

# Operations Research in Pig Production



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**PRODUCTION MAXIMIZATION  
VS ROBUSTNESS  
OR  
NOISY SYSTEMS  
VS MANAGED SYSTEMS  
OR  
QUALITY  
VS THROUGHPUT**

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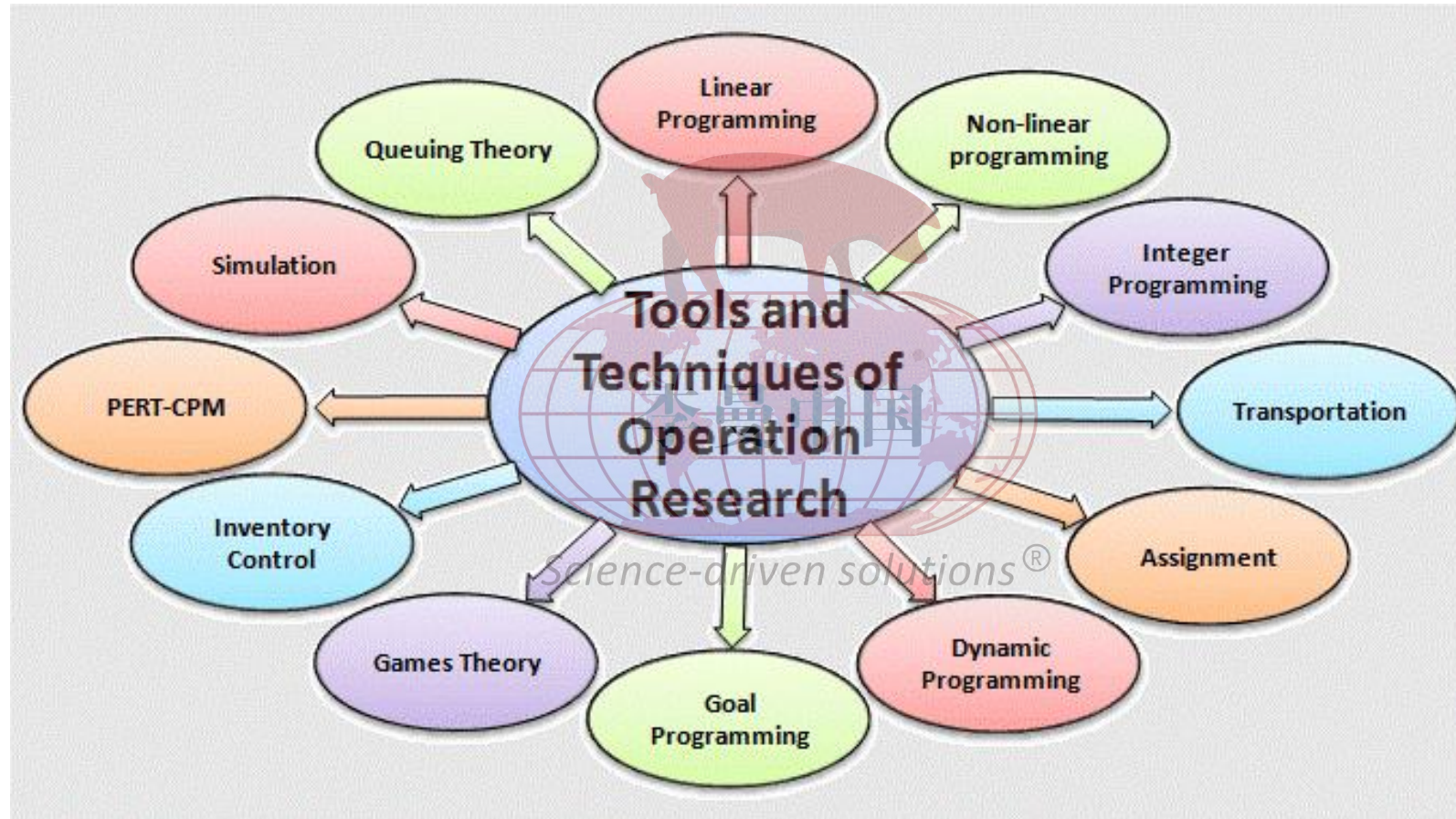
# If I had to do my training over...

- More economic modelling
- More operations research
- More non-parametric statistics
- Pay more attention



immunology

# Many parts



The modern field of operational research arose during World War II. In the World War II era, operational research was defined as "a scientific method of providing executive departments with a quantitative basis for decisions regarding the operations under their control".

