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ZOOCENTRIC DESIGN: PIGS, PRODUCTS, PROTOTYPES AND PERFORMANCES

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ABSTRACT
This paper is concerned with how we apply design to our association with other non-human animals. It exemplifies this with the domestication and current use of the pig (*Sus domesticus*). After a brief review of the process of domestication, the paper looks at modern production and the increase in concerns for animal health, welfare and performance and the link to food for human consumption. The paper elaborates on the extreme nature of intensive pig production systems and the role that design plays in their operations. It points out the prototypical nature of the modern pigs' evolution and the means by which man contributes his own prototypes to these changes. It pays some attention to the often conflicting concerns of efficient production and animal welfare. It exemplifies this in a brief study of 2 design products - floor systems and feeding systems, and through the use of a Holmesian type puzzle, shows the complex interrelationships of the two products. The paper emphasises the need for designers to avoid extreme anthropomorphism, adopt whenever possible a zoocentric and salutogenic (health oriented) approach and remain fully aware that all technical decisions are also likely to be ethical decisions. The paper concludes with some suggestions of what might be incorporated into the curriculum of product design courses.

Keywords: Zoocentrism, design, pigs, products, education

1 INTRODUCTION

We share this planet with an estimated 1.3 million animal species of whom around 5000 species are mammals like ourselves [1] and all of whom participate in sustaining planetary life referred to as "The Web of Life" by Fritjof Capra and "Gaia" by James Lovelock. If we human beings contribute badly to this partnership, then all living systems are likely to suffer, including ourselves. Our species, numbering around 7 billion is spread all over the planet. It is highly intelligent and with colossal technical power it clearly dominates all other species and demonstrates this with its ability to exploit all the other species to varying degrees and usually to its sole advantage. This paper is about understanding how students of design, think and respond when confronted with design problems where the central focus is an animal rather than a human being. Early explorations by one of us (SB) seeking creative solutions to farm animal orientated design problems but with students of agriculture, animal production and agricultural engineering were disappointing. These students were very familiar with the problems but their creative thinking and design skills were undeveloped. With students of design the opposite is true – they are creative designers but inexperienced in a deep understanding of the animal centred problem situation. So, for comparative purposes, we have chosen to exemplify the zoocentric perspective with a farm animal familiar to most students, - the pig, and using a systemic approach, have tried to describe the difficulties we perceive for product design students in dealing with a well-researched domain out with their familiarity. The problems for design students are not, - can they generate creative design solutions, but can they really understand the fundamental problems, can they access the diverse but extensive research data and understand it, and finally can they integrate it systemically into their design thinking. So, inevitably the paper devotes more space to the design students' weaknesses – understanding the animal system, than on their relative strengths of creative thinking.

2 THE PIG

2.1 The Domestication of the Pig (Family *Suidae*)

There are 10 living species of the Genus *Sus* [2]. They are omnivorous, highly social and intelligent animals. Most modern pigs in the west probably originated from the European wild boar *Sus scrofa* and are now referred to as *Sus scrofa domesticus* or just *Sus domesticus*. There are about 100 breeds of *Sus domesticus* and 13 of these in the UK. About 9000 years ago, Neolithic man probably made the first serious attempt to domesticate wild pigs. Zeuner (1963) has suggested that the process of domestication may have taken place in roughly 4 stages [3]. In the initial phase only loose contacts would have existed between the wild pig and human settlements. From scavenging to being fed on scraps of food, the pig would have then entered the second stage of domestication, a phase dominated by man's intention to subjugate large numbers of this guest species. Strict captivity would then have controlled breeding activity and individual animals would have become entirely dependent on the human host. The host's attempts at husbandry in this early period would have resorted to little more than containment. In the third stage of domestication, man's husbandry improved and animals would undergo selection for certain valued characteristic. Eventually and almost imperceptibly, a fourth stage would have been reached where the wild stock no longer contributed to the value of the new improved breed. The domesticated pig would have become a more standardised animal and its valued characteristics were now more likely to be lost by crossbreeding with wild animals. The pig must have proved an ideal subject for domestication. Rejected and despised by nomadic people because of its unaccommodating attitude to droving and continuous travelling, its social and self-sufficient habits would have proved ideal in the relatively static environment of village life. Its ability to find its own food from a variety of sources in woods and wasteland or to succumb to herding or confinement in a stockade or dwelling house must have made it a useful source of meat and fat. Its omnivorous habits were perfect for life in and around the early settlements.

