

There's no such thing as **NON**-model-based Systems Engineering

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Chesapeake INCOSE

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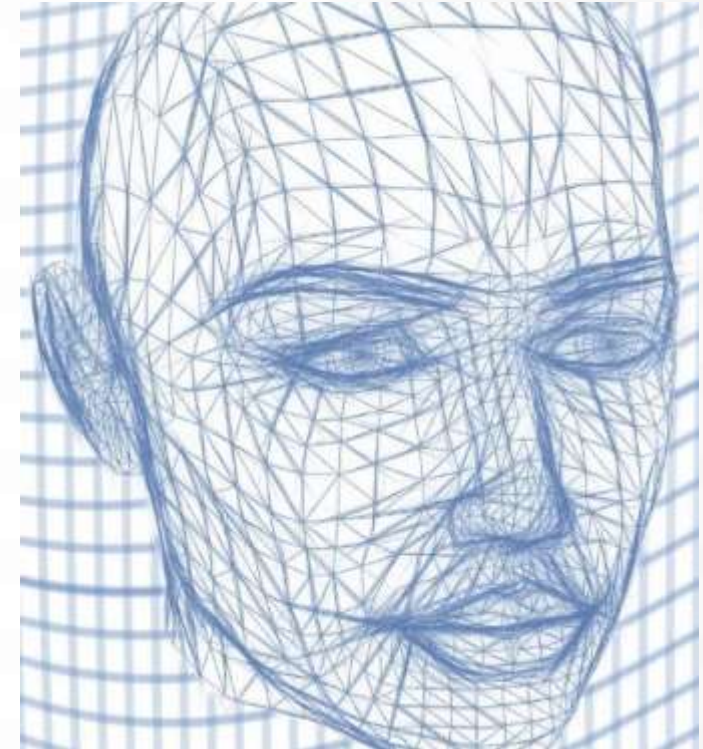




How do we use models?

How do we use models? Thinking . . .

“Well, the first rule is that you can’t really know anything if you just remember isolated facts and try and bang ’em back. If the facts don’t hang together on a latticework of theory, you don’t have them in a usable form. You’ve got to have models in your head. And you’ve got to array your experience both vicarious and direct on this latticework of models. . . . You’ve got to hang experience on a latticework of models in your head.”



-Charlie Munger

Latticework offers organization and context

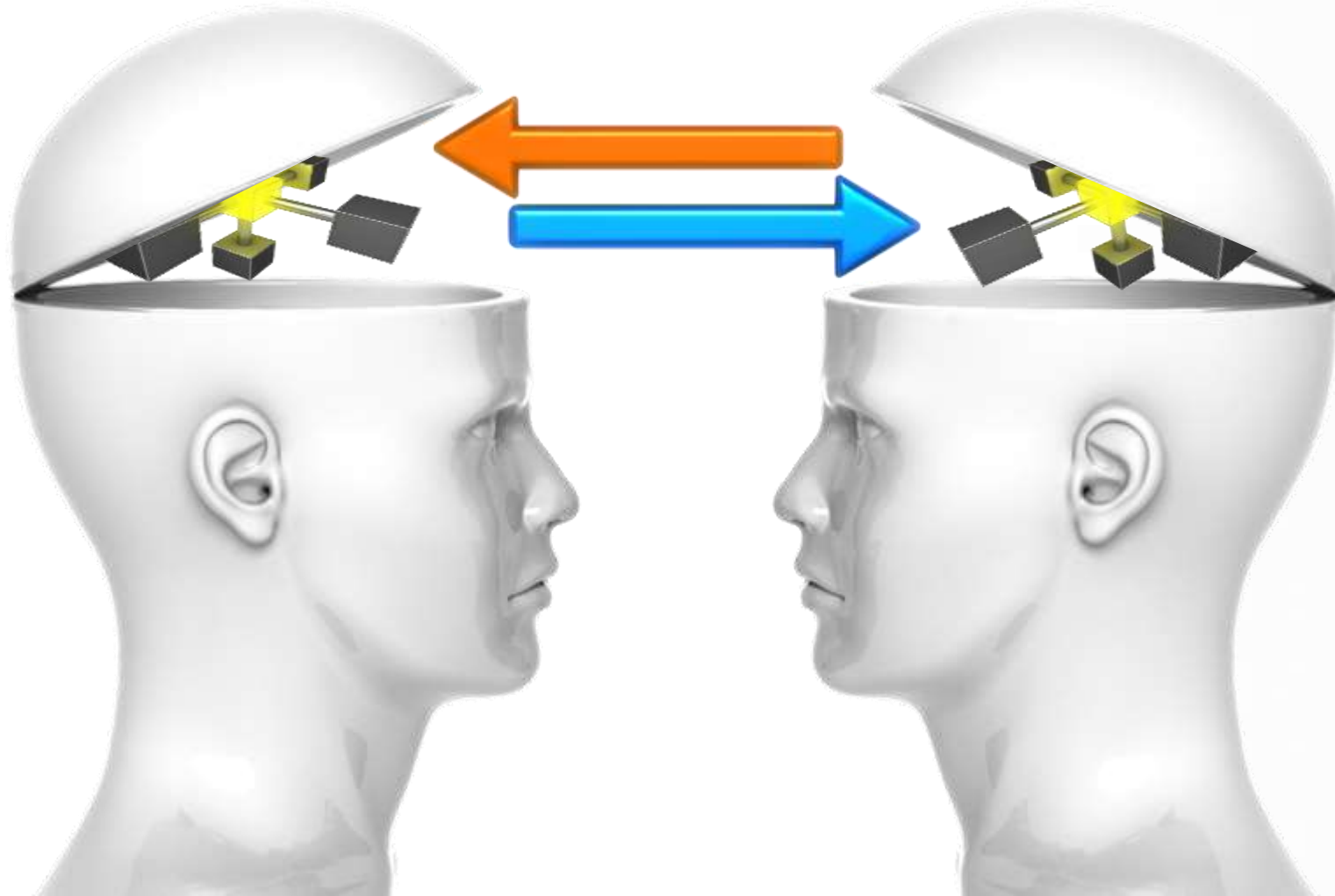


How do we use models? Communication . . .