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# Why is product failure increasing?

E.g. Few gilts last productive lifespan, wide variation in weekly output, mortality and cull rates, excessive sorting

Why?

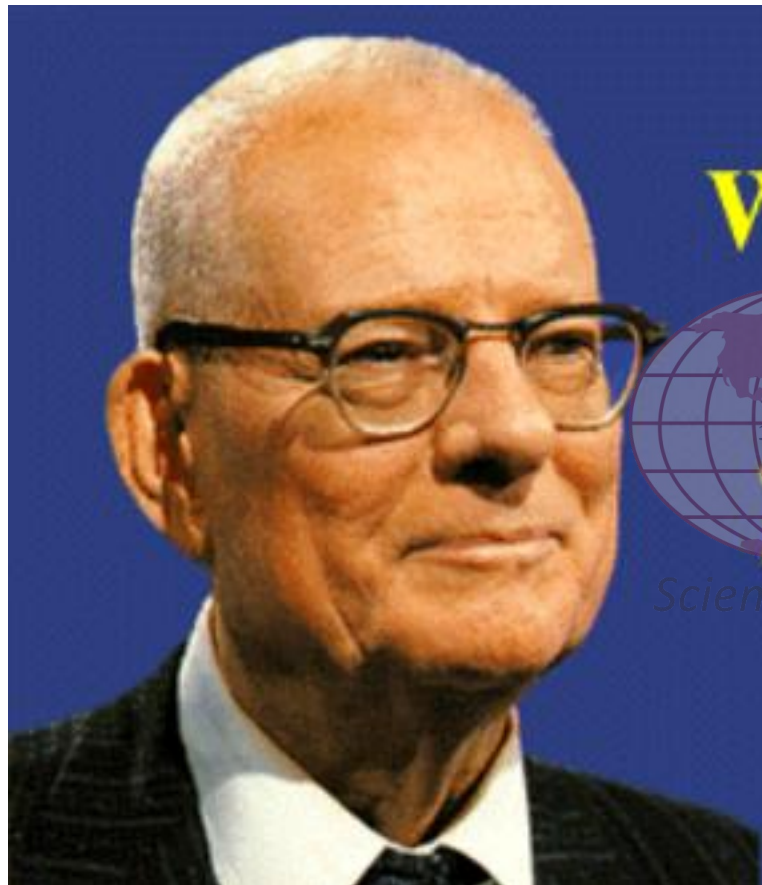
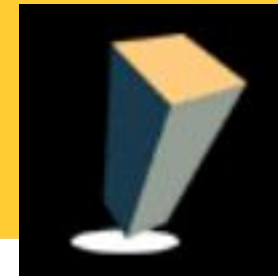
- Biology
- Economic underestimation
- Lack of measurement and analysis of inputs and outcomes
- Lack of analytic tools



# “Chester Whites in a tin shed”







**W Edwards Deming**  
1900-1993  
李曼中国  
*"We have learned to live in a world  
of mistakes and defective products  
as if they were necessary to life.  
It is time to adopt a new  
philosophy in America."*

# Quality is Job 1.™

## Profile in quality #14: Driveability.

*The sophisticated engineering of today's Ford Motor Company cars and trucks is truly remarkable. For instance, today's Mercury Cougar XR7 and Ford Thunderbird Super Coupe have a speed sensitive electronic rack and pinion steering system that provides optimum driving control. Their new adjustable suspension system monitors driving conditions, automatically making adjustments to optimize ride and handling. And both cars are equipped with four-wheel disc anti-lock brakes. If your goal is to build the highest quality cars and trucks in the world—you don't do it any other way.*

**Ford, Mercury, Lincoln, Ford Trucks.**  
**Our goal is to build the highest quality cars  
and trucks in the world.™**



FORD MOTOR COMPANY

Buckle up—together we can save lives.

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# Challenges

- Biological systems are complicated and messy
  - But production constructs are fixed with limited slack capacity
- Biological systems are difficult to monitor
  - Subjective
  - Expensive
  - Interventions limited
  - Instrumentation?



