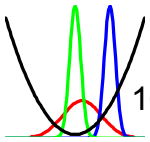
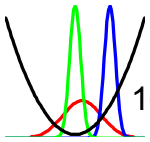
Performance characterization

Don Clausing



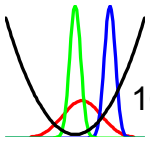
Failure modes

- Noises lead to failure modes (FM)
- One set of noise values leads to FM_1
- Opposite set of noise values leads to FM_2
- Simple problem solving chases the problem from FM_1 to FM_2 and back again, but does not avoid both FMs with the same set of design values – endless cycles of build/test/fix (B/T/F)



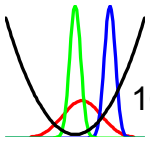
Failure modes occurrence

- Failure modes occur when the essential performance characteristic deviates excessively from its ideal value
- Some failure modes are simply values that deviate so far that output is not useful; e.g., voltage from power supply is too low
- Some failure modes are catastrophic; e.g., paper that arrives too soon jams in copier



Performance characteristic

- What is good performance characteristic to use when reducing the occurrence of failure modes?
- Don’t merely count occurrence of failure modes
- Can’t distinguish between following two cases



Case 1 – easy to fix

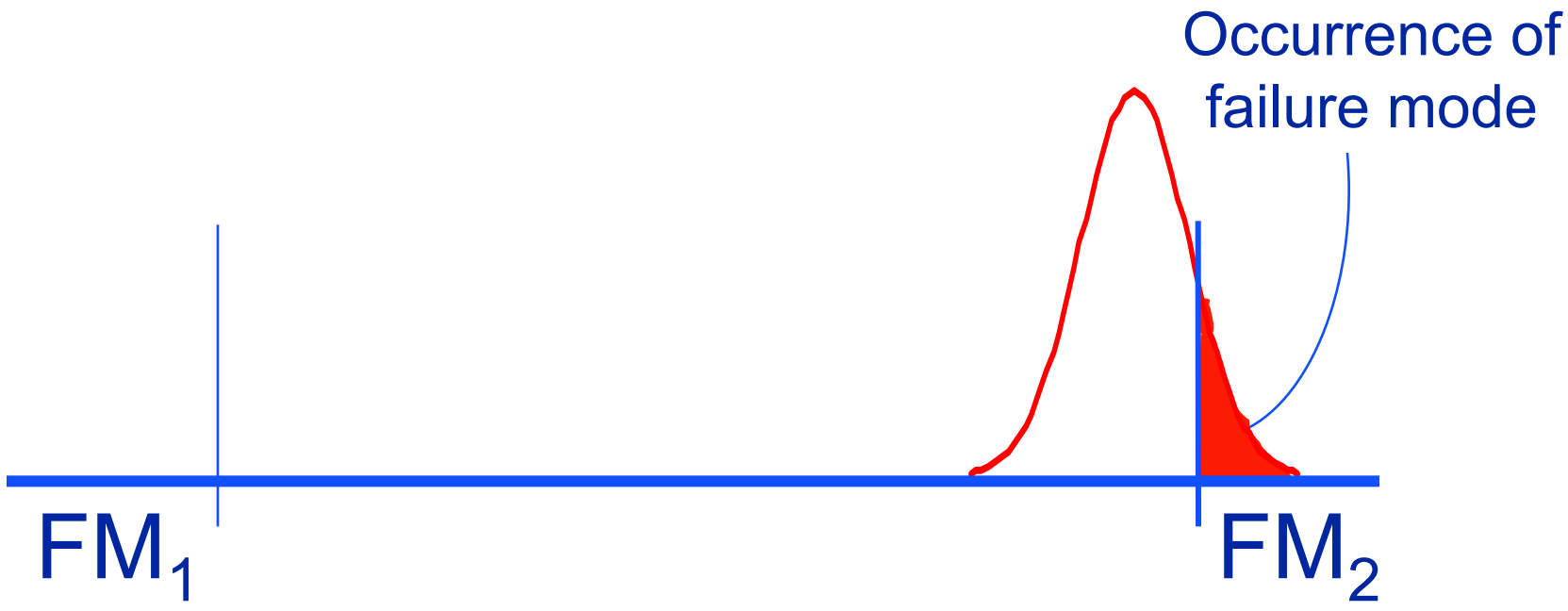


Fig. 5

Case 2 – difficult to fix

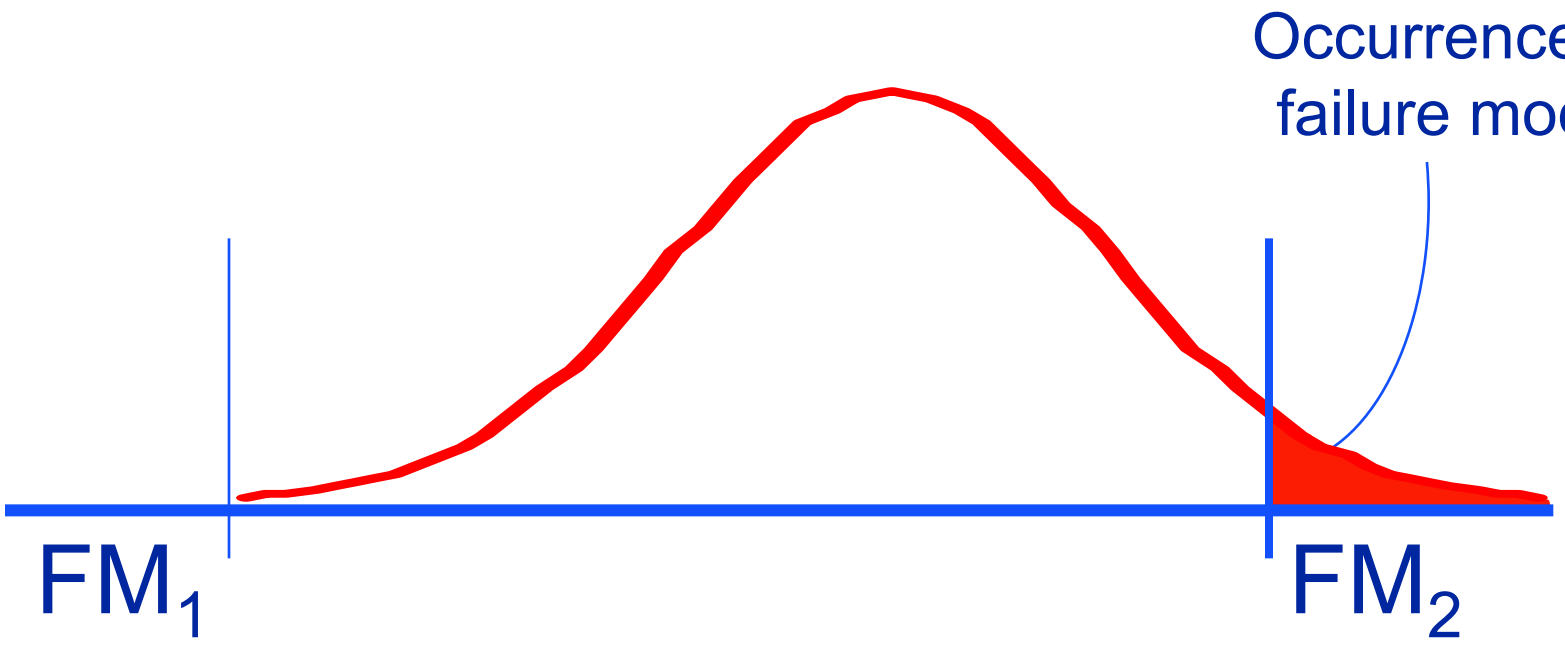
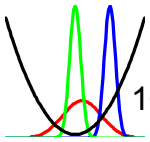