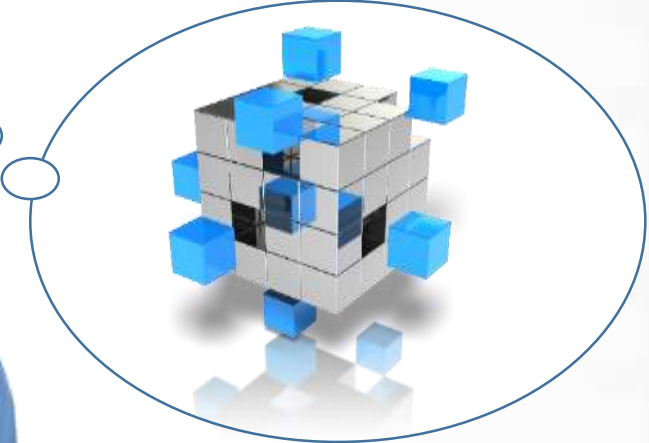
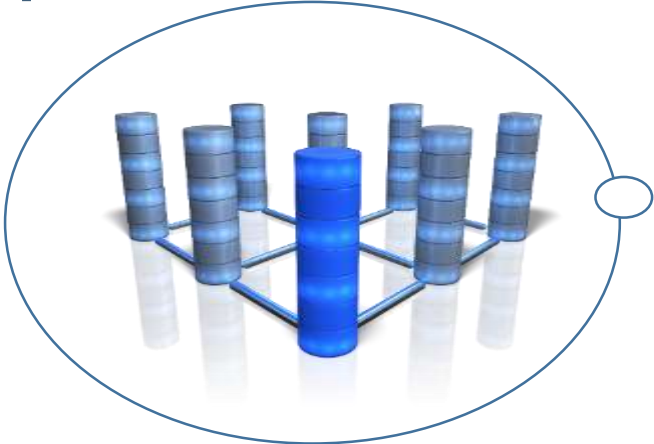
Purpose: to transfer information from sender to receiver



The object of communication



Impediment to communication . . .



HORSE



HORSE



HORSE

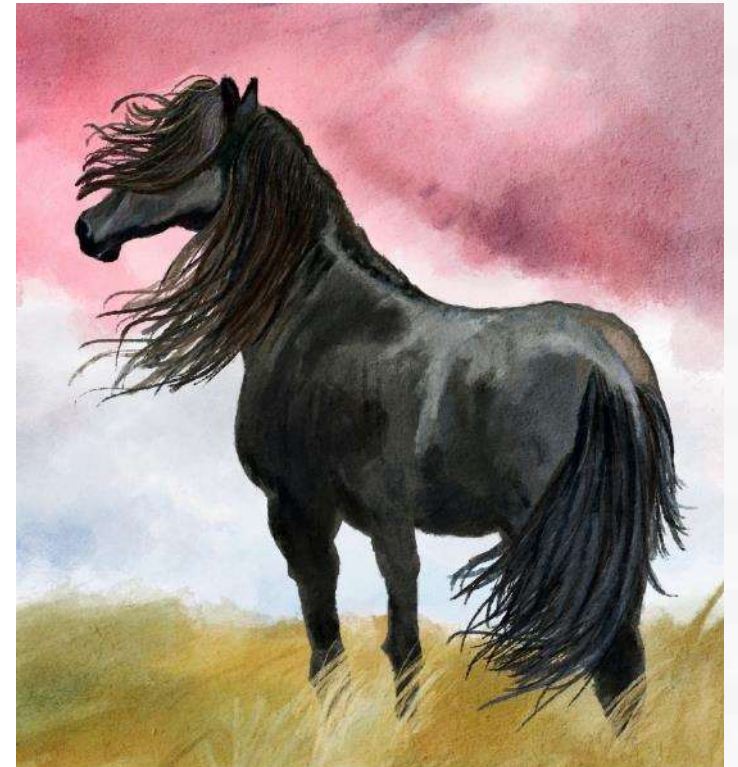


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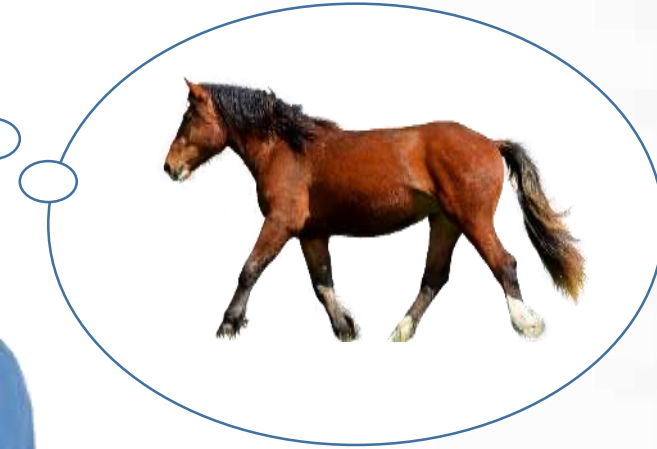




HORSE



How could this be an impediment to communication?



How could color/breed possibly matter?



Surfacing the model aligns communication





What is a model?

