

# **'System Components' as a litmus test for your ontological architecture**

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Ontology for Big Systems &  
Systems Engineering

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# Session focus

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- “In this session, we will focus on two topical areas in particular: (37R9)
  1. have a discussion on system components ... and, (37RA)
  2. have a discussion on the requirements for engineering modelling languages, and the shortcomings of what is available. (37RB)”
- I will focus on the first item; system components.
- ‘Components as a litmus test for your ontology: in particular, your ontological architecture’

# Why ontological architecture?

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- Building a large scale systems without some kind of organisation guarantees a disaster.
- Building an ontology for a large scale system without some kind of organisation guarantees a disaster.
  - Another name for ontology organisation is ontology architecture
  - A sensible basis for ontological architecture is the principles that organise it.
    - Sensible to make these explicit
    - Sensible to consciously decide on these principles
- Some references for ontological architecture:
  - Partridge, C. (1996). Business Objects: Re - Engineering for re - use. Oxford, Butterworth Heinemann.
  - Partridge, C. (2002). LADSEB-CNR - Technical report 06/02 - Note: A Couple of Meta-Ontological Choices for Ontological Architectures. Padova, LADSEB CNR, Italy - <http://www.borosolutions.co.uk/research/content/files/ladseb-t-r-06-02.pdf/view?>
  - Salim K. Semy, Mary K. Pulvermacher, Leo J. Obrst. September 2004. Toward the Use of an Upper Ontology for U.S. Government and U.S. Military Domains: An Evaluation. DOCUMENT NUMBER MTR 04B0000063, MITRE TECHNICAL REPORT
    - p. 3-10 Table 2. Ontological Choices Summary.
      - Recap of (2002) paper above.

# Why individual litmus tests?

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- Easy for architectural principles to become 'abstract'
  - Lose connection with reality
  - Lose understanding of connection with reality
- Some individual cases offer a good way to illustrate and test these architectural principles.
  - System components are one of these
    - See what principles are in play
    - See how these principles operate
- Some references for system components:
  - Partridge, C. (2002). LADSEB-CNR - Technical report 04/02 - What is pump facility PF101? Padova, LADSEB CNR, Italy.  
<http://www.borosolutions.co.uk/research/content/files/ladseb-t-r-04-02.pdf/view?>
  - Partridge, C. (1996). Business Objects: Re - Engineering for re - use. Oxford, Butterworth Heinemann.

# The litmus test approach

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- Stages:
  1. Set up the example
  2. Identify the (ontological) issues and principles at stake
  3. Clearly identify the ontological (metaphysical) architectural choices made
    - Show how these impact the example
- From a large scale system perspective,
  - test fails if one cannot deliver on stages 2 and 3.
    - The architectural choices need to be made explicit and their impact made clear
- The role of intuition (and natural language)
  - The man in the street's intuitions are useful here as a starting point for their understanding
  - In terms of the final result, they are just as useful as in other large scale projects
    - E.g. Engineers building a new offshore oil rig.

# Setting up the example

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- Situation
  - There is a car.
  - It has a front right tyre.
  - When the car was built, a tyre was 'installed' in the front right side of the car.
  - At some point in time, this tyre was taken off and a new tyre installed.
- Count the objects ... (hopefully this is not contentious)
  - #20 – car (system).
  - #25 – car's front right tyre (system component).
  - #21 – original tyre.
  - #22 – replacement tyre.
- Obvious puzzle
  - Seem to be too more objects than you see when you look at the car
  - What is the connection between the system component tyres and the 'manufactured' tyres?