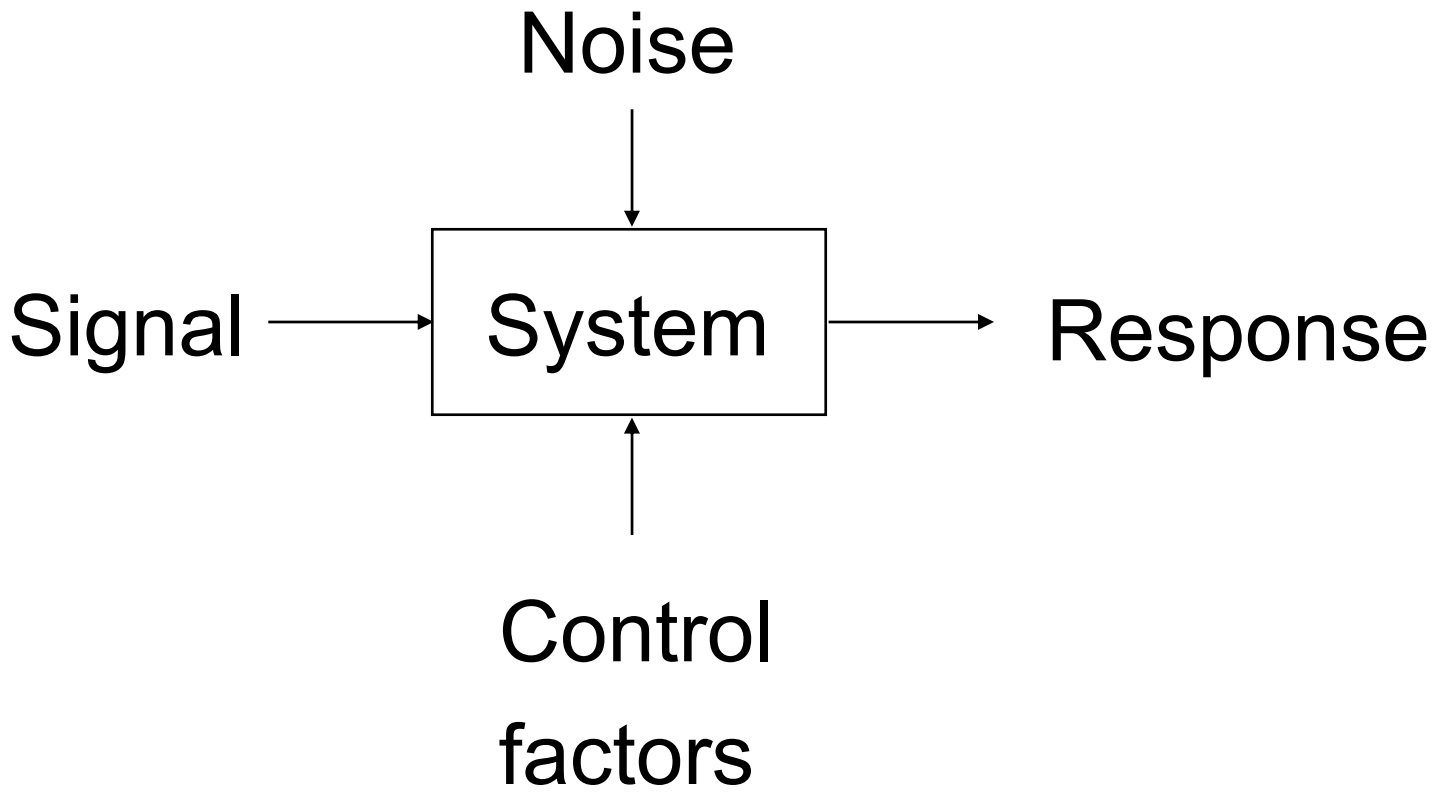
Fig. 6

Case 1 and Case 2

- Both cases have same failure rate
- But situations are very different
- Counting failure rate is very weak approach to the reduction of failure rate
- Concentrate on ideal function –
  What is the system supposed to do?
- Then make system do it all of the time