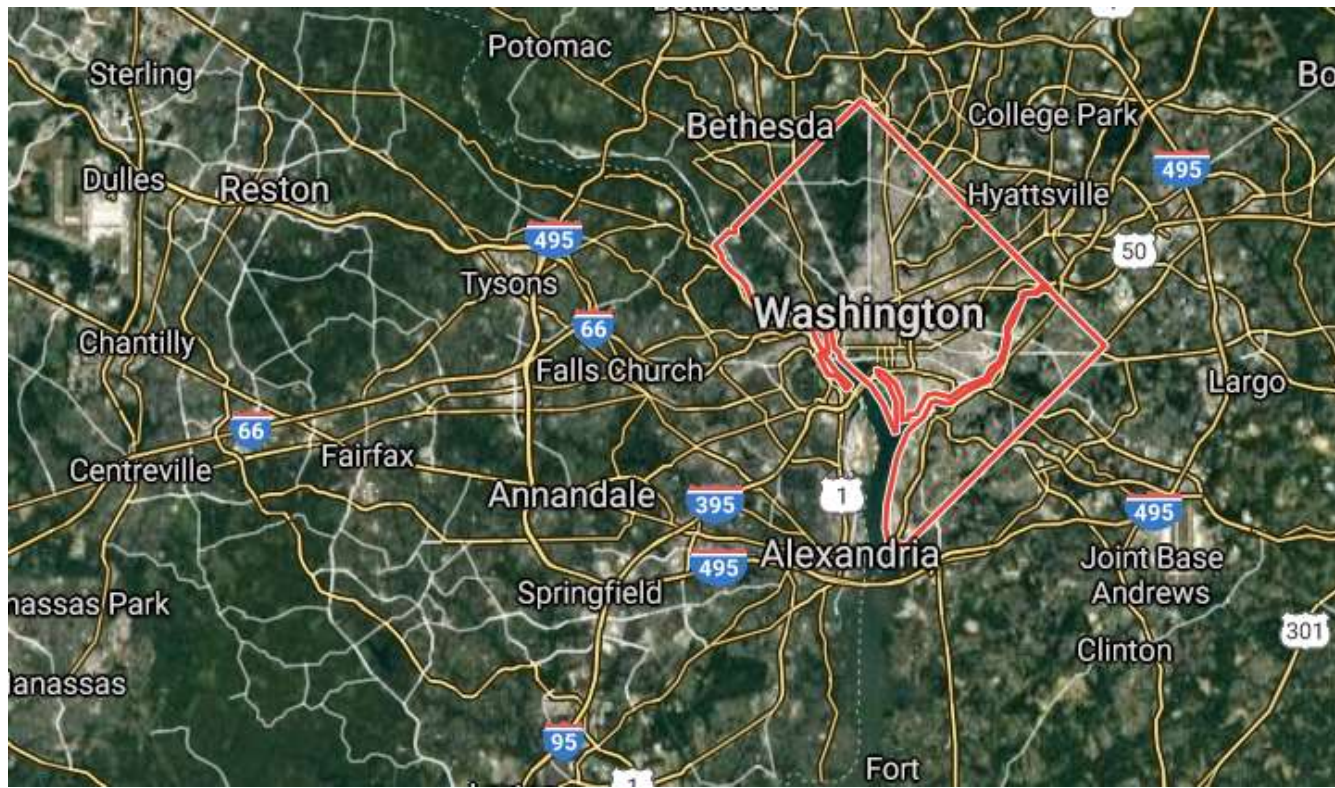
What is a model?

A model is a limited representation of a particular reality

Key word: **limited**

“A map is not the actual territory”

Alfred Korzybski, A Non-Aristotelian System And Its Necessity For Rigour In Mathematics And Physics



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Confusion- Model becomes reality

I am an INFJ!

So? I'm an ESPN!



Reminder- George E.P. Box



“All models are wrong but some are useful . . .”

Representations are NOT reality

Hence, models are “wrong” by definition . . .

The test of a model- George E.P. Box



“All models are wrong but some are useful . . .”

“. . . the practical question is, ‘How wrong do they have to be to not be useful?’”

The farmer and the engineer . . .



The farmer and the engineer . . .

I think I can help!



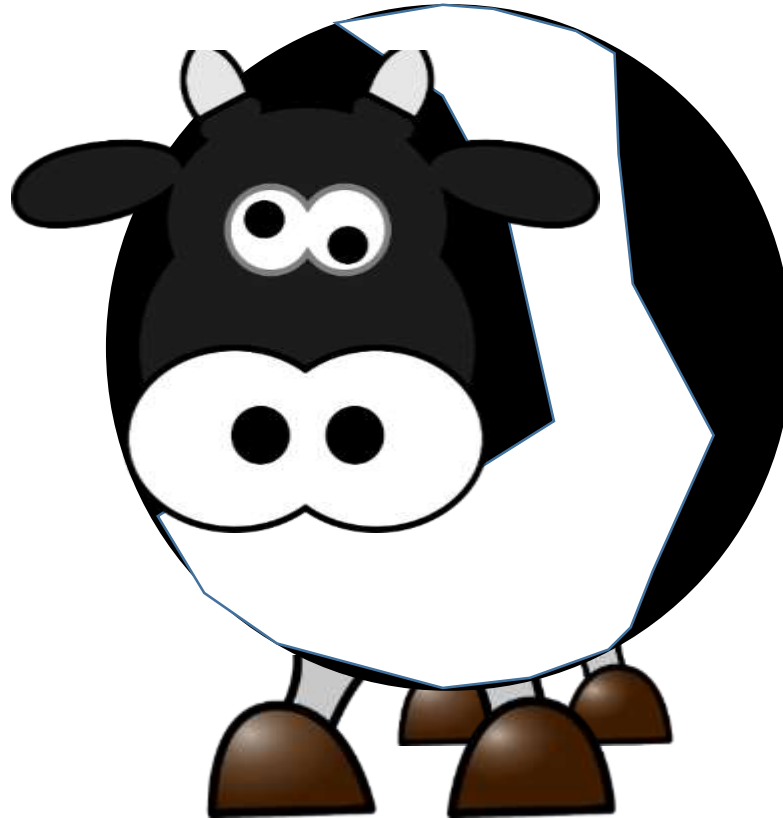
Two weeks later



I have an answer!



