece of equipment that local people in developing country can build. I have observed many clever ways that local people have devised using parts of old cars to make trailers. A local welding shop could mount a steel loading ramp on an old car axle.

## Loading system layouts for extensively raised animals

Figure 5 shows a layout with a curved loading ramp and diagonal pens for holding cattle prior to loading. The advantage of diagonal pens is the 60° angle eliminates sharp corners. All animal traffic is one-way through the holding pens. The round crowd pen takes advantage of the natural behaviour of animals to want to return to where they came from. A facility of this type is not required for tame cattle trained to lead with a halter. Figure 6 shows a holding yard with a double herringbone layout.

## Loading ramp and unloading ramp width

For all species, ramps used only for unloading should be equal to or greater than the width of the vehicle. This provides a wide, clear path for animals to move off the vehicle and not be crowded which causes tripping. For extensively raised cattle, a level dock at the top of the ramp of a minimum of 3 m is recommended. Extensively raised cattle often exit a truck quickly. The level surface at the top of the ramp allows them to get their footing before descending the ramp.

For loading intensively raised animals, a ramp equal to the full width of the vehicle works well. For extensively raised cattle and sheep, the animals are driven up a ramp in single file or in double file with two animals walking up

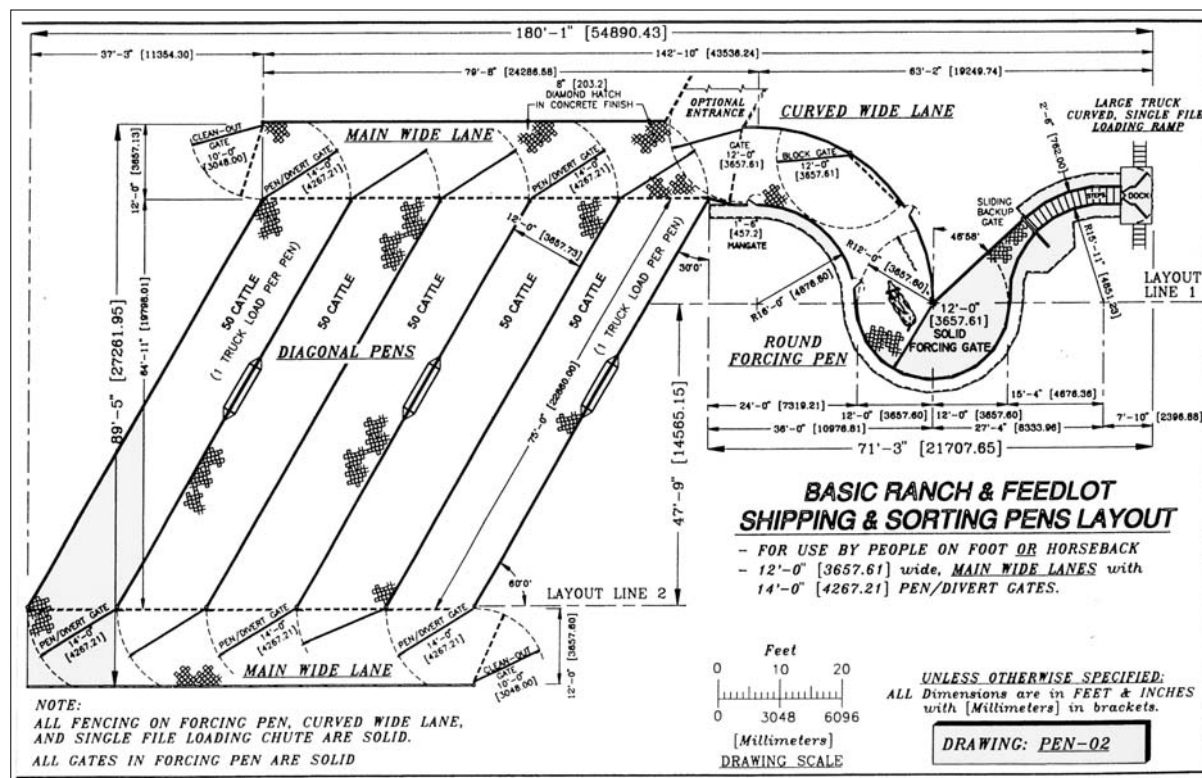


Figure 5

Layout of a shipping and loading facility with long narrow pens laid out on a 60° angle  
 All cattle traffic is one-way through the facility  
 The curved loading ramp is especially recommended for extensively raised cattle