# Ontological issues and principles in play

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- Can two things be in the same place at the same time? (Makes pointing difficult)
  - The original tyre and the car's right hand tyre seem to be for a while.
  - Principle: identity (and difference) at a time
    - Associated principle: Nature of change over time.
- Can the same thing be different at different times? (Makes re-identification difficult)
  - The car has different tyres as parts at different times.
  - Principle: identity (and difference) over time
    - Associated principle: Nature of change over time.
- Are there different kinds of parthood?
  - The example has two kinds:
    - The car's right hand tyre seems to be an integral part of it, always part of it
    - The original (and new) tyres are only a part for a period of time, and not a part at other times.
  - Principle: relation between parthood and change over time

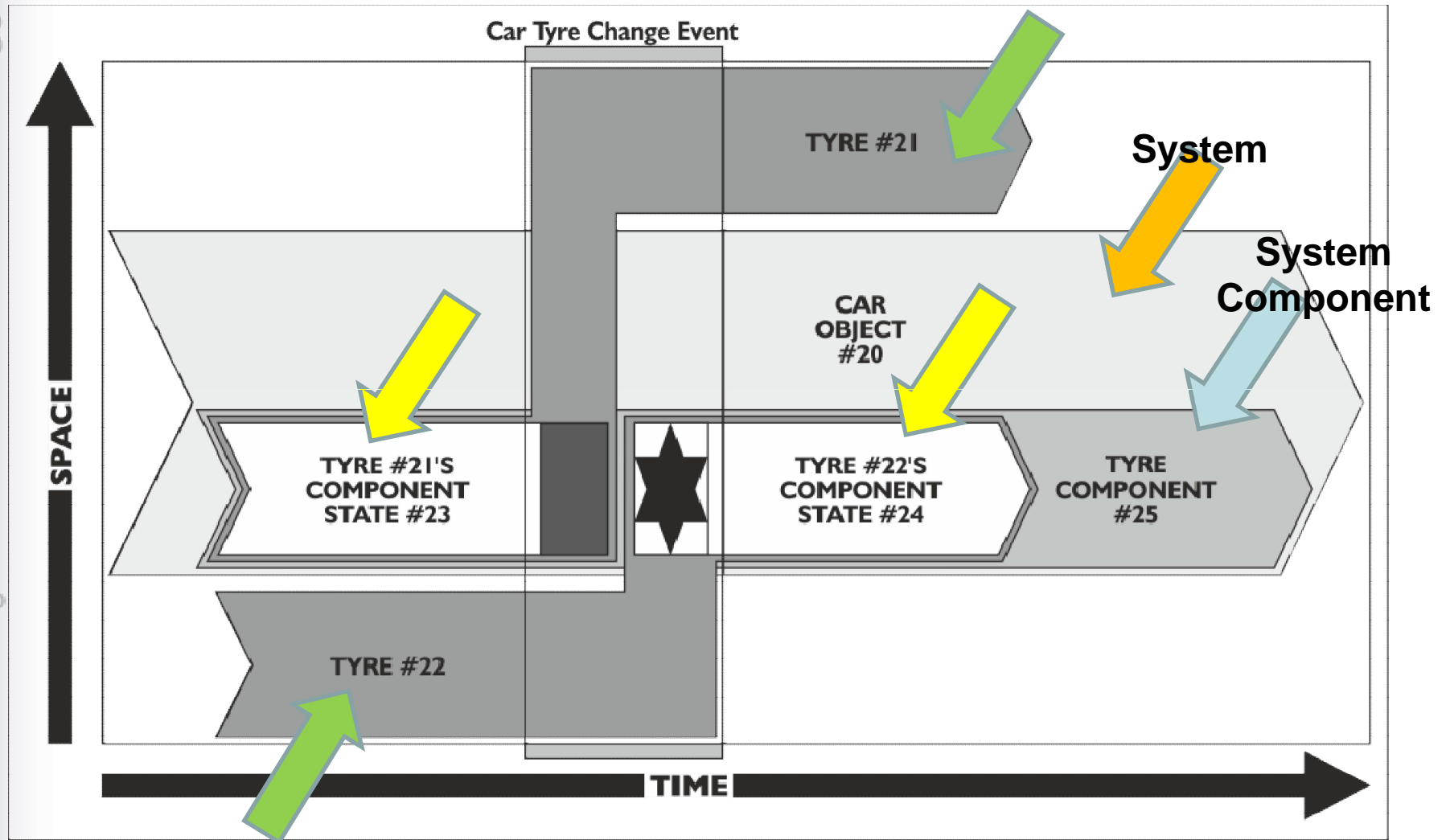
# BORO Approach - 1

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- Principle: Nature of change over time.
  - Issue:
    - McTaggart J., (1908) The Unreality of Time. 1908. Mind 17.68: 457–474.
      - Series A and Series B
  - Proposed solution
    - There are no 'real' changes - things are extended in time
      - Unreality of change
        - Change is just being different at different times
    - An extensive literature;
      - Noonan - 1976 - The Four Dimensional World, Analysis, 37: 32–39;
      - Heller - 1990 - The Ontology of Physical Objects, CUP;
      - Lewis - 1986 - On the Plurality of Worlds, OUP;
      - etc.



