Quantity of Space

It is recognized that the space requirements of pigs change as the animals grow. Traditionally we have recommended space allowances for specific weight ranges, which reflected the approximate divisions of nursery, grower and finisher pig. These traditional ranges need not apply as we endeavour to design new management systems. In addition, we are marketing pigs at higher weights than we did previously, and space allowances need to reflect this practice. To provide the flexibility needed for designing new management systems for pigs, we need to express space allowance as a continuous function, based on the body weight of the animals, and not on wide weight ranges. The new Code of Practice (Agriculture Canada, 1994) will reflect this approach.

What is the relationship between body weight and space requirements? The pig represents a three-dimensional object, with length, width and height. Space requirements, such as floor contact area, are expressed in two dimensions, roughly equivalent to length and width of the object. As long as the shape of an object remains proportional, the relationship between weight and space requirement will remain the same as objects change in size. The pig stays roughly the same shape throughout the grower/finisher phase, and we should be able to determine an appropriate relationship between weight and space requirement. Figure 1 illustrates the relationship between the size of an object and the area in contact with the floor. Doubling the weight (or volume) of the object increases its floor contact by only 60%.

Figure 1. Relationship between weight and floor contact area.

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Weight</th>
<th>Floor contact area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 1 x 1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1.26 x 1.26</td>
<td>2</td>
<td>1.6</td>
</tr>
<tr>
<td>x 1.41</td>
<td>2.8</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Doubling the floor contact area represents an increase in weight of 180%. The traditional rule of thumb of 25 lb/ft² (roughly 125 kg/m²) was based on a market sized pig, and should not be applied to nursery or grower pigs which require more space relative to body weight. The relationship between space requirement and body weight takes the form of: \( \text{Space} = k (\text{Body Weight})^{2/3} \), where \( k \) is a constant. The question that remains is the appropriate value of this constant for grower/finisher pigs. This may be derived by traditional production trials, or from determining behavioural space requirements.

**Figure 2. Relationship of gain to space allowance.**

- Edwards et al. (1988)
- Kornegay and Notter (1984)

**Space Requirements Based on Growth Trials**

Traditional growth trials have expressed space allowances in terms of the final weight of the pigs. Several studies were summarized by Kornegay and Notter (1984) and the results illustrated in Figure 2. Another approach, in which space allowance is frequently adjusted for body weight, is represented by a study by Edwards et al. (1988). Both illustrate that growth rate declines when space is restricted and, in general, feed intake also declines. In addition, reduced space allowance will also result in more aggression, uneven growth, and more health problems. Despite these disadvantages, more pork is produced in a pen that is crowded than in one with fewer pigs. On a purely economic basis, crowding pigs on a fully slatted floor to a level of 0.027 m²/kg BW^{2/3} (0.62 m²/110 kg pig) is advantageous (Edwards et al., 1988). I believe that establishing space requirements at such a low level would not be in the best interests of the swine industry. Public concern for the welfare of farmed animals is largely related to overcrowding and behavioural problems.

**Growth Requirements Based on Behaviour**

Grower/finisher pigs in confinement housing spend approximately 80% of the time lying, 10% eating, and 10% standing but not eating. Let's consider how these figures can be used to estimate the space requirements of a group of 15 animals. When providing space, consider: frequently all pigs are lying, during warm weather more space is required, room for two pigs feeding and one pig drinking in our pen of 15 is reasonable. The dunging area for a pen of 15 pigs on fully slatted floors has been reported to be 1.8 m² (Wiegand et al., 1994). This totals 12.37 m² for the 15 pigs, that is 0.825 m²/pig, or 0.036 m²/kg BW^{2/3}. This is very close to the Canadian Code of Practice. These estimates require that pigs use vacant lying, eating, drinking and dunging space for general movement.

**Space Management**

Using the Canadian Code of Practice as a standard, we can calculate that a pen of 20 grower/finisher pigs being marketed at 110 kg would require 17.25 m². Figure 3 illustrates the use of space by these pigs in an all in/all out system. Considerable space is wasted in this system, and it may be possible to re-claim this space using other management programs. One way is to consider that when the heaviest pigs are at market weight, the pen average is only 95 kg. Therefore, pens could be designed for 95 kg, rather than 110 kg, pigs and still meet the standard. Note: most pens take about 5 weeks to empty, resulting in wasted space when only a few pigs are present. Similarly, space is wasted early in the cycle as the small pigs do not require the entire pen. Approximately 40% of the space is lost due to these three conditions.