Figure 6

A holding yard with two rows of diagonal pens laid out on a 60° angle  
 Animals unloaded from trucks move into the pens through the outer alleys and leave the pens through a central alley  
 A 70°-80° angle can also be used; do not use a steep 45° angle

side by side. Two pigs walking up a double file race works well (Fig. 7). Building a single file race that is too wide can cause two cattle or pigs to become wedged within it. This is a common mistake. The ramp should be single file or double file but never an animal and a

half wide. If animals are becoming wedged together in the loading ramp, the ramp should immediately be widened or narrowed.

## Holding yards

The initial design of yards should take into account the largest number of animals to be



Figure 7

Ramp with solid sides: two pigs can walk through this ramp side by side  
 Solid outer walls block the animal's vision and a 'see through' inner partition enable pigs to see each other to promote following  
 This double alley works well for many species

held at one time and should also consider future expansion needs. For all species, pens used to hold animals overnight should have sufficient space so that all the animals can lie down at the same time without having to lie on top of one other. Pens should be equipped with water troughs, or if animals are held for longer periods of time, larger pens with access to both feed and water are essential. In some big terminals, animals may spend several weeks in the yard. In this situation, enough feed trough space has to be available so weaker subordinate animals can access the feed. In large shipping terminals, races and restraining equipment for veterinary inspection and treatment will be required. Drawings and information on the design of these facilities is available (5, 8, 9).

## **Behavioural principles of design and handling**

Both intensively raised animals that are trained to lead with a halter and extensively raised wilder animals may balk or refuse to move if they see a reflection in a puddle or a change in flooring, such as a drain. It is important to walk through facilities before the animals enter and look for and remove any type of distraction. When building new facilities, drains should be placed outside the areas where animals walk and concrete floors should be sloped to prevent puddles from forming. Lighting and changes in contrast are also important. Livestock are very sensitive to harsh contrasts of light and dark. Most livestock are partially colour blind and the retina is most sensitive to yellowish green and bluish purple with no receptor pigment for red (12). Using light colours in hot countries helps to keep animals cooler. What is most important is that all fencing and walls be painted the same colour to avoid contrasts of light and dark.

In facilities with covered buildings or those used at night, the placement of lamps is an important consideration. Animals have a natural tendency to move from a darker place to a more illuminated place (3, 4, 16). At night, lamps that provide diffuse indirect light inside

a vehicle can be used to attract approaching animals. Animals will not approach blinding sunlight. Loading and unloading ramps should be positioned so that the animals will not be facing blinding light from the sun as they move on or off a vehicle.

Facilities that will be used for extensively raised animals with large flight zones should have solid sides on loading ramps and veterinary races to prevent them from seeing people and other distractions such as vehicles outside the fence (6, 8). Many different materials can be used to cover the fence. Steel sheets, plywood, planks or old conveyor belting works well. Thin plastic or netting that flaps should not be used because rapidly moving objects may cause livestock to refuse to move or to become agitated. Solid fences are especially recommended in areas where extensively raised animals are exposed to many people and vehicles passing the fence.

In both new construction and existing facilities, distractions that cause animals to balk or refuse to move should be removed. Some examples of distractions are dangling chains in races, clothing hung on a fence, people visible to approaching animals, shadows and reflections on shiny metal or water (Fig. 8). Removing distractions can greatly improve animal movement. In indoor facilities, adding a lamp to illuminate a dark alley can often improve movement because animals are attracted toward the light (8, 9). Reflections on a wet floor can sometimes be eliminated by moving a ceiling lamp. Solid shields can be built to prevent animals from seeing people ahead of them.