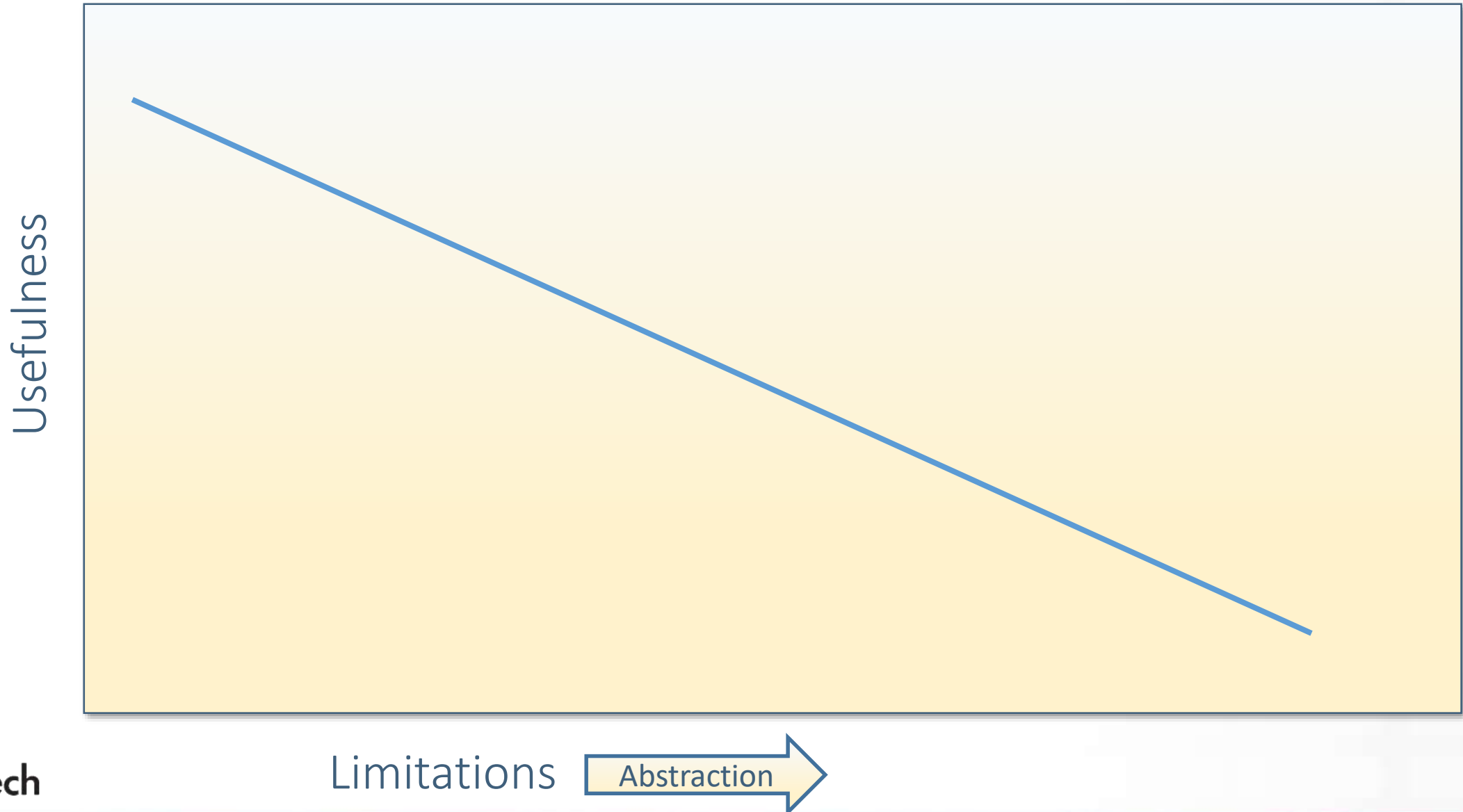
Some assumptions. . .



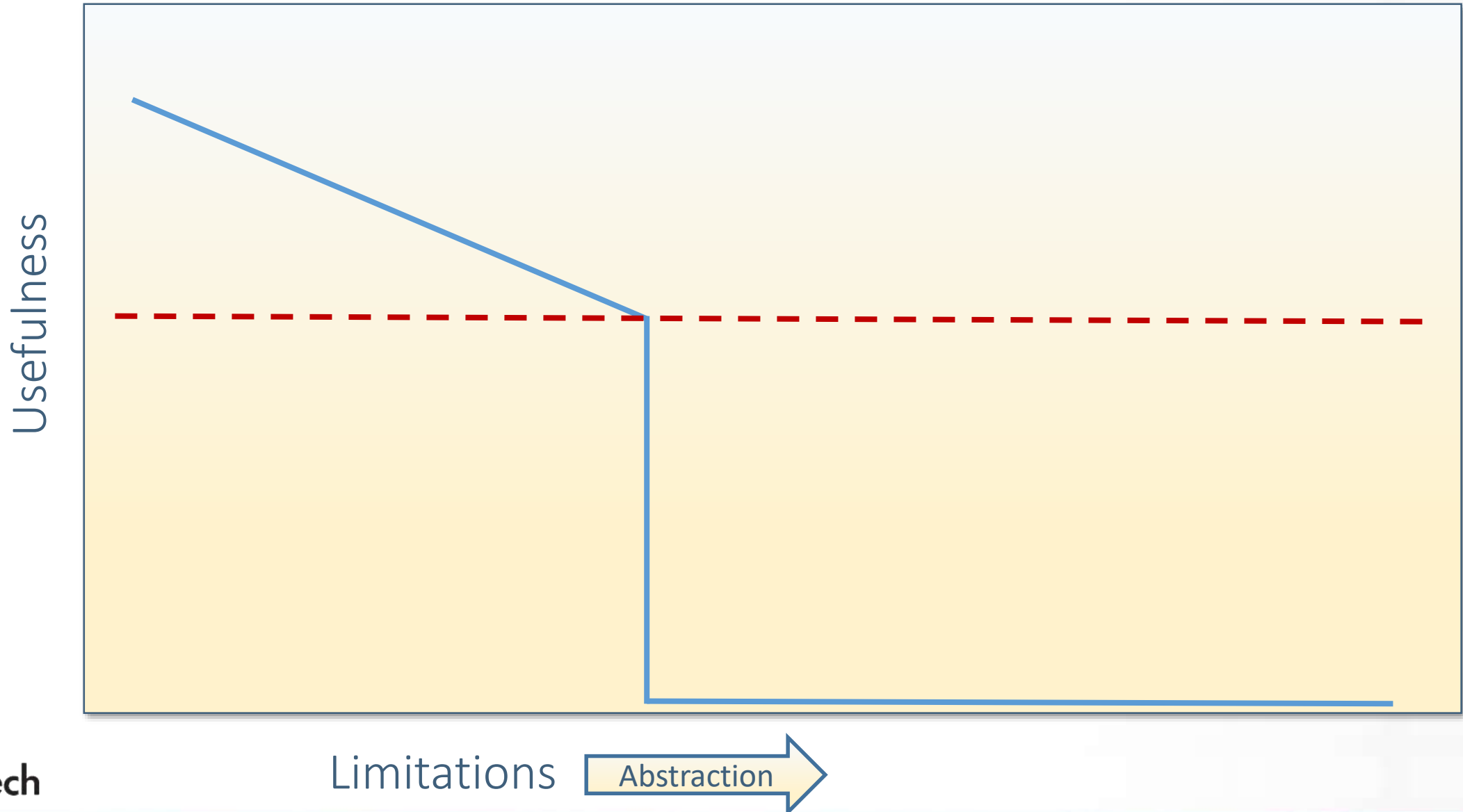
First we assume a spherical cow . . .