# Visualising the time extended objects



# Dissolving the issues - 1

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- Notice that the issues/question disappear under this approach.
- Can the same thing be different at different times?
  - Sure, a thing that is extended in time, can at particular times be different
- Are there different kinds of parthood?
  - The example has two kinds:
    - The car's right hand tyre seems to be an integral part of it, always part of it
    - The original (and new) tyres are only a part for a period of time, and not a part at other times.
  - Only one basic kind of parthood,
    - Can overlap at a time, but this is not the same as being a part.
    - Can rescue part-at-a-time by taking states or temporal parts (see space-time map)

# BORO Approach - 2

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- Identity – criterion of identity
  - Issue:
    - Criterion of identity was introduced by Frege (The foundations of arithmetic) and strongly emphasised by Wittgenstein (Philosophical Investigations).
  - Proposed Solution
    - Extensionalist criterion of identity
      - For individuals, their spatio-temporal extension is the criterion of identity
    - Common position in philosophy

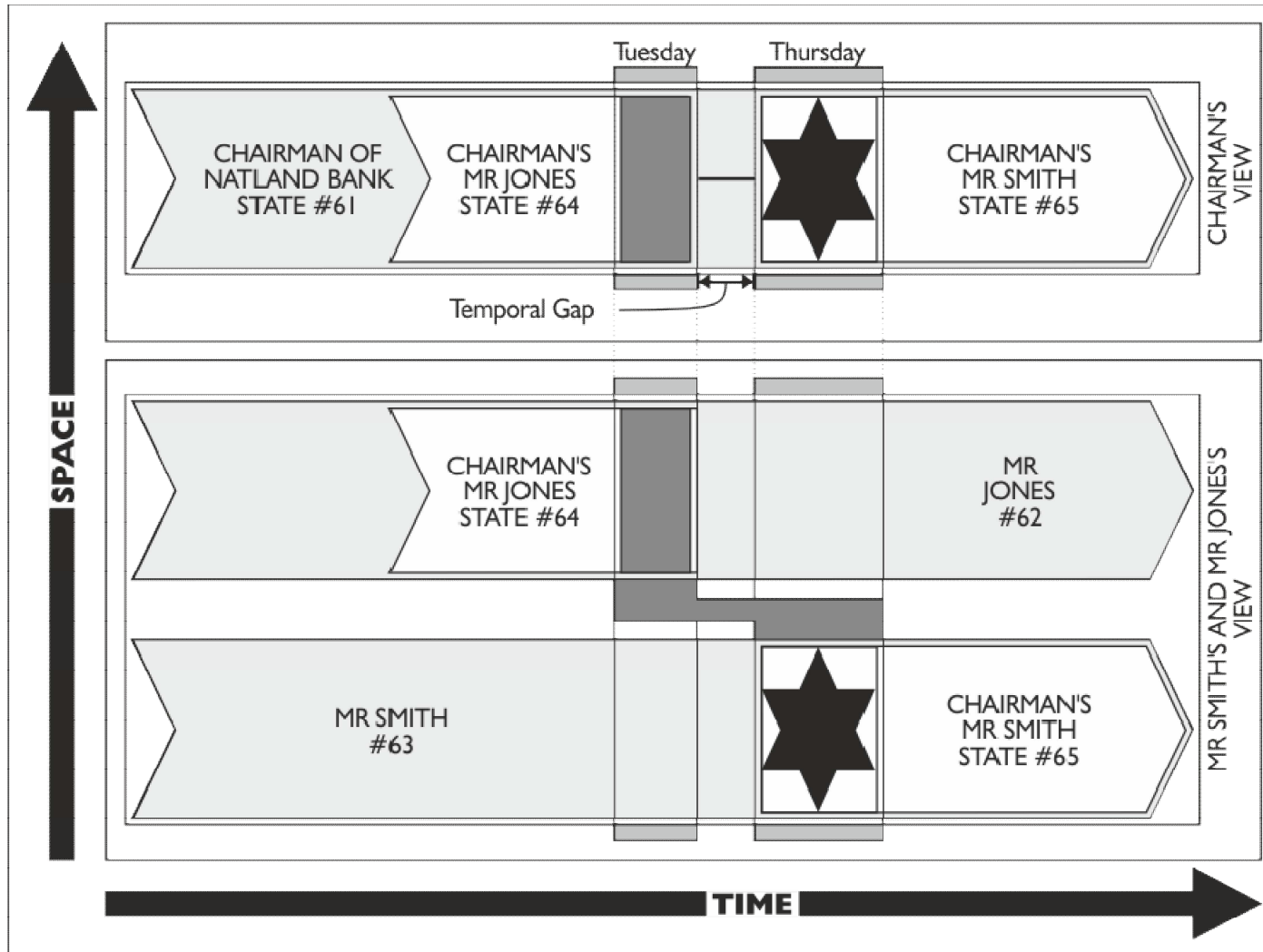
## Dissolving the issues - 2

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- Can two things be in the same place at the same time?
  - Sure, they can overlap completely for a period of time.
- But, can two things be in the same spatio-temporal extent?
  - Not if we adopt this extensional criterion of identity.
- We can see how space (and time) link to identity.

# Overlapping pattern is commonplace

Another example