To troubleshoot problems, a person should enter the alley, race or loading ramp and position their eyes at animal height. Equipment should also be engineered to reduce noise (4). Banging and clanging noises from metal hitting metal should be silenced with rubber bumpers. On gates powered with air cylinders, the hissing sound of air exhausts should be muffled or piped outside.





Figure 8  
Shadows and bright spots may cause animals to balk and refuse to move  
Elimination of shadows, bright spots and reflections will often improve animal movement

## Training animal handlers

People handling animals should be trained in principles of animal behaviour and handling (9, 10). What is especially important when working with extensively raised animals is the principle of the flight zone and the point of balance (Figs 9 and 10). Handlers need to learn to work on the edge of the flight zone. If animals rear or become agitated, the handler should back away from the animal and get out of the flight zone. To move an animal forward they must stand behind the point of balance at the shoulder (8, 9). Handlers should not shout or scream at animals. Cattle and horses are more sensitive to high frequency sound than humans (11). Yelling and screaming at cattle raises the heart rate more than the sound of gates slamming (19). Animals should be moved at a walk or a trot. Abusive methods of handling such as beating, tail breaking, throwing, dragging, deliberately slamming gates on animals, poking sensitive areas, such as the eyes, nose or rectum should not be allowed.

## You manage what you measure

One of the author's greatest frustrations as an equipment designer has been getting people to handle animals quietly. When a new facility is set up, people are trained to handle animals quietly. Unfortunately they often gradually lapse back into old rough methods. Sometimes people do not realise this is happening. To

maintain high standards of animal welfare, handling needs to be measured. The use of numerical objective scoring by major meat buying customers has resulted in significant improvements in handling and stunning in slaughter plants (10). The percentage of animals falling during handling or moved with an electric prod has been greatly reduced.

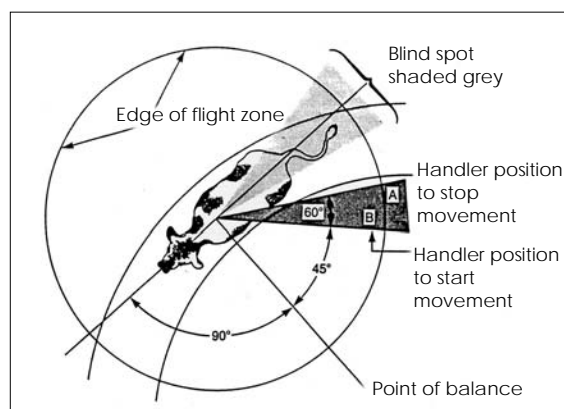


Figure 9  
Handlers working with extensively raised cattle or sheep should work on the edge of the animal's flight zone  
The flight zone is penetrated to make the animals move and the handler backs off to stop movement  
To move an animal forward, the handler should stand behind the point of balance at the shoulder

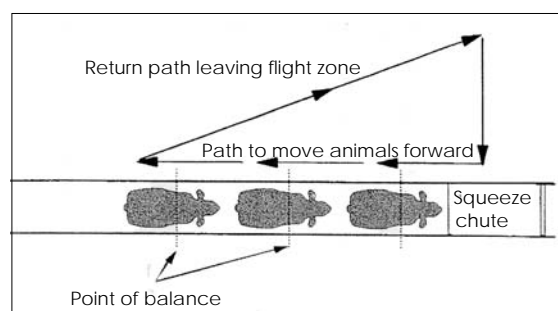


Figure 10  
Handler movement pattern to move animals through a race  
This pattern is especially useful for moving all species of extensively raised livestock

Animal handling can be quantified with ease by measuring the following variables during handling, loading and unloading:

- The percentage of animals that fall where the body touches the ground or floor: the use of non-slip flooring and calm, careful handling will greatly reduce the percentage of animals that fall during loading, unloading and movement through a facility.