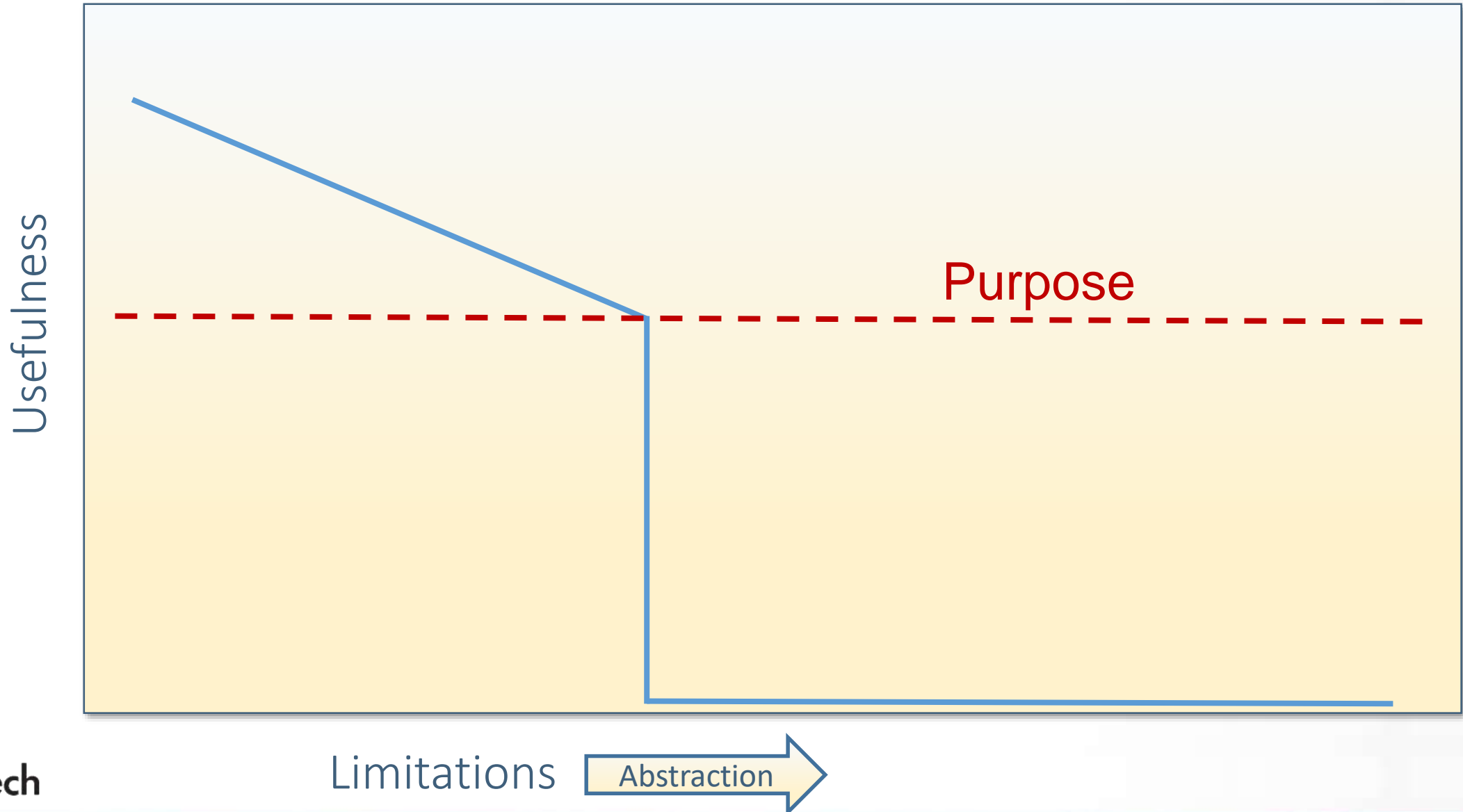
“How wrong do they have to be to not be useful?”



“How wrong do they have to be to not be useful?”



“How wrong do they have to be to not be useful?”



This map is “wrong” . . . but is it useful?



It's not to scale

Points don't align in relationship to each other

But . . .

Metro stops are in order so

IF it's intended use is to tell where you are in relation to where you want to be . . .

It is useful!

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What is a system model?

First . . . What is a system?

INCOSE Definition

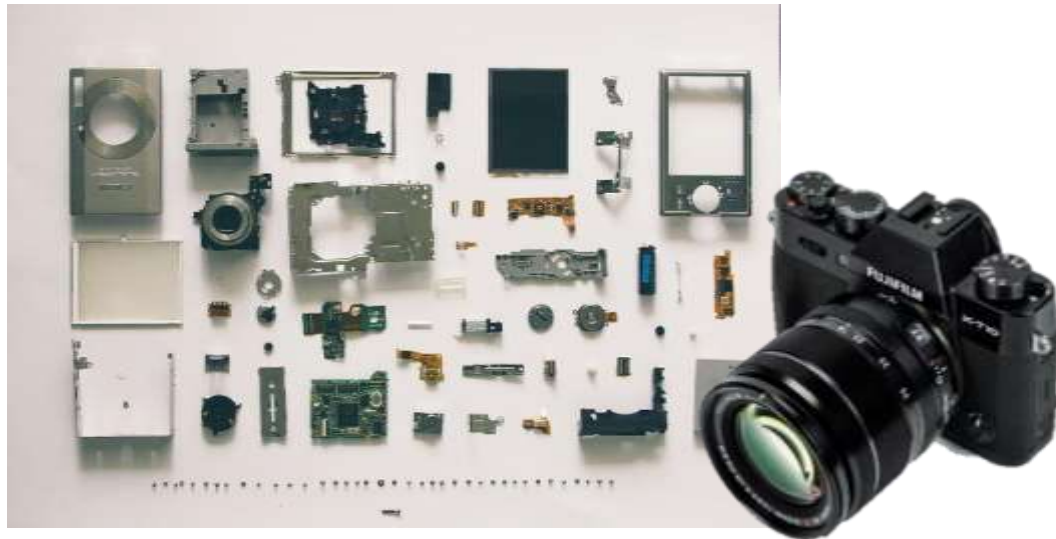
A system is an arrangement of parts or elements that together exhibit behavior or meaning that the individual constituents do not.

