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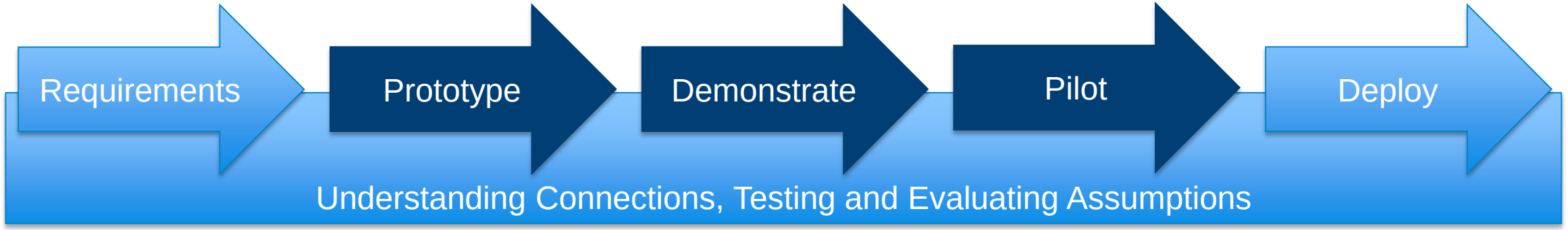
Systems Engineering Toolkit for DfMA in Infrastructure



This toolkit aims to provide systems engineering principles, tools and pointers for developing configurable product platforms for Design for Manufacturing and Assembly in infrastructure.

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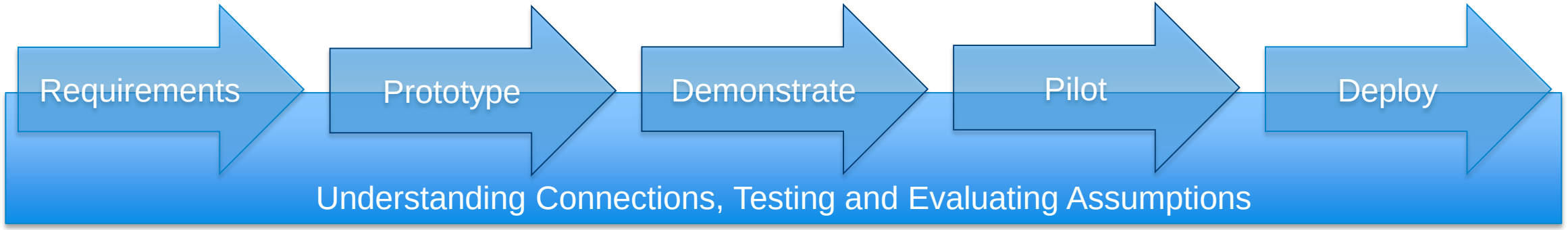

Checklist for modelling systems

1. Hierarchy of components? (breakdown structure)
2. Possible interdependencies? (direct, common mode failures)
3. Emergent dynamics and behaviours?
4. Boundaries of the system?
5. Do the boundaries of the model match system boundaries?

