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Optimizing across levels

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Essential Knowledge

Optimization is defined as the action or process of making the best of something; (also) the action or process of rendering optimal; the state or condition of being optimal (http://dictionary.oed.com.floyd.lib.umn.edu). But what is optimal?

In the grand scheme, optimal is the best point the system can achieve as a whole. Although not inherently implied, optimization can be done in such a way so as to maximize productivity.

We are accustomed to considering optimization as a local function—pigs weaned per sow per year, nursery survivability, pounds marketed per square foot of finishing space. And if our system is limited to a single phase of production, such optima might be sufficient. Because of the degree of inter-phase interaction in the swine industry, true optimization requires consideration from the system's perspective. Anything less produces sub-optimization—the condition that develops when the individual components of a system fail to work together to achieve maximum performance (Evans and Lindsay, 2005).

At its core, optimization requires an established definition the system's objective—along with a method to measure that objective. Optimization occurs within the system's constraints, i.e., capacity, market specifications. However, system optimization and profit maximization are not necessarily the same. It is possible, though, to optimize in such a way so as to maximize profit (Fetrow, 2006).

The prospect of system-wide optimization seems, at best, daunting and, at worst, impossible. However, other industries have found ways to optimize using different approaches. These include Total Quality Management, Six Sigma, Design for Six Sigma, Taguchi Methods, and field trials. Each has advantages and drawbacks (some are provided in **Table 1**), and all are restricted in their ability to handle interactions.

Two-phase optimization example

Production and performance in the nursery is dependent on both the quality of animals placed (Larriestra et al, 2006) and the conditions during those pigs' time in phase. Because the quality of animals placed is dictated by the conditions in the sow unit, the optimum production for a two-phase system requires a balance between sow unit and nursery interests. And for biological systems, the relationship is dynamic.

Figure 1 depicts the dynamic relationship for a two-phase system where nursery survivability (the end objective) is related to sow parity, lactation length and time of placement.

References

Evans, J.R., Lindsay, W.M. Introduction to Quality. In The Management and Control of Quality, Sixth ed. Thomson Southwestern, Mason, Ohio, pp. 12-14.

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Larriestra, A.J., Wattanaphansak, S., Neumann, E.J., Bradford, J., Morrison, R.B., Deen, J. (2006) Pig characteristics associated with mortality and light exit weight for the nursery phase. *Can Vet J.* 47:560-566.

Table 1: Approaches to determining optimum

Approach	Explanation (http://oxfordreference.com)	Advantages	Drawbacks
Total Quality Management	An approach to managing people and business processes that emphasizes the importance of customer satisfaction and sees continuous improvement as the means to achieve this.	Focuses on customer on continuous improvement	Lack of focused approach leads to efforts fading over time
Six Sigma	A total quality control philosophy centered around reducing variation to the extent that the tolerance in a production process is at the sixth sigma—representing a failure rate of less than 1 in 250 000.	Highly structured, project-centered and focused on financial returns	Greater focus on short-term rather than long-term returns; potential for scope creep
Design for Six Sigma	A philosophy that seeks to incorporate the principles of Six Sigma into the design of a new process or product	Designed to eliminate problems before they occur	Incorporation only in design stage; requires prioritizations and creativity
Taguchi Methods	Methods concerned with the optimization of product and process before manufacture that concentrate on quality loss rather than quality. Optimization involves experimental design using simple designs to estimate main effects.	Statistically efficient design and factor-level approach allows for consideration of interactions	Controversial with respect to statistical assumptions; not well-explored in biological contexts
Field trials	Experiments or tests carried out in the environment in which a product is produced.	Statistically valid and observed within the system	Expensive and results can be difficult to replicate, especially in the context of interactions

Figure 1: Response surface with a single optimum