The engineered system



Ideal function

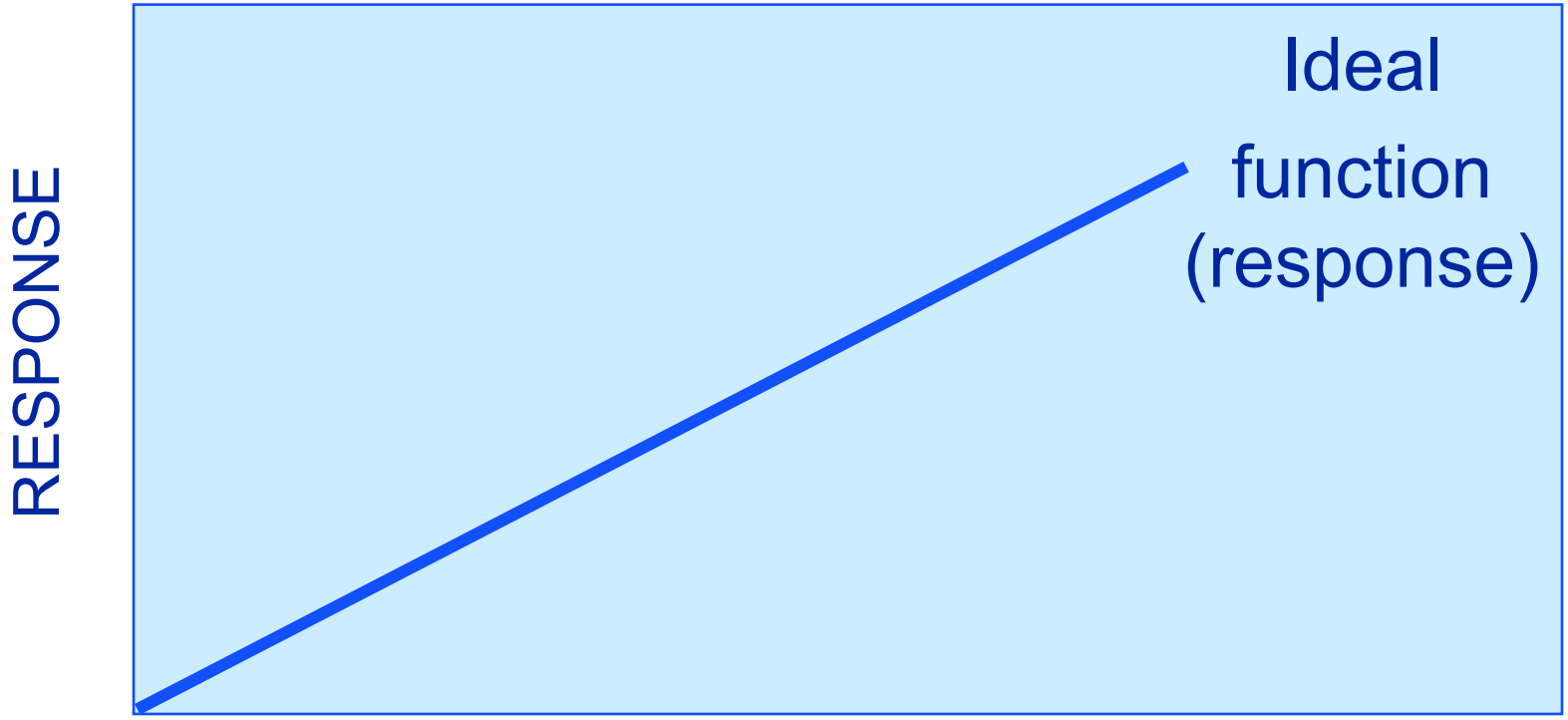


Fig. 9

Actual response

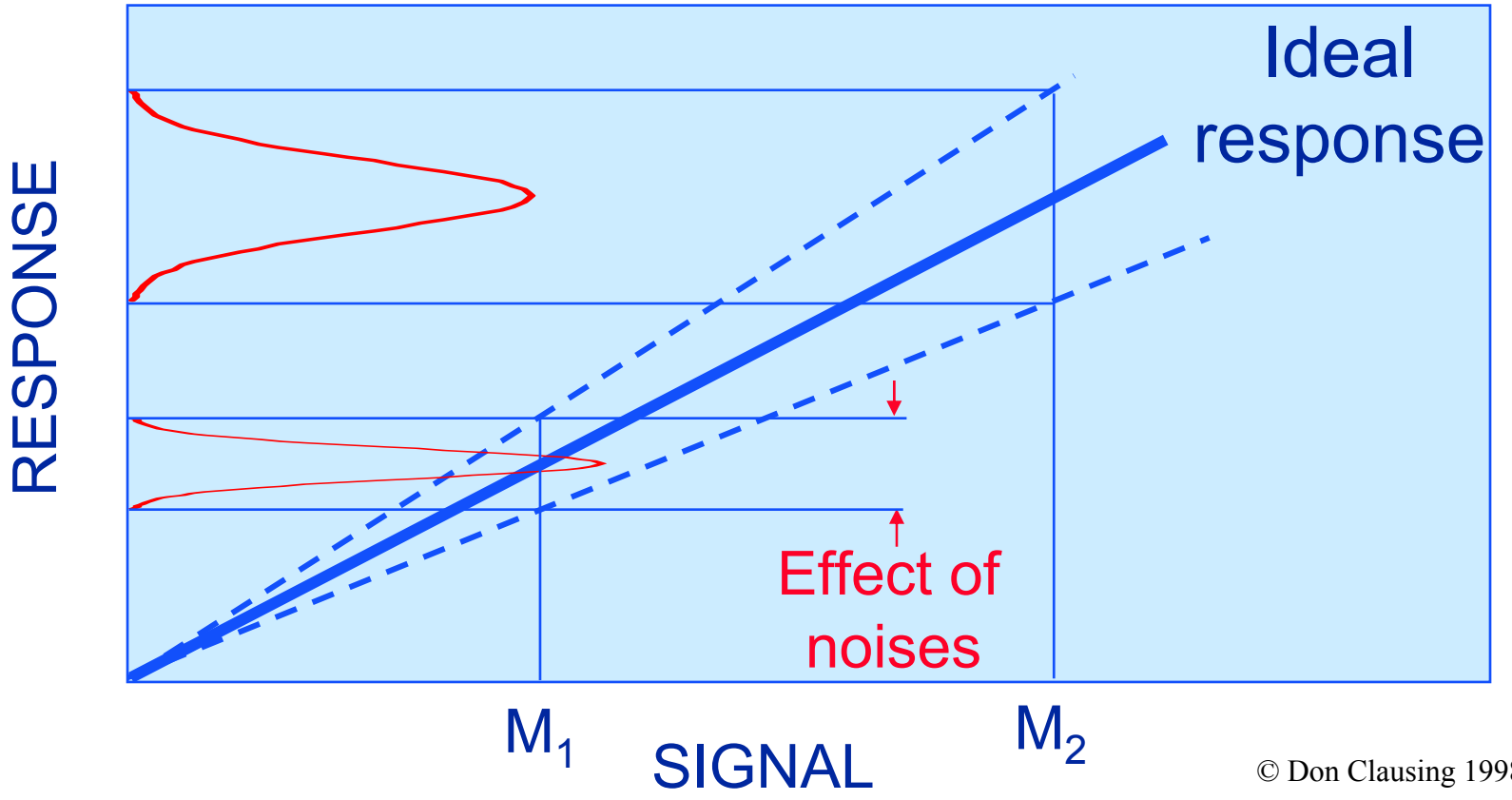
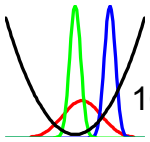


Fig. 10

Keep performance close to ideal

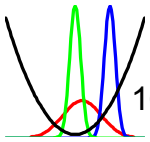
- Identify ideal performance (function, response)
- Then make actual performance stay as close as possible to ideal
- Linear response is called “dynamic” – desired value for response depends on input value of signal



Examples of dynamic response

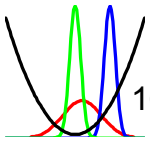
- Car turning radius
- Car stopping distance
- Copy quality
- Casting
- Electrical resistance

What are the signals?