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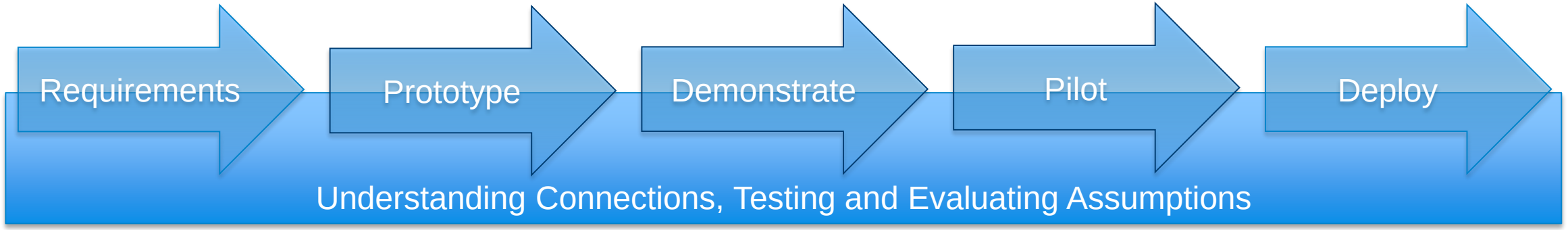
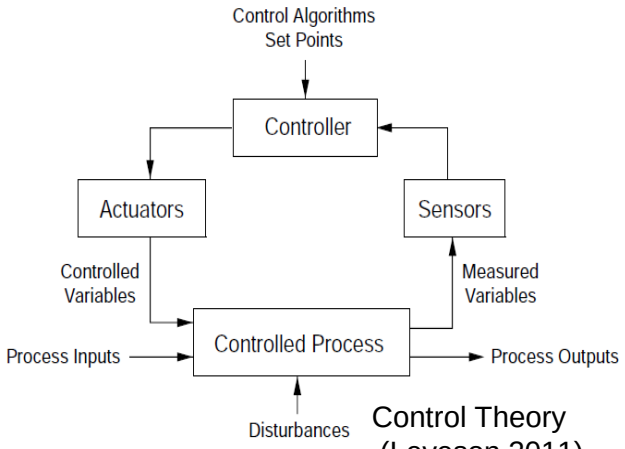
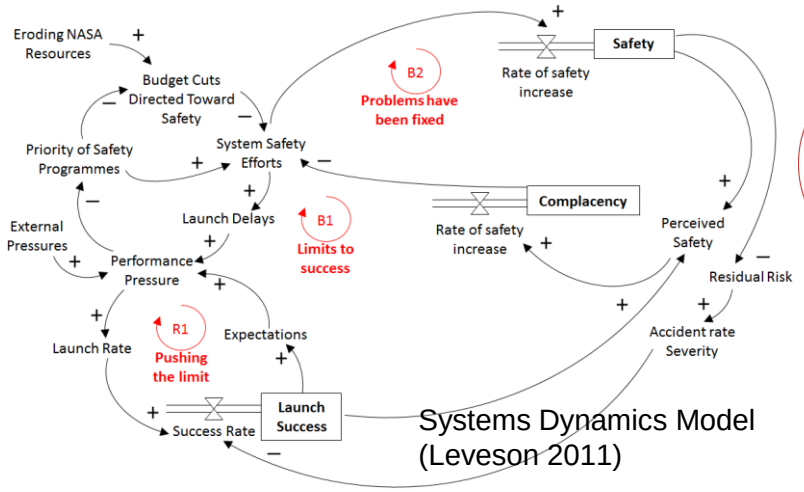


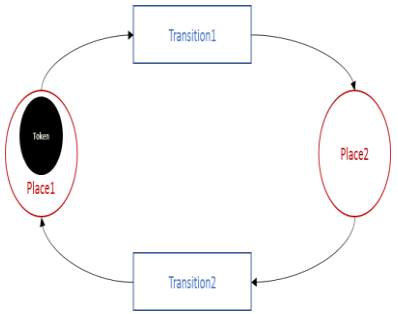
Modelling systems - examples



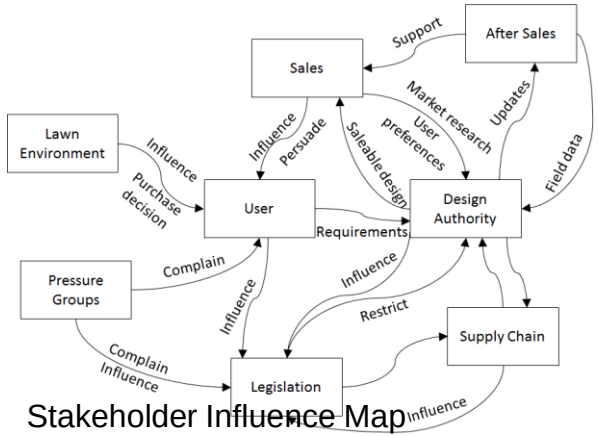
Control Theory (Leveson 2011)