<https://www.incose.org/about-systems-engineering/about-systems-engineering>

Taking the systems view

“First, systems thinking is the view that systems and problem situations cannot be addressed through reducing the systems to their component parts . . .

Second, systems thinking is a process: an ordered, methodical approach to understanding problem situations and identifying solutions to these problems.”



Robert Edson, *Systems Thinking Applied* p.5

A Warning!

“According to the systems view, the essential properties of a . . . system, are properties of the whole, which none of the parts have. They arise from the interactions and relationships among the parts. **These properties are destroyed when the system is dissected, either physically or theoretically, into isolated elements.** Although we can discern individual parts in any system, these parts are not isolated, and the nature of the whole is always different from the mere sum of its parts.”

Fritjof Capra, *The Systems View of Life*





What makes a system model useful?

Making useful system models

- Purpose- the purpose of systems engineering is to make a prediction as to whether a specific design will satisfy the stakeholder needs
- To be useful the system model must help to make that prediction
- Questions:
 - How will the design behave?
 - Will that meet the stakeholders' needs?

Useful system models- Characteristics

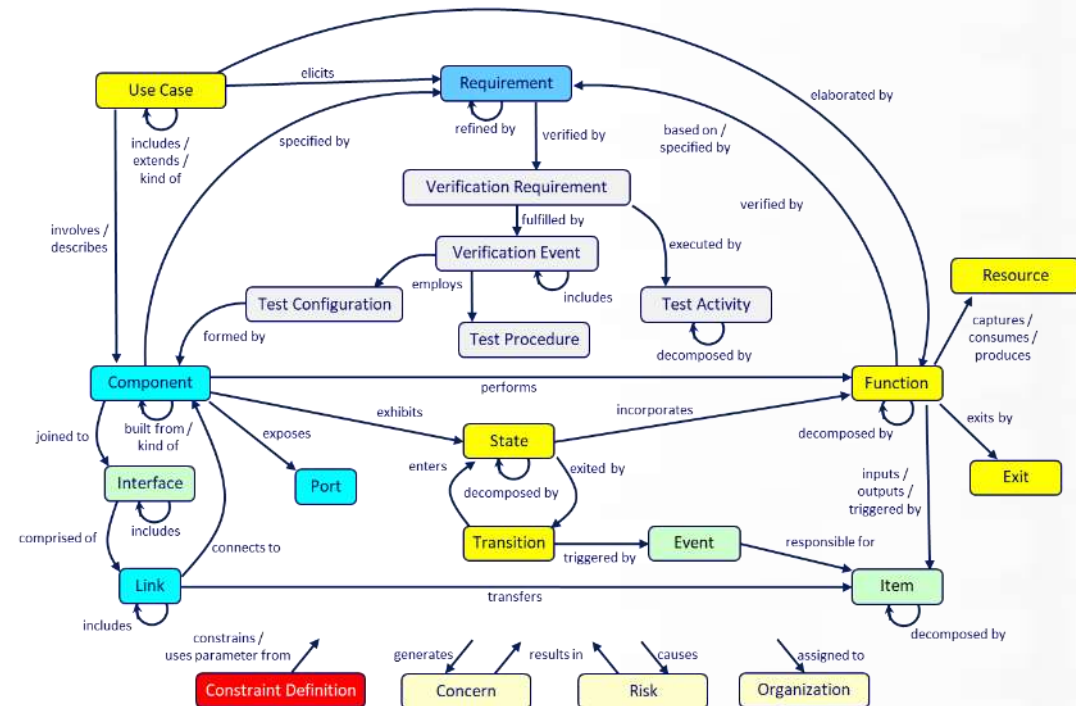
- Offers a system view
- Complete and consistent
- To be useful the system model must help to make that prediction
- Questions:
 - How will the design behave?
 - Will that meet the stakeholders' needs?



Making them useful

Making useful system models

- System (design) behavior emerges from the interactions (relationships) of the system elements
- To predict what that behavior will be, the model must show the elements in full relationship