2.2 Design and Domestication

The contemporary domestic pig came about by two processes of change. First of all natural selection was responsible for the change from primitive mammal to wild pig, then domestication changed the wild pig into the domestic species. The change from proto-mammal to wild pig probably took about 140 million years whereas the pig has only been domesticated for about 8000 years. Although the total contribution of domestication to change in the pig may be small when compared to evolution there are two main types of effect. **Intended effects** are brought about by artificial selection and design whereas **unintended effects** result mostly from uncontrolled selection pressures in the agricultural environment. In reality, the intended and unintended effects of domestication are related. Where the environment of the pig is intentionally changed to facilitate the process of domestication, this is brought about by design, but it too can have intended and unintended consequences. For example, constraining the animals in too small a space can increase territorial aggression, increase animal injuries and decrease animal welfare. Every act of design will result in changes to the pig's lifestyle. Every imposed change on the pig's lifestyle will affect its welfare to a greater or lesser extent by limiting the expression of what the animal wants [4]. In addition, it may have effects on the animal's health and consequently its welfare. Both factors are important to "good welfare," defined by Marion Dawkins (2012) as "…the state of an animal that is both healthy and has what it wants" (p.142).

2.3 Modern Pig Production and Animal Welfare

An estimated 9 million pigs are slaughtered every year in the UK mainly for popular foods and food products but less than 2% of this is derived from organic sources. Almost all pigs (98%) are fattened in sheds and 93% of growing pigs and 60% of sows are also kept indoors. It is estimated that 55% of sows farrow (give birth to their young) confined to crates and 35% of all systems use no straw bedding [5]. The average size of large-scale intensive pig farms is 500-900 sows and their progeny. Intensive animal farming is usually characterised by an increase in capital investment per animal in housing and equipment, a reduction in labour usage per animal, an increase in the nutrient intake per animal to achieve a high rate of output and a standardization of the final product. The extreme version of these systems is often referred to as "factory farming." In addition, with powerful and sophisticated extractive technologies and a large demand for all sorts of consumables, about 185 different products can now be derived from one pig and used in anything from the production of ammunition to heart valves [6]. Clearly good design has a major role to play in these systems. The more closely confined the pigs are kept, the less able they are to look after themselves and the more responsible their carers have to be to ensure their health and welfare. With fewer experienced stockmen looking after larger numbers of animals, this becomes an extremely difficult task which is further compounded when livestock producers are put under severe economic pressure. These are the systemic conditions that set the context in which designers have to operate both technically and ethically. But the methods of intensive livestock production are neither new nor unusual and there is a large source of both historic and contemporary literature available which embraces and incorporates design. For example, around 300-100 BC, the Romans fattened edible dormice in clay pots and kept wild birds in cages for culinary purposes. They also practiced pig keeping using housing systems similar to those generally found in the late 19th century in the UK. However, the well-travelled James Caird in 1847, recalls that if he were to erect a new set of buildings on his farm, he would incorporate many of the foremost ideas of the new High Farming: **"central heating of the feeding houses, mechanical handling of feed in mobile trainways and the use of open-boarded floors, the latter presenting a suitable means of increasing the output of meat from livestock farms by using straw for feeding rather than bedding" [7].** Around this time too, the Rev. A. Huxtable and J-J. Mechi were great users and protagonists of sparred floors, with Huxtable also prototyping a hydraulic system of subterranean pipes for the transport and spreading of liquid manure (slurry). These technical systems were not accepted by everyone and just like today, such intensification had its critics. However, none of these periods of intensive farming lasted very long and livestock practices returned to good husbandry and what Temple Grandin has referred to as the "ancient contract." This generally remained true up until the 1930's but then came the devastating Second World War with food rationing and great austerity. After the war, in the period of recovery, the Government implemented the Agriculture Act 1947 to rapidly produce more cheap food. Some believe this was the incentive, subsidized by Government, for the rise of the latest episode of intensive livestock farming, and this time supported by scientific and technological discoveries, intensification was pushed even further ultimately resulting in "Factory Farming." In 1964, Ruth Harrison's book, "Animal Machines" exposed the poor welfare conditions of animals in factory farms in the UK, and following sustained pressure over succeeding years, resulted in The Codes of Recommendations for the Welfare of Livestock. These exist today in revised form, almost half a century after the publication of "Animal Machines" and a tribute to Ruth Harrison's persistence on behalf of farmed animals. The current Code of Welfare for Pigs, contains sections on stockmanship, health, accommodation, management and specific recommendations for the different stages of pig production. These Codes are essential reading for any designer or manufacturer dealing with the pig production industry and confirm the view that a systemic, holistic view must be retained at all times regardless of what aspect of the problem the designer focuses on. So, consider the following design problem.