Systems Dynamics Model (Leveson 2011)



Petri Net (Peterson 1981)



Stakeholder Influence Map (Burge 2011)

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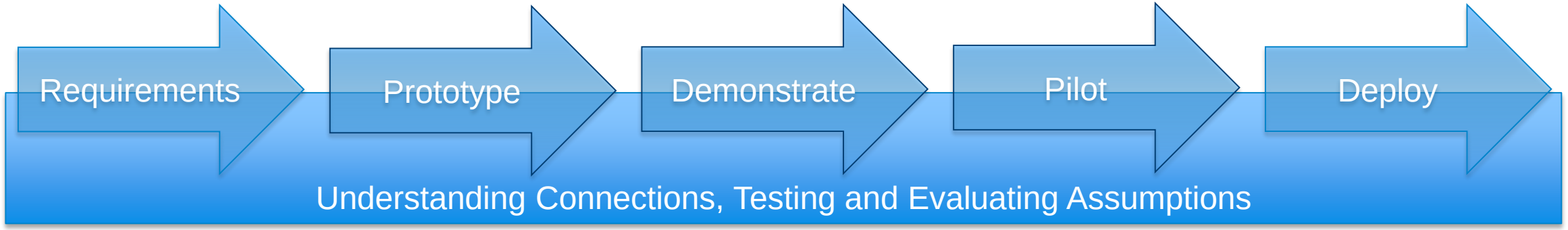

Checklist for systems issues

1. Safety
2. Resilience / antifragility
3. Security
4. Manufacturing constraints
5. Assembly constraints
6. Environmental impact
7. Carbon / Pollution
8. Quality
9. Human factors
10. Life-cycle / Maintainability
11. Training needs
12. Affordability / Cost-effectiveness
13. Reliability of supply
14. Value engineering
15. Integrated logistics
16. Electro-magnetic compatibility

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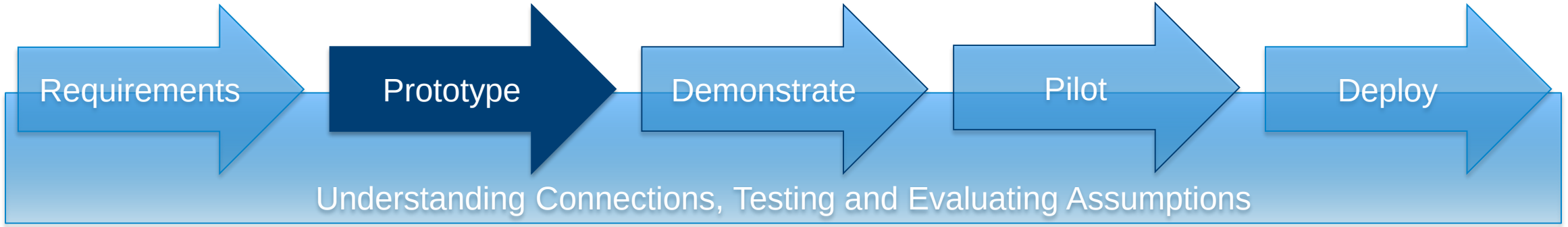
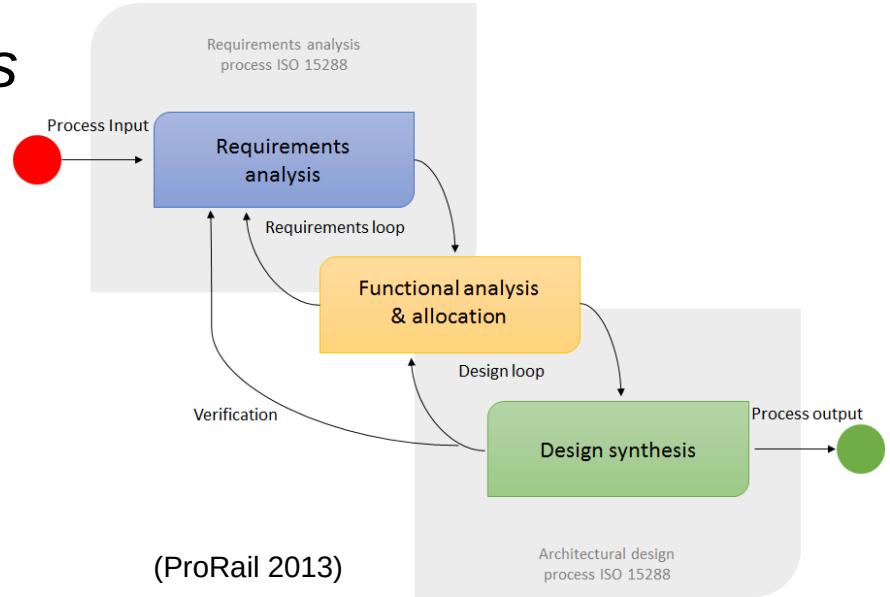