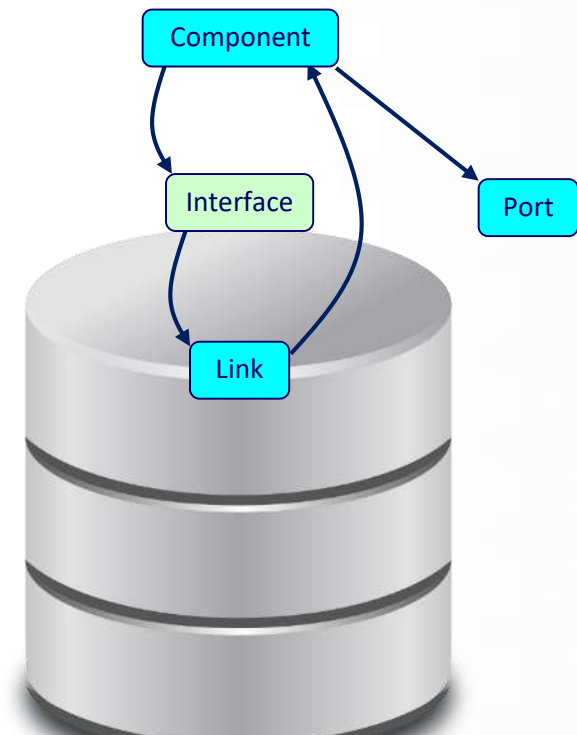
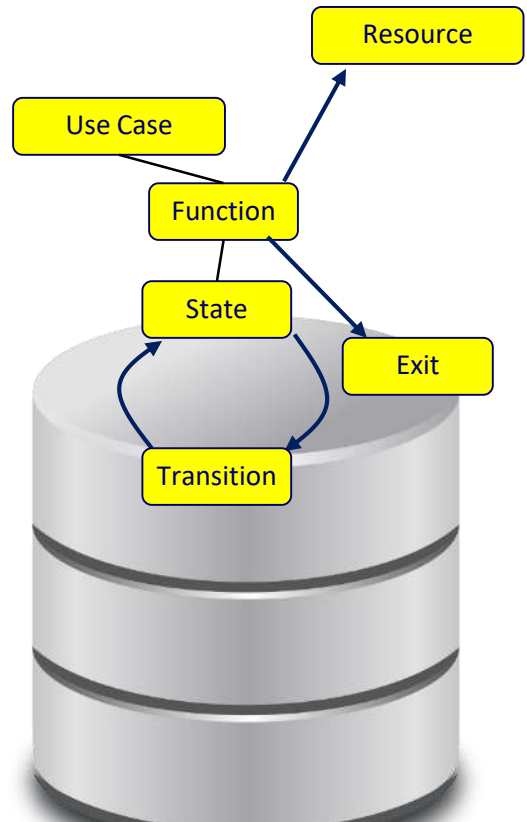


Making useful system models- Issues



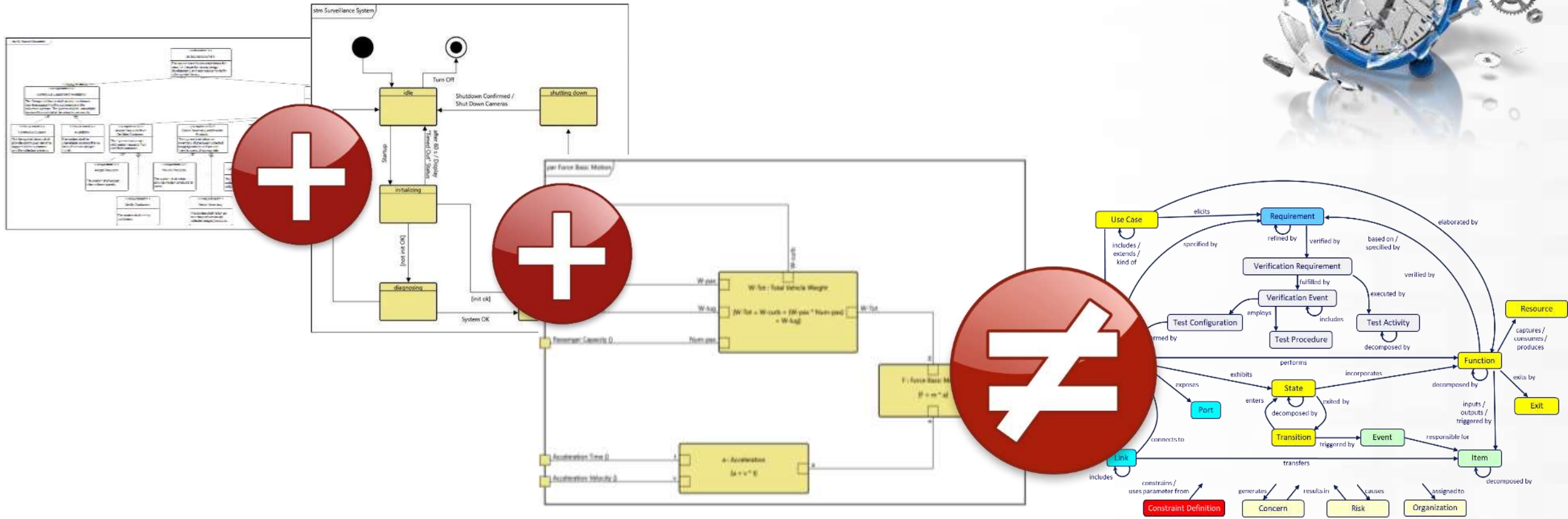
Failure to provide a clear system view leads to an inability to predict its behavior

Issue: Many Models/Many Tools



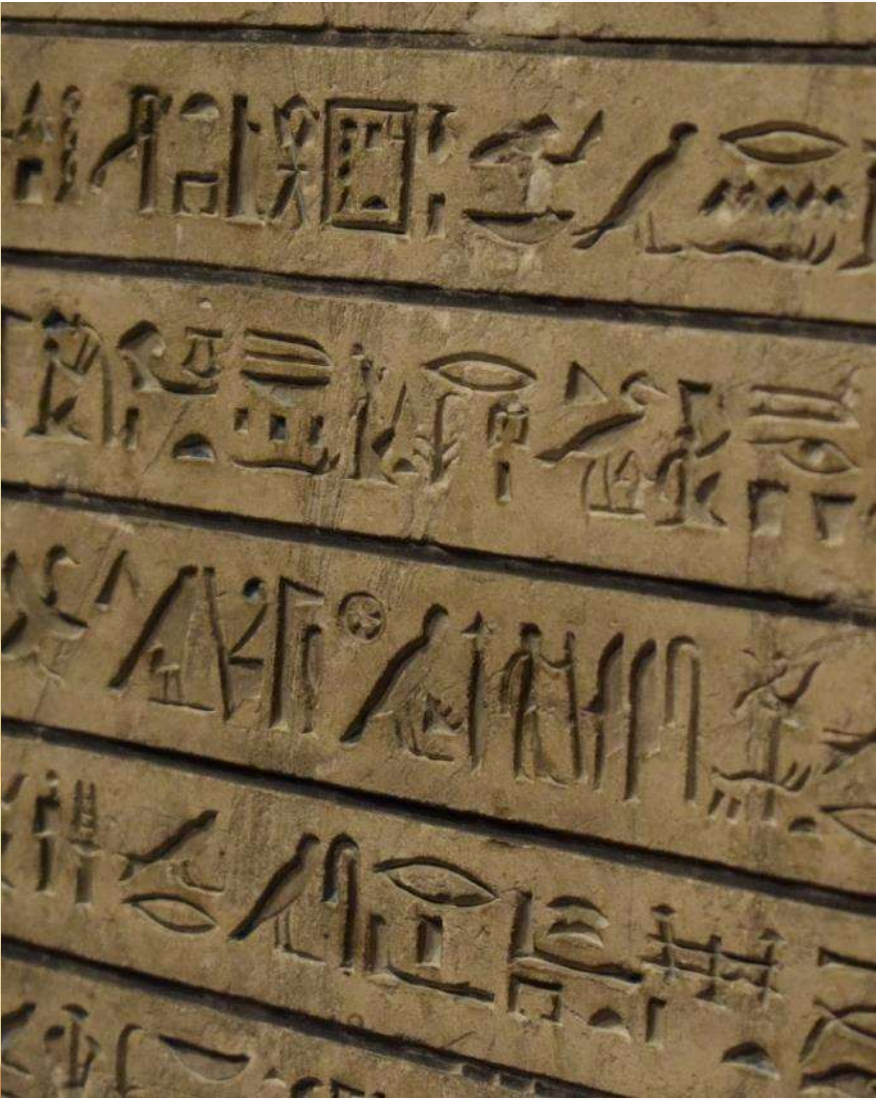
“ . . . properties are destroyed when the system is dissected, either physically or theoretically, into isolated elements”