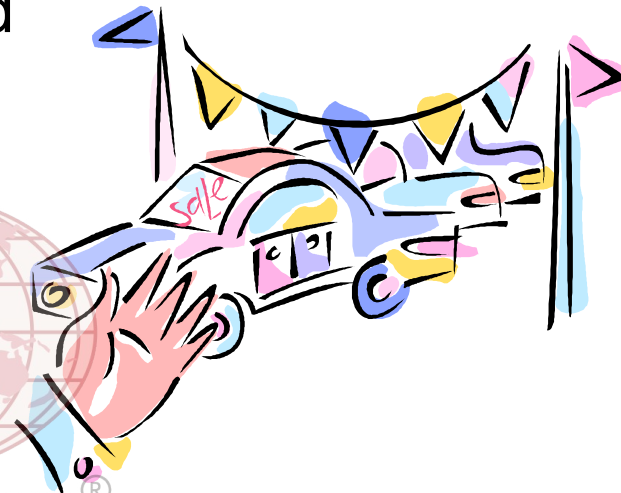
# Cyclical Variation

- Variation between consecutive units drawn from a process (season, disease)
- Variation AMONG groups of units
- Batch-to Batch Variations
- Lot-to-lot variations



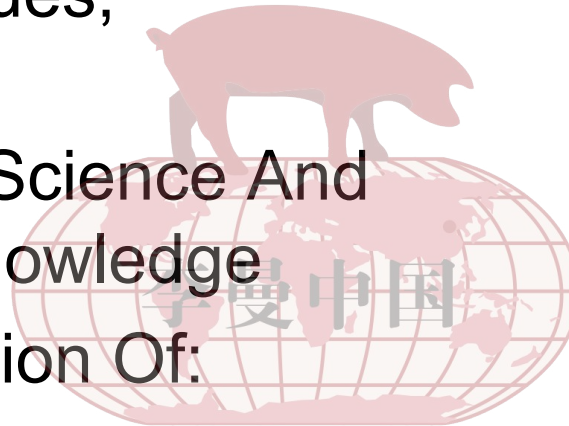
# Taguchi's Loss Function

- Taguchi defines Quality Level of a product as the Total Loss incurred by society due to failure of a product to perform as desired when it deviates from the target performance levels.
- This includes costs associated with poor performance, operating costs and any added expenses due to harmful side effects of the product in use
- Upside and downside costs often differ, eg heavy vs light

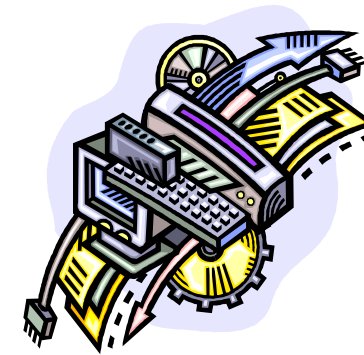
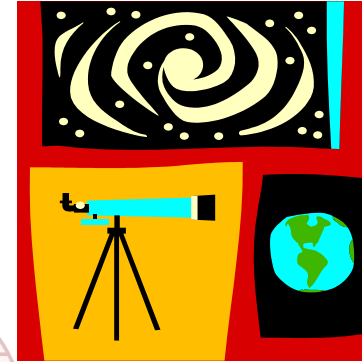


# The Taguchi Approach – SYSTEM DESIGN:

- All About Innovation – New Ideas, Techniques, Philosophies
- Application Of Science And Engineering Knowledge
- Includes Selection Of:
  - Inputs
  - Processes
  - Parameter Values



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# Sorting

- A "Last Resort" Improvement Step
- Identifies Parameters Having the greatest Influence On Output Variation
- Tightens Tolerances On These Parameters
- Typically Means **Increases In Input Costs**



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# Classes of pigs for intervention

Pigs	Atomistic	Ecologic	Financial
Unsustainable Euthanize	Likelihood of success is too low to maintain	Damage to population is too high to maintain	Negative value pig $MR - MC < 0$
Marginal Euthanize or treat	Unsustainable unless treated	High damage unless treated	Low value pig $MR - MC < 0$ , $MR - MC - TC > 0$
Needy Treat	Low value unless treated	Damage potential affected by treatment	Higher value - treatment $MR - MC < 0$ $MR - MC - TC > 0$
Tough Enjoy	Not affected by treatment	Not affected by treatment	High value pig $MR - MC = \max$



# Statistics: It's not your university's variation

- Standard variation statistics based on sum of squares
  - Focused on means
  - Over/under treated equally
  - Emphasizes outliers
- Alternative Target MOTAD – Target Minimization of Total Absolute Deviations
  - Or Target MOTND – Target Minimization of Total *Negative* Deviations
- Or transformations, e.g. counts