Prototyping - Engineering responsibilities and reviews

1. Functional analyses
2. Verification designs meet requirements
3. Peer review, sub-system review
4. Interface management
5. Systems definition review



(ProRail 2013)

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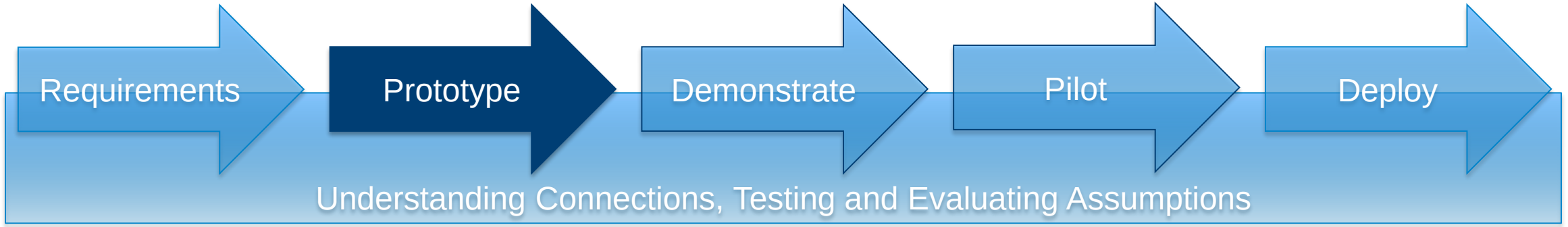
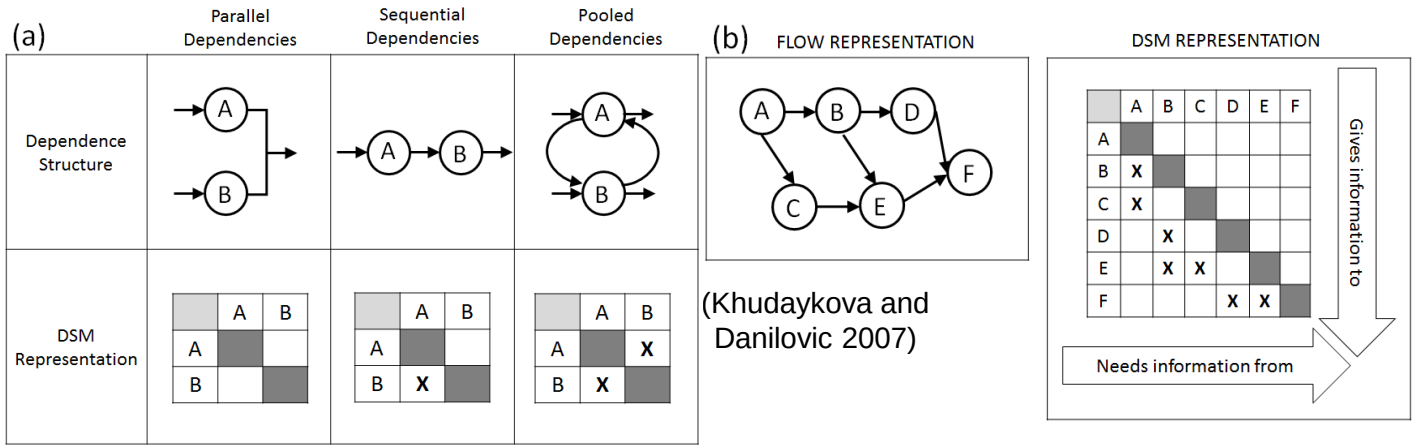