Issue: Fallacy of Several (9 or Many) Views



“ . . . properties are destroyed when the system is dissected, either physically or theoretically, into isolated elements”

Issue: Standardize on arcane expression

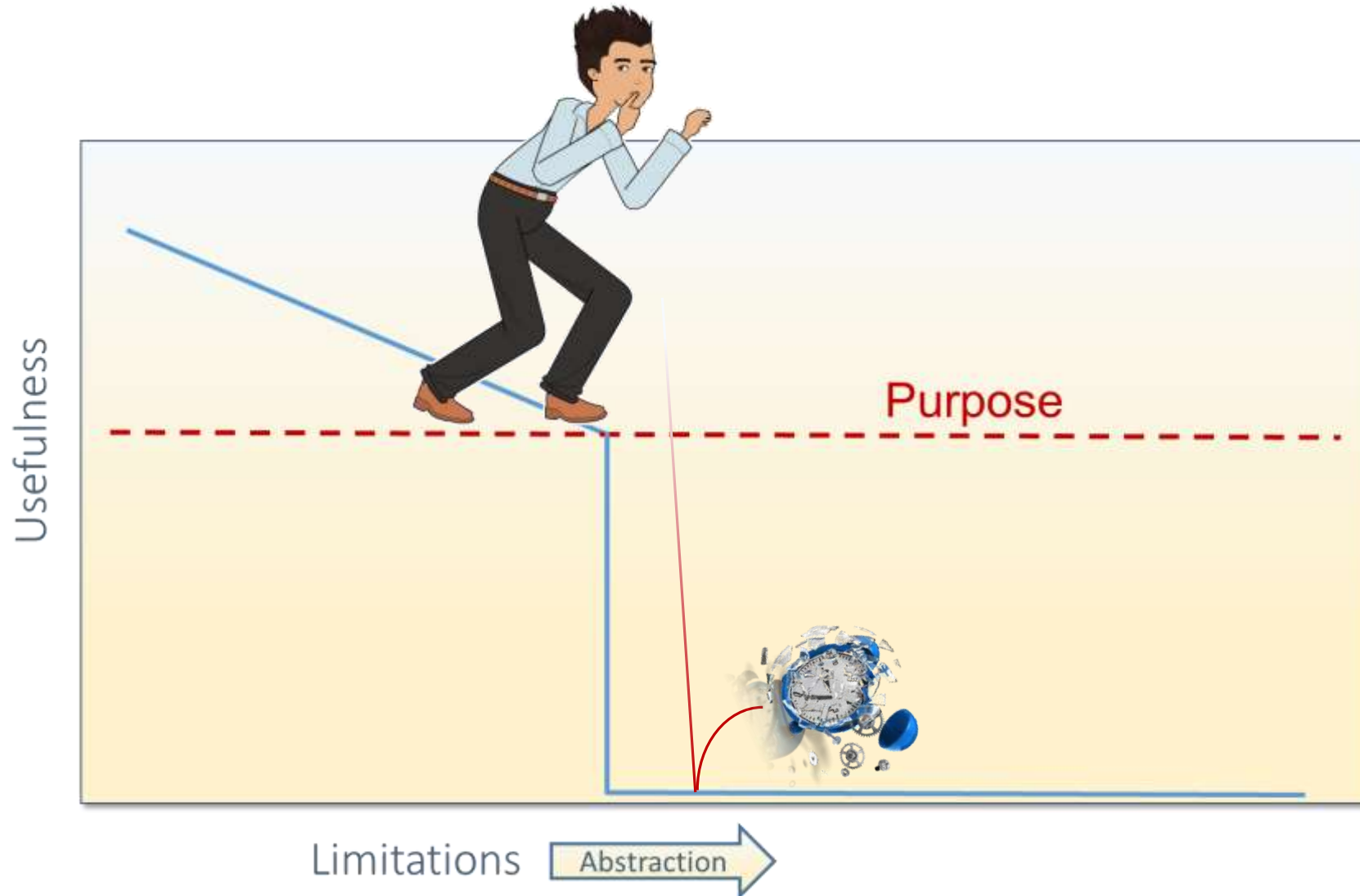


Issue: Oversimplification

See Spot run . . .



Issues: Effects



Can't see system

Can't think

Can't communicate

Can't predict



Takeaways

Conclusions

- Models help us think and communicate
- To think about systems we need to be able to see them in whole not in parts
- We need to make predictions about possible solutions
- We need to communicate our ideas findings and conclusions to a variety of others

Lessons

- A wide audience needs a wide vocabulary- don't constrict it
- A wide audience needs clarity- don't obfuscate with arcane expressions
- A complex system/subject needs a rich vocabulary- don't oversimplify it
- A system needs to be seen in whole- don't fragment it
 - With multiple tools per model
 - Views without a database model underpinning them

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Thank You!

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