Boning-room Layout

Plant layout identifies the physical arrangements within any processing environment. It is a basic requirement for any processing facility that there be adequate space for:

- the operation of equipment;
- personnel to work;
- material movement;
- storage; and
- all support activities.

Of greatest importance are the requirements that the plant be capable of producing the finished product in adequate quantities and that the product be of acceptable quality.

Design philosophy

When planning a new layout it is important to remember that the primary objective of any plant layout is to enhance profitability by optimising operating conditions. A design team should always aim to maximise output while minimising costs. When preparing a layout design, the design process should ensure that allowances are made for:

1. Integration of all factors likely to affect the layout and operation of the work area
2. Effective utilisation of space, equipment and personnel
3. Ease of future expansion
4. Ease of rearrangement of equipment
5. Ready adaptability to change in product, packaging and process
6. Practical minimum distances for movement of materials and people
7. A logical sequence of work flow, and clean work areas
8. A pleasant and safe work environment for all employees.

Boning and packing is a multi-stage, labour-intensive process. The layout of the facility in which it is carried out can have a major influence on the efficiency and profitability of the process and can directly impact on operating costs by:

- eliminating bottlenecks and improving product flow;
- making more efficient use of labour;
- improving food safety;
- controlling OH&S risks; and
- making better use of available space.

Research has proven that the more times meat is handled, the greater the risk of unacceptable bacterial loads on the product. Large primal cuts can be handled some 8-10 times when table boned, sliced, handled and packed using manual systems. Work surfaces in boning rooms become contaminated during boning operations and are then a significant source of contamination of boneless meat. Scientists have concluded that table boning produces significantly higher microbial contamination than rail boning and the boning-slicing stage of the total operation can be the major source of microbial contamination.

Boning-room performance

In preparing for a layout design it is useful to compare the performance of existing layouts to determine which layout features are effective and which are not.

The configurations of existing plants are known to vary considerably. These variations have been, to a greater or lesser degree, as a result of:

- existing chiller and/or freezer layout;
- method of boning (hot, warm, cold);
- type of commodity produced (manufacturing beef/mutton, prime lamb, Japanese ox);
- the number of different product lines packed.

Comparisons between different layouts can be difficult to make owing to these variations. The data in Table 1 is indicative of performance that is being achieved from some existing beef plants and is a useful indicator of the effect of both good and poor layout designs.

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TABLE 1 Performance of Plants

Plant	Slicers	Packers	Slicer to Packer Ratio	Carcases per day	Production Ratio
A	15	15	1:1	148	9.8
B	18	15	1:0.83	360	24
C	16	21	1:1.31	300	14.3
D	27	14	1:0.52	325	23.2
E	20	13	1:0.65	264	20.2

Production ratio is determined by the carcases processed per packer per shift.

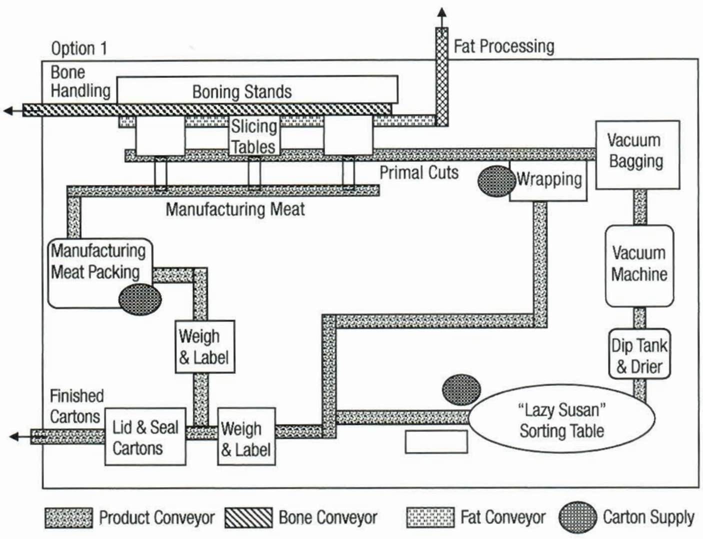
Layout efficiencies

Operations that can be made more efficient by improved layout of facilities include:

- boning and slicing;
- transfer of product (edible and inedible) and packaging materials;
- packaging of bulk product;
- processing of wrapped and vacuum-packaged products;
- weighing, labelling and carton closure; and
- entry and exit of personnel.