Prototyping – Identification

- Interfaces
- Interdependencies
- Risks



(Khudaykova and Danilovic 2007)

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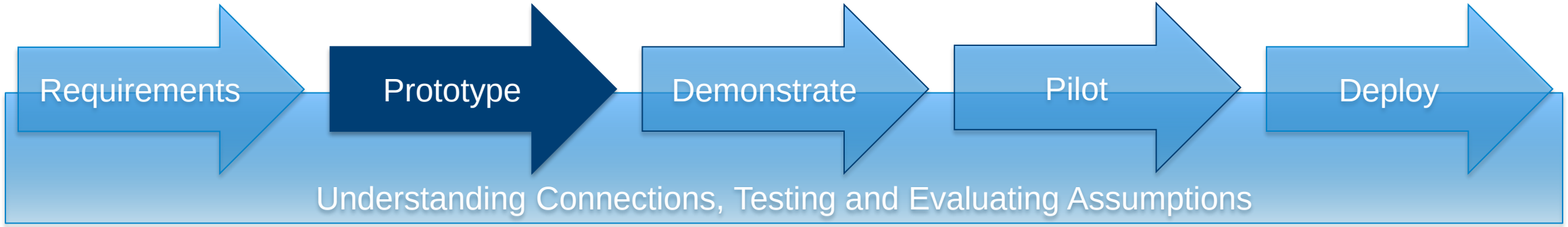
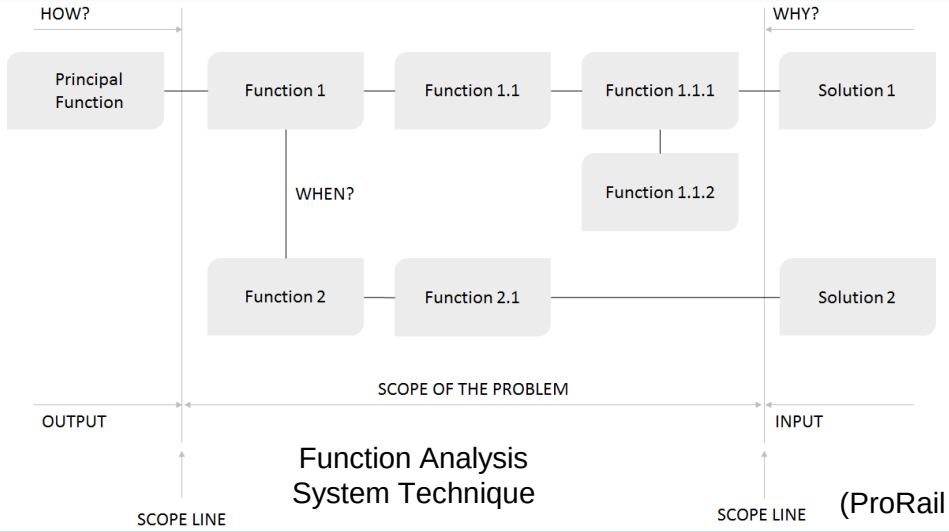


Prototyping - Questions

- Product, e.g. Are there emergent behaviours across components?
- Processes, e.g. Where are bottlenecks?