# Corporation sole

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- Interesting ancient and well-established example, where the 'system component' does things and has rights.
  - Corporation sole
    - When acting properly, i.e. not ultra vires, in this official capacity then this person is acting as a corporation sole. ... These two manners of contracting are quite distinct one from the other and nothing effected in one capacity will affect duties or responsibilities in the other.
    - Introduced to enable the bishop to own property, rather than the office holder.
    - Extended to the monarch, so that (for example) the death of one office holder did not undermine the declaration of war. The office had declared war.
  - Interesting because an example of a system component (or social role) where the component/role quite clearly is intended to have causal powers and responsibility.
    - Bishop, not the office holder, owns the property.
    - Monarch, not the office holder, declares war.

# Alternate suggestion

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- Simplistic-NG proposal: System component is virtual.
  - Material system has virtual (i.e. immaterial) components.
- This proposal is articulated inside an explicit ontological architecture
  - So example is acting as a litmus test for the proposal.
- Do these virtual objects have a clear spatial location?
  - When it is 'materially present' – then it's location is dependent upon the material object that it is constituted by
  - When it is not, the location must be to an extent vague, as (for example) if there is no material tyre we cannot know which way it is facing (or whether it is fully inflated)
- Corporation sole issue
  - Can virtual (immaterial) system components have causal powers?
    - And if so can current science explain this?