Is it possible to re-claim this space? The traditional system with separate grower and finisher pens reduces the loss due to small pigs by about half (10%), but requires additional pens, movement of pigs, and cleaning. In previous tests we tried a continuous flow system which involved removing pigs at market weight, and replacing them with grower pigs. The resulting pen had pigs ranging from 30 to 100 kg.
Space was used more efficiently, however, social problems existed which preclude the use of such a system. The system also loses the health advantages of an all-in/all-out system. Another approach is to incorporate a room of small pens for the stragglers from each group. By emptying pens, and moving the remaining 5-6 pigs to a smaller pen, the pen may be re-used about two weeks earlier. The new pens should maintain the pigs in their original social groups, since otherwise the ensuing aggression and social upset will reduce gain by about 10% over the next two weeks. We are currently examining a system in which both small and straggler pig problems are addressed using additional small pens. Here is how that system would work: pens are filled with more grower pigs than normal, when the pen reaches maximum allowable density the pigs are de-grouped - the heaviest 20% of the pigs being moved to the small pens. By the time these largest pigs reach market, the original pens are becoming crowded again and the smallest 20% of the pigs are moved to the small pens. The original pens go to market shortly after. This system has the potential of reducing space requirements by 20%. Before it can be recommended we must demonstrate that de-grouping the pigs and moving does not interfere with growth.

Quality of Space

Quality refers to how well a given quantity of space accommodates the needs of the animals. If the quality of space is improved, then the same quantity of space will enhance animal welfare and growth. Similarly, if the quality of space is improved, the animals' welfare and productivity may be maintained with less space.

Walls and Corners

Pigs prefer to lie against walls rather than in the centre of the pen. Solid walls are also preferred to spindle walls and by combining their use, the solid walled area is used for sleeping and the spindled area for dunging. It is not clear if this preference for solid walls relates to avoiding drafts, or pigs in the adjacent pen. As group size increases, the amount of wall space per pig decreases. This results in pigs lying several deep around the walls, which may have similar effects to crowding, as pigs must walk over others to leave or enter the group. In large groups it may be advantageous to consider partial partitions. Corners serve two purposes within the pen:
1) immediately after re-grouping, pigs use corners to escape from attacking penmates,
2) Pen shapes with more corners result in less aggression. Corners may be added using a partial partition extending from one wall. False corners, created by feeders, may result in poor dunging patterns (Wiegand et al., 1994).
Pen Shape

Despite the advantages of providing wall space for pigs, walls are costly and many barns are designed to minimize their use. The result of this approach is square pens, which have a lower perimeter to area ratio than do rectangular. However, many producers have found that pigs are more excitable and difficult to handle in square pens. Figure 4 illustrates the problem. Whenever the stockperson enters a pen the pigs will initially move to the opposite end. As you approach the pigs they will eventually circle around you in order to increase the distance between you and them. The distances between yourself and the pigs, and yourself and the side of the pen, are equal. The result of trying to sort an animal out of a square pen is a group of pigs running in a circle around the stockperson. In a rectangular pen, the stockperson maintains control of the pigs until he or she is much closer, it is also easier to stand to the side and let pigs pass by when it is desired.

The emphasis of reducing ammonia production in The Netherlands resulted in researchers attempting to reduce the dunging area within pens. One approach was to build triangular pens, with the waterer and slatted area in one tip of the triangle. The corner made the area a desirable dunging area, and the total slatted area was reduced. Results were inconsistent and the original design is no longer being considered. However, the concept may have some merit and could reappear in another form.

Location, Orientation and Design of Features

Features refer to equipment such as feeders or waterers within the pen. A very common approach has been to place multi-space feeders in the fenceline between pens, near the slatted end of partially slatted pens. Such a location and orientation causes problems in narrow pens. Pigs eating from these feeders orient perpendicular to the pen wall, and effectively reduce the width of the pen by their body length (1.4 m for a market pig). This obstructs the movement of pigs between the sleeping area and the dunging area. Solutions include: rotating feeders 90° effectively becoming two single-space feeders, or move the feeder to the sleeping end of the pen.

The advent of the single-space feeder has given us more freedom in terms of pen layout. Because pigs can access the feeding space from either side, only one side of a single-space feeder needs to be available for access. With a multi-space feeder, the pig must approach from that side that avoids interference with other pigs. Single-space feeders may be placed in corners or oriented such that pigs stand along the wall while eating, but such positioning and orientation is not recommended for multi-space feeders. We are currently conducting a study on the effect of position and orientation of single-space feeders.

The single-space feeder may allow us to reduce the space allowance for pigs. A single-space feeder can

Figure 4. Handling problems in square pens. As the stockman moves from A to B in the square pen, pigs may circle the stockman without coming nearer. In the rectangular pen, the stockman may approach closer without losing control. By moving to point C, the stockman may allow pigs to move freely to the other end of the pen.