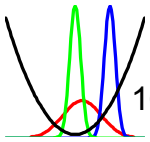
Case study – hitch

- Used to connect implements to tractor
- Transmits power from tractor to implement
- We can all see its function
- But what is a good engineering statement of its function?



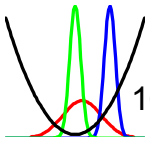
Functions of hitch

- Provide mechanical interface with implement
- Provide proper vehicle performance
- Meet ISO dimensional requirements
- Protect people from moving parts



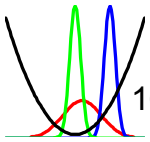
More detail on first function

- Provide adequate performance in working range
  - Proper attitude through working range
  - Provide adequate depth
  - Provide adequate lift capacity at breakout
  - Provide Draft Control
- Provide adequate performance in transport mode
  - Provide adequate height
  - Provide proper kick angle
  - Provide adequate lift capacity at transport
- Provide easy hookup and disconnect
- Provide easy linkage adjustments



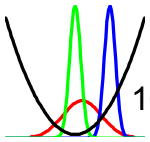
Yes, but what is ideal function?

- Meet ISO dimensional requirements
- Protect people from moving parts are important generic requirements, but are not elements of the ideal function.



Functions of hitch

- Provide mechanical interface with implement
- Provide proper vehicle performance are related to ideal function. Candidate for ideal function:
  Transmit load