- The percentage moved faster than a walk or trot: a calm pace at a walk or trot is recommended; animals that run, jump or lope are scored as speeders.
- The percentage of animals that run into fences or gates.
- The percentage moved with an electric prod: alternative driving aids, such as flags or a plastic bag on a stick, should be used.
- The percentage that vocalise during handling: vocalisation (moos, bellows and squeals) are correlated with physiological measure of stress in cattle and pigs (1, 7, 18, 20). Do not use for sheep.

In slaughter plants, 98% of cattle vocalisations during handling were associated with aversive events such as electric prod use, falling, missed stuns or excessive pressure from a restraint device (7). Each animal is scored on a yes/no basis. It either fell or did not fall, it hit a fence or did not hit a fence. Numerical scoring enables a yard manager to determine if handling is improving or worsening.

To maintain high standards requires constant vigilance. Paranhas de Costa, a cattle handling specialist in Brazil, reported that when supermarkets audited bruises on carcasses and made transporters pay for them, bruises in cattle dropped from 20% to 1.3%. When the supermarkets reduced the frequency of the audits, bruises rose back up to 9%. (M.J.R. Parahas de Costa, personal communication, 2006).

## Accountability for losses

During a 35-year career, the author has observed that holding people financially accountable for losses caused by death, sickness, or meat quality deficits motivates people to handle animals in a considerate manner. The worst abuses often occur when losses from death and bruises can be passed on to the next segment of a marketing chain.

One study showed that cattle sold on a live weight basis had twice as many bruises compared to cattle sold by carcass (2). When cattle are sold live weight the slaughter plant pays for the bruises and when they are sold by

carcass the producer is held accountable for losses caused by bruising.

## The importance of fit animals for transport

It is almost impossible to design facilities to humanely handle animals that are not fit for transport. Old breeding animals should be sold for slaughter or euthanised on the farm before they become debilitated, emaciated or too lame to travel. Producers need to be informed that they will receive more money for their animals if they are marketed when they are in good condition. Increasing the value of old breeding animals also motivates people to treat them better. Some other examples of animals that are not fit for long-distance travel are newborn calves and pigs that have been fed excessive doses of the beta-agonist ractopamine (a feed additive used to increase weight gain and grow lean muscle). Ractopamine may make pigs more difficult to move and more likely to become fatigued, no longer being able to walk (13). The author observed that problems with high doses of ractopamine stopped when producers received a twenty dollar fine for each pig that was too weak to walk off the truck and in and out of pens.

All lairages, stockyards and port facilities must have equipment for handling non-ambulatory animals that have fallen. Small animals, such as sheep or pigs, can be rolled onto a sled. Sleds can be easily constructed from many readily available materials, such as sheet metal, plywood or old conveyor belting. Humanely handling large livestock that have fallen is very difficult. The dragging of animals should be prohibited. One of the cruellest things that the author has observed was the tying of a chain to a fallen animal on a truck. The old emaciated dairy cow crashed to the ground when the truck drove away. The author has observed that over 90% of fallen non-ambulatory animals can be prevented by marketing animals when they are still fit for travel.

People who handle large numbers of animals should receive bonus pay for reducing bruises or death losses. The author has observed that the worst way to pay handlers is based on how fast they can move animals. Paying people to reduce losses is one of the most effective methods for improving animal handling. Contracts for the delivery of animals to a destination should contain financial incentives for delivering animals in good condition. Animals that have a low economic value are often treated the worst. The author has observed many abuses of old cull breeding animals due to their low value.

welfare. Financial incentives to motivate people to handle animals carefully will help reduce bruises, dark cutters and death losses. Livestock producers should transport animals that are fit for travel. Good engineering and design make it possible to handle and transport animals that are in good condition with an adequate level of welfare. The worst animal abuses often occur when debilitated, emaciated or severely lame animals are transported over long distances.

## Conclusions

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Both well-designed facilities and well-trained people are required to maintain good animal

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