# Problem of virtual plenitude

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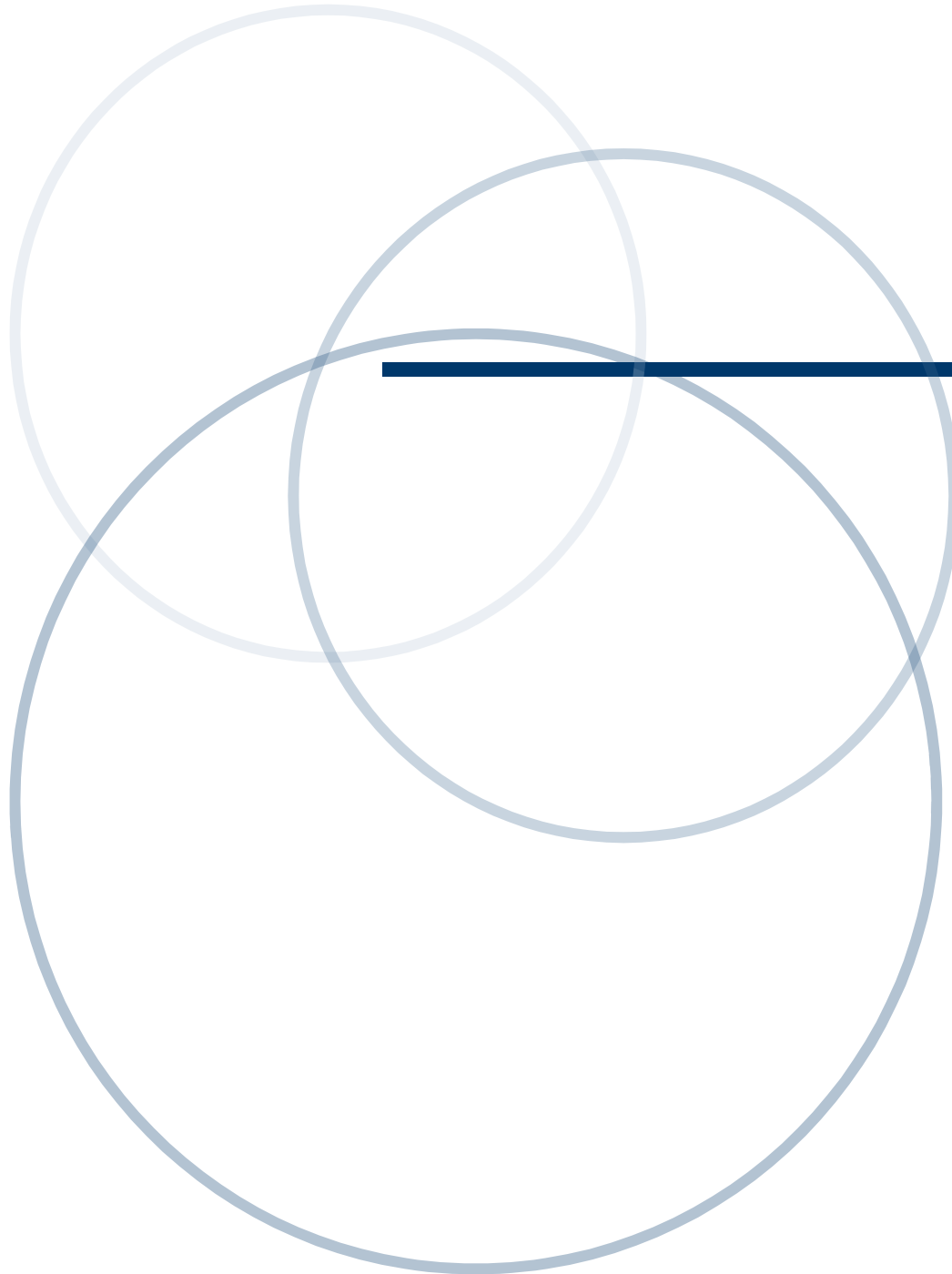
- Problem of virtual plenitude
  - (“radical multiplicative approach” [Baker 2004])
- Virtual components and their real counterparts all the way down to the bottom.
  - My car has a virtual right headlamp and a real headlamp playing that role.
  - The right headlamp has as components a virtual bulb and a virtual reflector as well as real bulbs and reflectors playing the virtual roles.
    - Do both the virtual and the real headlamp have their own components?
      - Maybe they share the real components but not the virtual ones.
      - Whatever we decide, how do we motivate the decision – it seems arbitrary.
      - In this way, it fails the explanatory test.
- What happens if we apply Occam’s razor to this?



# Designed system components

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- Often the system component is designed in from the start.
- This raises other ontological concerns.
  - Deontology
    - Design is de-ontic, it is intended to represent what 'should' be built.
      - When talking about a car's right wheel, when it does not have one, one could be talking about the wheel it would have if it conformed to the design.
        - In a possible world semantics, the counterpart wheel.
  - System component types
    - Design is usually for a type not an instance.
    - Even where for an instance, it can be regarded as representing a number of possible types.
      - When talking about a car's right wheel, may well be talking about the (possible) prototypical instance's wheel.



Questions?