Forces on system

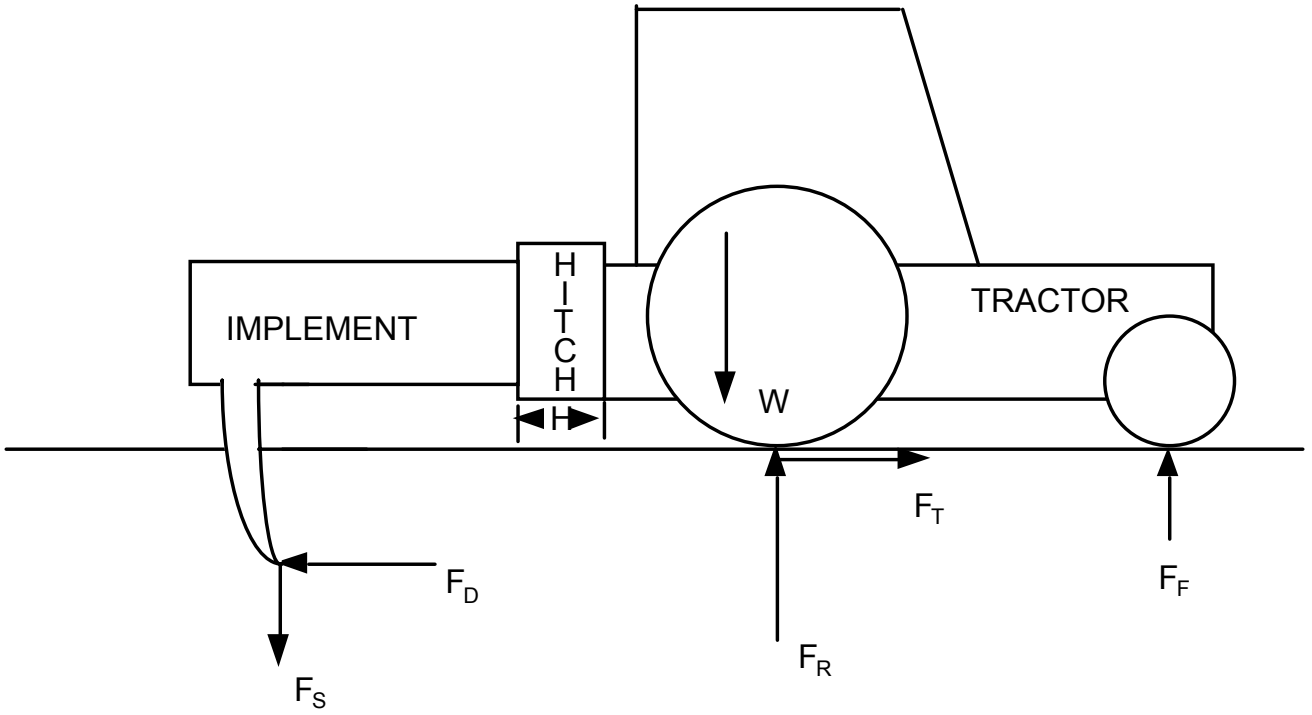
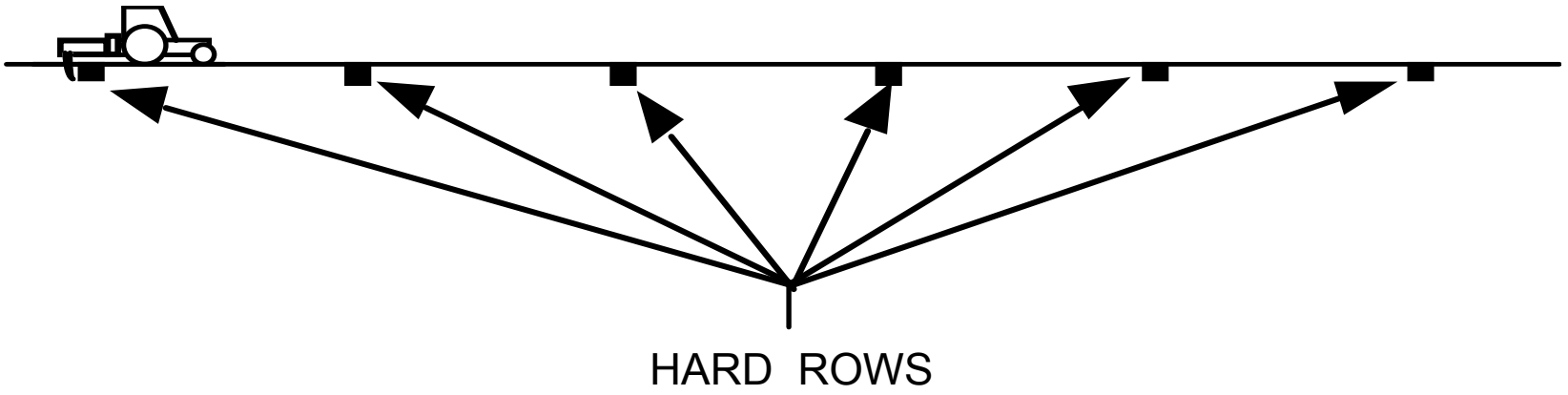