Two sample layout options are shown in Figures 1 and 2 respectively.

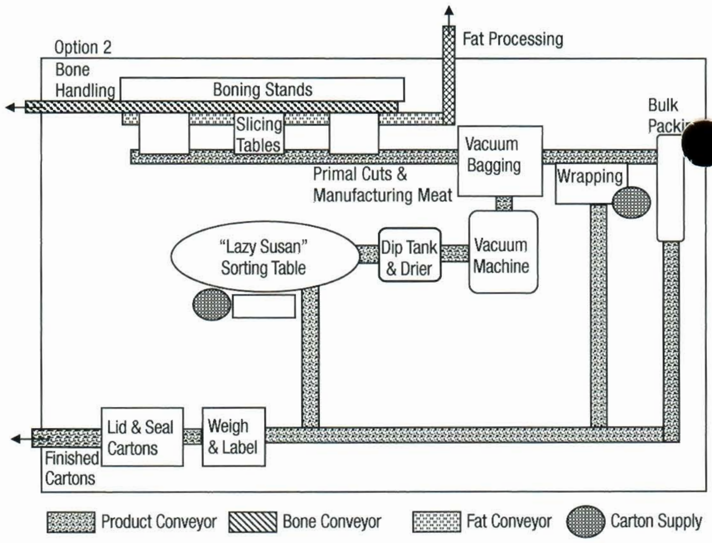
Figure 1 Schematic diagram sample layout, Option 1



Manufacturing meat is separated from primal cuts at the slicing station and sent to a separate manufacturing-meat processing station.

Manufacturing meat is transported on a common conveyor with the primal cuts. Primal cuts are removed for packing at the wrapping station and the vacuum-packing station. Manufacturing meat falls from the end of the conveyor directly into cartons, where it is positioned in the carton as required.

Figure 2 Schematic diagram sample layout, Option 2



Boning and slicing

Boning and slicing operations are most efficient when boners are stationed above and facing the slicing tables, and boneless meat falls onto the tables. This eliminates the boners' having to lift and/or throw product. A beef-side boning chain allows for the most efficient use of labour and space. Where lack of head space precludes the installation of a side chain, a quarter chain will deliver some of the cost efficiencies of a side chain. However, the provision of space, equipment and labour to quarter the sides of beef is an added expense for quarter boning.

Table or belt boning, for which quarters/carcases have to be lifted and product thrown, or passed, to slicers or for which slicers have to stretch to pull product towards them, is slower and less productive.

Slicers are best placed facing at right angles to the boner so that the slicer can easily access meat from the boner and deliver pack-ready product to the packaging process. A belt conveyor to transport fat and other inedible product is best located at a height where no lifting is involved.

With rail boning and table boning the bones are dropped onto a low-level conveyor to transport them directly to a bone-collection, or pre-breaker, room in preparation for sending them to rendering. Some bones are removed at the individual boning stations while others can continue to the end of the rail where they are cut down. When side boning beef, leaving the entire skeleton intact is generally not effective due to the difficulty in re-positioning the side during boning of the hind quarters. The attached fore quarter skeleton becomes unwieldy and can catch on stands and other equipment. The skeleton is also difficult to handle intact at the cut down area at the end of the rail. When mutton boning, the smaller carcase skeleton can be left intact for effective handling.

Transfer of product and packaging

(i) **Product.** The slicer to packer ratio data in Table 1 are heavily influenced by the varying methods of material handling employed. In both cases where the ratio is 1:1 or worse (plants A & C), packers were stationed on slicing tables, servicing one or two slicers, and packing direct into cartons.

In the other three cases, slicers placed meat on belt conveyors for transport to central packing points, as in Figure 2. Packing can be further specialised by slicers placing meat for bulk packing on one belt and primals for individually wrapping (IW) and/or vacuum packaging (VP) on another, as in Figure 1. The two streams operate independently up to the carton-closure operation. Layer packing can be integrated into either stream, dependent on volume.