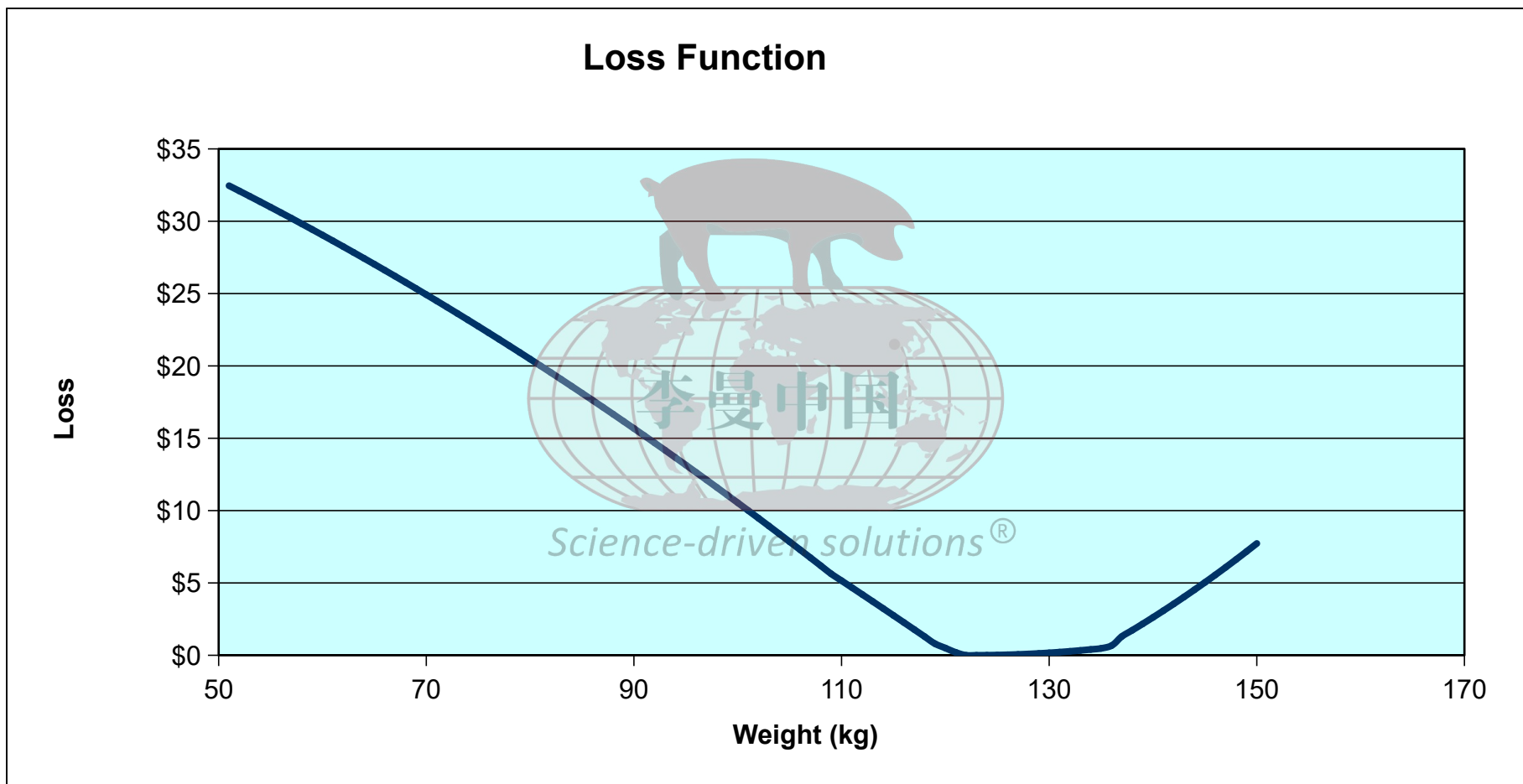
# Economics: It's not in a P&L

- First step: Loss functions
  - Inputs and outputs
- Multiple by distribution to get batch loss
- Add to management accounting
- Determine specifications
- Identify compensatory behaviors
- Identify determinants of under and/or overs



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# Market hogs



# Problems

- Biologic complexity
- Non-linearity
- Stochasticity
- Non-normality
- Lack of production engineers



# Why operations research?

- We are underestimating variation costs
- Reduce our reliance on averages
- Not only internal costs but also externalities are better addressed
- Labor is a growing constraint
- Instrumentation is increasing
- Predictability is a virtue



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