3 DESIGNING FOR PIGS

3.1 Products and the Problem of Parts

"*You operate a medium sized company that specialises in precast and in-situ concrete work. Your present work has a reputation for high quality precision standards mainly supplying the construction market in offices, schools and domestic buildings. You have a reputation for innovation and you are keen to enter new markets like agriculture. You have also recently taken over a company that designs and installs systems for the storage and distribution of granular and particulate materials like sand and cement. You have been consulted by a pig production company that has several large units distributed throughout the UK. It is also considering expanding into Europe. Many of its existing buildings were built during the great expansion in intensive livestock production 25 years ago. The company now needs to renovate and upgrade many of these existing buildings and the first phase in this programme is to renew the floors in several buildings and install new feeding systems.*

The sheds requiring renovation were originally used to house growing pigs weighing 25-45kg in pens containing 50-60 pigs on in-situ concrete floors covered with straw bedding which was cleaned out periodically on a batch basis when the pigs weighed 45kg and were moved to a finishing stage which took them to 90kg and slaughter. The floors in these buildings are in very poor condition although the insulated superstructure of the sheds is still sound and the mechanical ventilation was replaced only 2 years ago. There is no mechanical feeding system, the pigs having previously been fed ad libitum from *hoppers filled daily by manual labour. On going through some old papers dealing with the design of the original buildings, your client found an intriguing chart, unfortunately faded in several places, which he believes explains the fundamental concept of the buildings and which would appear to have been validated by the great success of the pig performance over the last 25 years. He would like you to apply similar principles to the design of the renovated sheds and there new use. The chart is reproduced in FIGURE.1. What can you deduce from this chart about the floor and feed systems which you are about to install in these buildings and which are now to accommodate pigs weighing 45-90kg kept in groups of 10-15 pigs on a controlled diet and with no straw bedding?* (see later section 3.2).

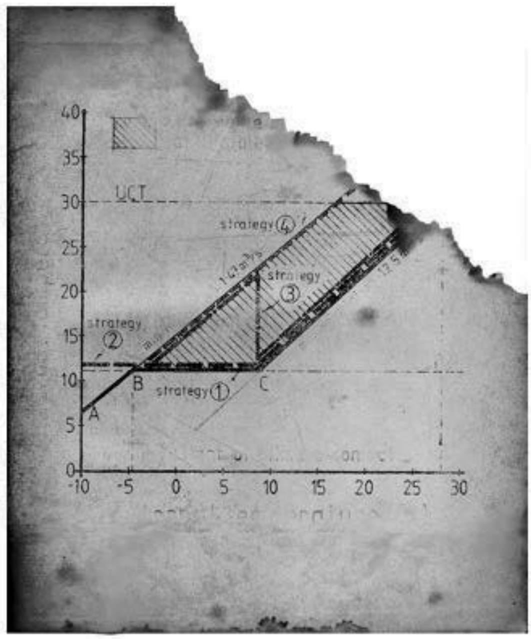

Figure 1. Example of chart

On the face of it, for you, this is a problem of designing and installing two independent systems-floor and feed, but in actuality you are being involved in co-creating and prototyping a whole new pig production system. Your co-creators are your client and the pigs. With the former you can readily anthropomorphise with the latter, this is not a good idea. The main objection to anything other than an anthropocentric perspective is that for humans there is no alternative to human centeredness. Unfortunately, this is often extended to the argument that all values must also be human centred. Curry (2006) however has pointed out that this is an anthropogenic position and just “because value is generated by human beings, it does not follow that humans must be the main repository or central concern of value” [8]. It is difficult to avoid anthropomorphic speculation but the animal behaviourist Marion Dawkins has two suggestions. First, treat anthropomorphic anecdotes about animal behaviour seriously but only as a starting point for more thorough scientific study and second, use anthropomorphic thinking to derive hypotheses that then might lead to testable predictions and a strong scientific basis for decision making. As she says, “anthropomorphism does not provide evidence in itself but is a means to an end.” With these cautionary words in mind, we can now proceed to systems thinking. The feed and floor sub-systems are only part of a bigger system of production which in itself is a subsystem of a nested hierarchy of systems of management, economics, politics and even culture perhaps. These nested systems are continuously subjected to two-way perturbations so that, if the whole system is to be sustainable for as long as the previous one was (c 25 years) the resilience of the parts and their connectedness needs careful consideration. So, with the two subsystems in mind (floor and feed), the designer needs first to look for the connections between them and then between all the other systems at least at the production level. This type of relationship review also needs to be compared with the existing system in order to examine the likely impact on the whole system and especially on your two subsystems, of the other system changes like, no straw bedding, controlled feeding, and larger pigs in smaller groups. For example, larger pigs in smaller groups and a controlled energy intake are less able to respond to changes in the thermal energy demand of their environment. With no straw bedding, they will lose more energy by conduction to the floor which you will have to compensate for by insulating your floor slabs. The insulation will need to be as near the surface of the slabs as possible to be of thermal value to the resting pig, but the surface layer of the slabs will need to resist the harsh environment of the behaviours in the pig pens and the surface will need to be smooth enough to prevent abrasion to the pig's feet and legs and yet not so smooth that the pigs slip, fall and injure themselves. This is a difficult performance specification to achieve for the floor slabs but it is necessary in order to contribute to a good performance (growth, health and welfare) of the pigs and a good economic performance for your client. Furthermore, by moving away from a solid manure with straw bedding, your client is choosing to move to a liquid manure system (slurry) and there is a high probability that part of the floor system in the pig pens will have to be slotted to allow the slurry to drain into channels below the floor (a modern version of Huxtable and Mecchi's open boarded floors). These special floor panels will also have a difficulty in achieving their performance specification. In addition, any feed which is spilt from your feeding receptacles on to a slotted floor is lost and may influence the consistency of the slurry, making it less fluid and more difficult to handle with pumping equipment. Feed spilt on a solid floor is often recovered by the pigs. Finally, by designating part of the pen floor for certain behaviours like defecating and urinating you are trying to anticipate the pigs actions and these are likely to be a complex mix of responses to the thermal environment, the social behaviour of other pigs and indeed to the idiosyncratic behaviour of some pigs that then prompts similar behaviours in other pigs. When pigs decide not to comply with the rules built into your designed intentions, then the resilience of the whole system is put to the test. This is why the pig is central to the whole system and why designers, even though they are only dealing with parts of the system, need to concern themselves with an understanding of the whole dynamic process. Now to return to the Holmesian puzzle in FIG 1 and to see how it relates to the rest of this paper. It does so in two ways. First, the content of the original chart demonstrates how it is possible to look at a more holistic account of what is going on in the shed and how this relates to several sub-systems. Second, the need to decipher the relationships in the puzzle chart, reinforces the learning process and because it does so, we recommend that the method be used in the educational process and so we demonstrate it here.