Fat and bone are ideally removed from the edible processing area by using belt conveyors and/or chutes, with a resultant reduction in labour costs and elimination of manual-handling risks. Delivery of these materials direct to their pre-processing areas will reduce handling and associated costs. As the packing end of the process is often a congested area, many layouts run fat and bone conveyors countercurrent to the process line to move these materials away from the congested area.

(ii) **Packaging materials.** A significant reduction in congestion in packing areas can be achieved by delivering preformed cartons to a reduced number of packing points. By taking product away from the slicing area and centralising packing at two or three points, cartons and ancillary packaging can be delivered more efficiently. The most popular method is to have carton storage and erection operations (manual or mechanised) located on a mezzanine level with preformed cartons being gravity fed via chutes to the packing stations. Still-folded carton liners can be placed in cartons before delivery to the packers. Packers of bulk product need only to take a carton from the chute and unfold the liner; then the meat can be placed into the carton. No packaging material is stored in the work area, leaving an uncluttered environment to optimise throughput and a cleaner environment to minimise any risk of product contamination.

Minimising the number of carton delivery points reduces the complexity of the delivery system but must be balanced with the need to minimise congestion at the packing points. Figure 1 has three carton delivery points with packing of bulk, IW primals and vacuum-packaged primals well segregated. Figure 2 has two carton delivery points relatively close together for ease of carton delivery. However, the close proximity of the packing operations may reduce overall process efficiency.

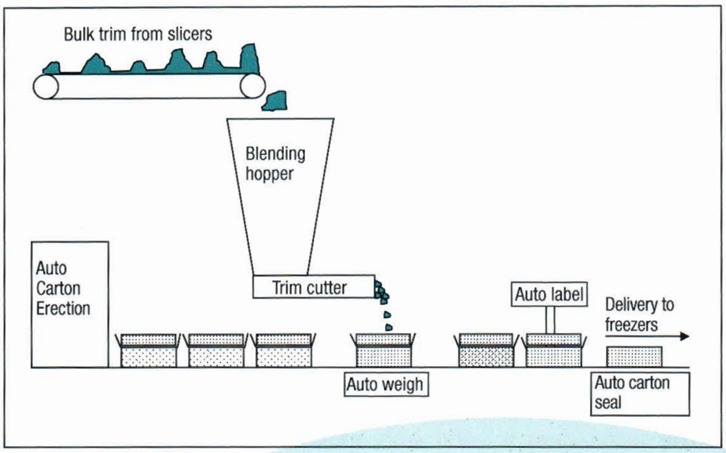
Packaging of bulk product

By placing all manufacturing meat on a single conveyor and transporting it to a separate packing station, the blending of product to meet chemical lean specifications is simplified. Packing directly at the end of the conveyor as in Figure 2 minimises the number of cartons that can be packed at once and hence the ability to blend product for accurate chemical-lean content.

Consideration should be given to weighing cartons at the packing point so that all cartons contain the correct weight of 27.2 kg prior to reaching the normal weighing and/or labelling station. This eliminates the need for a 'float' of meat at the weigh/label station. The existence of a float of meat anywhere in the process can provide unnecessary delays for some meat pieces and the potential for the development of microbial-growth conditions.

Automation of this complete process is possible and has been commercialised, as in Figure 3.

Figure 3 Commercial bulk manufacturing meat automated handling facility



The inclusion of a bulk holding hopper with mixer and trim cutter allows for blending the natural fall of manufacturing meat from the boning stations to give a more consistent chemical lean content. Care should be taken in sizing the hopper to ensure that adequate blending is achieved to give the necessary control of chemical lean consistency without creating sufficient delay to encourage significant microbial growth.

The inclusion of auto-carton erectors and sealers, along with in-line weigh and label systems, allows the process to be fully automated with the virtual elimination of labour.

Processing of wrapped and vacuum-packaged product

Isolation of the wrapping and/or vacuum-packaging processes from the bulk packaging area generally allows for the better usage of available space. Labour resources may, or may not, be better utilised, depending on the mix of products being packed and the overall process capacity. With large throughputs, labour utilisation is generally better with segregated packing stations. However, with low throughputs, the ability to share tasks between a few operators favours the use of closely located bulk and primal-cut packing areas.