Fig. 18

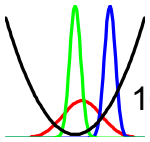
Noises in the field



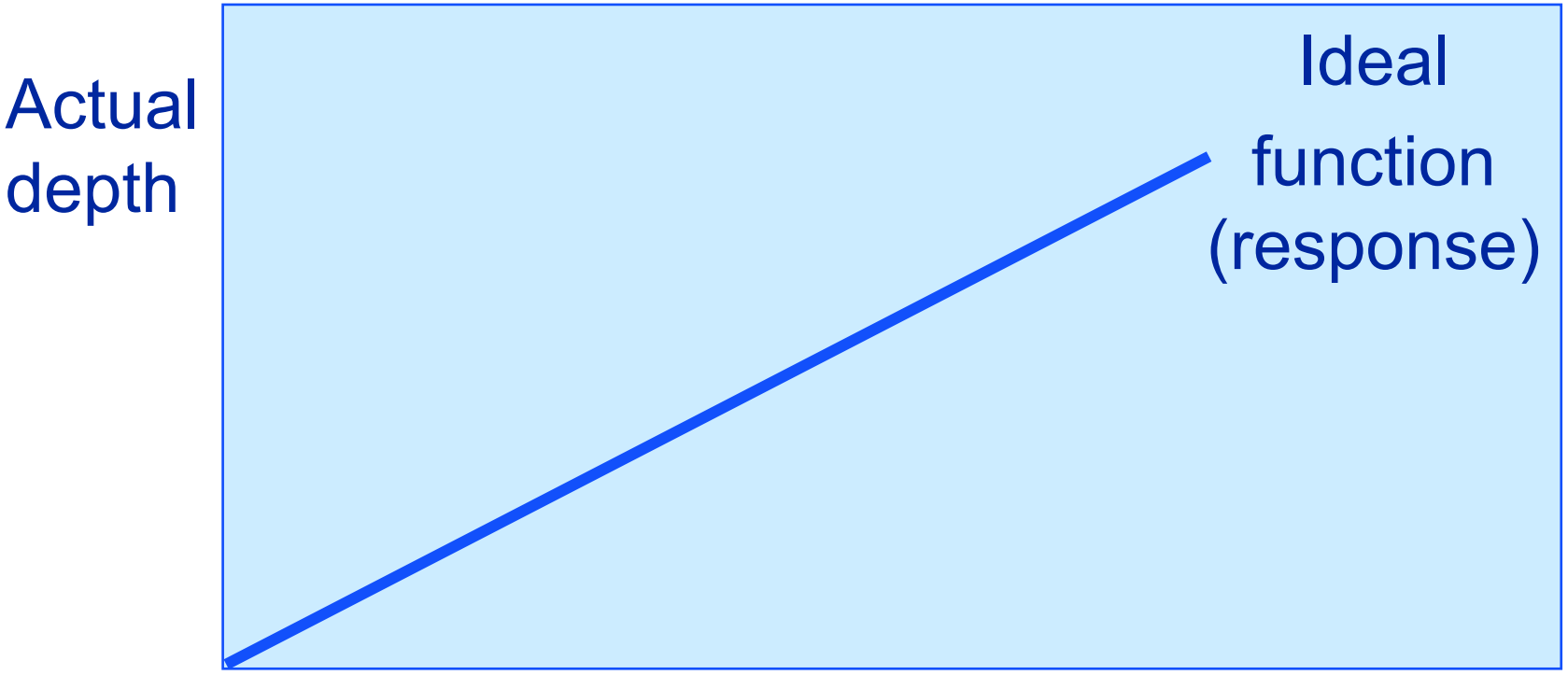
- Change in earth impedance causes forces to change
- Which changes do we wish to minimize?

Keep what constant?

- Constant force?
- Constant depth of engagement into the soil?
- Constant power?

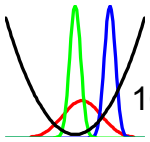


Candidate ideal function



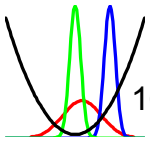
Determination of ideal function

- Identify the performance variations that we would like to go to zero
- The performance that remains when the undesirable variations are zero is the ideal performance
- In the hitch case further analysis, tests, and discussions with customers are needed to identify (verify) ideal function



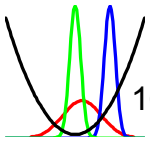
Ideal function

- Want Ideal Response to Signal – usually straight-line function
- Definition is often not trivial
- In the absence of explicit definition the objective of improvement activities is unclear; success unlikely



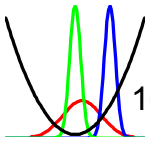
Signal/noise ratio

- Measure of deviation from ideal performance
- Based on ratio of deviation from straight line divided by slope of straight line
- Many different types – depends on type of performance characteristic
- Larger values of SN ratio represent more robust performance



Summary

- Knowing ideal function is crucial for success – we have to know where we are trying to get to, or it is unlikely that we will get there in a reasonable time
- Requires detailed engineering analysis of conditions for customer satisfaction



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