3.2 The Holmesian Chart and its Holistic Nature (Fig. 1).

The chart shown in Fig 1 is a Bioclimatic Chart of the type developed by Bruce (1981) [9]. The chart in Fig 1 was compiled for a specific building described in Baxter (1984, p.87) [10]. The chart describes a shed containing 300 pigs each weighing about 45kg, kept in groups of about 15 pigs and fed *ad libitum* on a barley based diet. The shed is moderately well insulated and ventilated with automatically controlled propeller fans. It is similar therefore to the example used in this paper. The horizontal axis of the chart refers to the external temperature in degrees Celsius for the locale in which the building is situated. In this case, from -5°C in winter to +27°C in summer. The vertical axis is also in degrees Celsius but relates to an equivalent internal temperature in the shed. It is on this axis that the internal thermal environment is specified and this is done so by calculating the pig's thermoneutral zone, the zone between the upper and lower critical temperatures. Specifying the thermoneutral zone, integrates pig size, feed intake, group size, floor type and air movement. In Fig 1, the thermoneutral zone extends from 12°C (LCT) to 30°C (UCT). This therefore specifies the internal thermal environment suited to the most efficient energy performance of the pigs. Now the question is, over what range of external conditions can the quality of the shed (insulation and ventilation) maintain these ideal inside temperatures? The slope of the two lines on the chart represents the thermal insulating standard of the shed and two ventilation rates from a minimum in cold weather ($1.47m^3/s$) to a maximum in hot weather ($12.5m^3/s$). This is the capacity of the fans and the effect of the automatic control system. The chart also shows the influence of 4 different ventilation control strategies on the internal temperature of the shed. The hatched area on the chart shows the acceptable and readily attainable conditions for this system. For example, if the outside temperature drops below -5°C, even with a minimum ventilation rate, the temperature inside will drop below the pig's lower critical temperature (LCT). The pigs themselves may compensate for this by lying huddled together but this will leave a greater area of floor space for random defecation and urination. If the temperature inside drops below the LCT for a prolonged period, then pig performance will slow down unless the pigs are given more feed or the shed is heated artificially.

4 THOUGHTS FOR THE CURRICULUM

It would be unreasonable to expect that the curriculum for E&PD courses should contain much zoocentric design, but perhaps it might be introduced as part of learning by problem solving, as the value for doing so is greater than just being aware and concerned for animals. It is worth reiterating the reasons for engaging in zoocentric design [11]:

1. Good design could improve the well-being of all animals associated with humans and could improve animal/human performance.
2. It provides a different perspective (zoocentric) and a new challenge to design thinking.
3. It extends our understanding of other species and deepens our compassion for them.
4. It increases our awareness and knowledge of the impacts of our design and technological decisions in human/animal relationships.
5. It provides new sources of ideas and knowledge to stimulate imaginative thinking.
6. It raises questions of moral and ethical concern.
7. It provides one step towards a truly ecocentric, natural design.

From this paper, three recommendations are worth making for incorporation in the curriculum:

1. A sample of design problems should be drawn from animal and food production systems.
2. Presentation of problem based learning using the Holmesian method is worth trying.
3. Students should visit at least one intensive animal production unit and/or a slaughterhouse.

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