With segregated primal packing areas the storage of wrapping sheets and barrier bags is confined to a smaller area, allowing for better control and potentially less wastage of materials. The most labor-intensive parts of the IW and VP operations are the placement of cuts of meat into barrier bags and the presentation of the bags on the plate for an effective evacuation and seal. Automated systems for presentation of the barrier bags, and for vacuum packaging machine cycling and unloading, are readily available. Full automation of the vacuum packaging operation is well advanced in the packaging of other commodities and is likely to be available soon for the packaging of fresh meat. For further information on vacuum packaging, reference should be made to the Meat & Livestock Australia (MLA) brochure Vacuum Packaging Primal Cuts

'Flow-wrapping' is already commercially available as a fully automated alternative to stretch-wrapping of primal cuts using air permeable film.

The technology for evacuation-sealing equipment and shrink-drying tunnels is now advanced to the stage where delays are a rare occurrence and the operation most likely to cause a bottle-neck is the sorting and boxing of vacuum-packaged cuts. Using a 'Lazy Susan' sorting table allows packers to pack the higher-volume lines more efficiently without the lower-volume lines being neglected and possibly compromising time-temperature requirements. The use of this sorting arrangement has produced increases in processing efficiencies of up to 60 per cent compared with those measured when short-length sorting conveyors were used.

Equipment and material suppliers can assist with good vacuum packaging layout recommendations to meet a plant's specific requirements.

Weighing, labelling and carton closure

The scales area is commonly identified as the point at which 'meat becomes money'; hence the accuracy of weighing and labelling systems is essential to ensure that the correct weights are assigned and the correct labels applied. Systems that are inaccurate or inefficient may allow for incorrect or underweight product to be delivered to customers, with resultant claims. Such claims can be expensive and generate a level of distrust between supplier and customer. Inaccurate systems can also unnecessarily 'give away' product to customers, affecting process profitability.

Much effort has gone into making the weighing, labelling and sealing of cartons as efficient as possible. Problems have been encountered with the scales software, with time taken to print labels seen as a major source of delay. If a manual (or manually assisted) carton-strapping system is in use, consideration can be given to installing the label printer at the strapping station. In this situation it is sometimes possible for one operator to carry out the two tasks of carton strapping and label application. If, however, cartons are glued automatically with no manual input, this arrangement is not possible. Options for label application with automatic carton closure include:

- automatic application at, or immediately after, the weigh station;
- manual application at the weigh station by the scales operator;
- manual application after the scales. This option is less labour efficient and would only apply if the processing speed were too high to allow the scales operator to apply the label. In this situation an automatic applicator would most likely be justified.

It can be argued that a single weighing and labelling station is most labour efficient. However, it should be considered that some cartons may need to be strapped and others glued, with each operation requiring an entirely separate station. Reliance on one weigh/label station can create major bottlenecks in the event of an equipment malfunction in this area. Provision of two or more stations, as in Figure 1, allows for the flexibility to bypass this situation.

Entry and exit of personnel

It is important that the layout of entrances to, and exits from, the boning and packing areas provides adequate space and sufficient facilities for:

- hand washing;
- boot washing;
- washing and hanging aprons;
- sterilising and hanging personal equipment – knives, steel pouches, mesh gloves etc; and
- disposal of paper towelling, single-use aprons and surgical gloves.

If insufficient space and/or facilities are allotted for these important operations, hold-ups in staff entry to, and exit from, work areas may lead to down-time and lost production. 'Short-cutting' of personal hygiene procedures is also likely to occur.

There is no single layout design that will work for all boning operations. Preparation of a new layout must involve considerable planning to ensure that an optimum balance is achieved of:

- product quality and hygiene;
- operator safety and comfort;
- process efficiency and flexibility; and
- yield and economic performance.

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Contact

Processing and Product Innovation

Meat and Livestock Australia

Tel: (02) 9463 9166 Fax: (02) 9463 9182

MEAT & LIVESTOCK AUSTRALIA

165 Walker Street, North Sydney NSW 2060

Tel: (02) 9463 9333 Fax: (02) 9463 9393 www.mla.com.au

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