Function Analysis System Technique (ProRail 2013)

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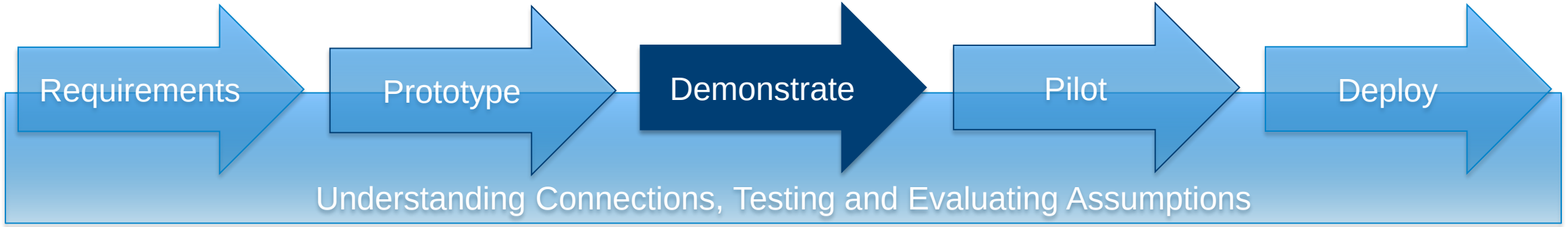

Demonstrate - Engineering responsibilities and reviews

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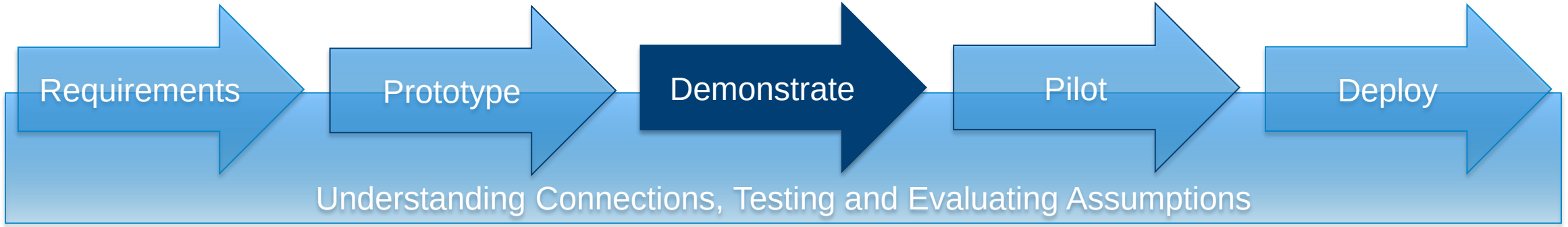

Demonstrate - Identification

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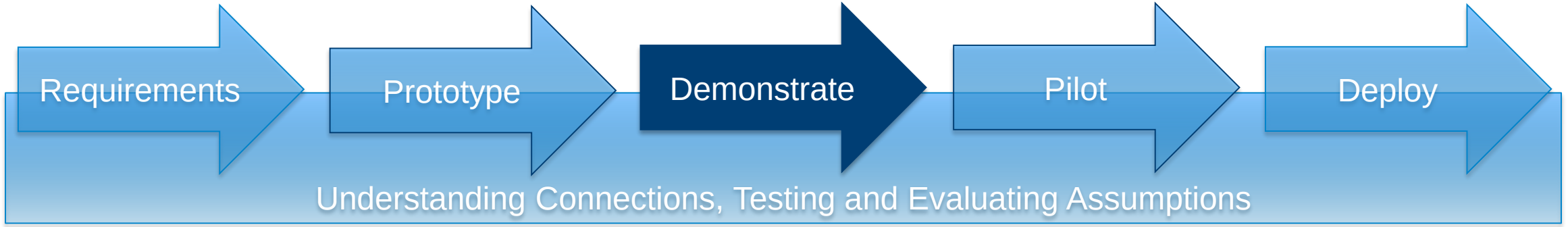

Demonstrate - Questions

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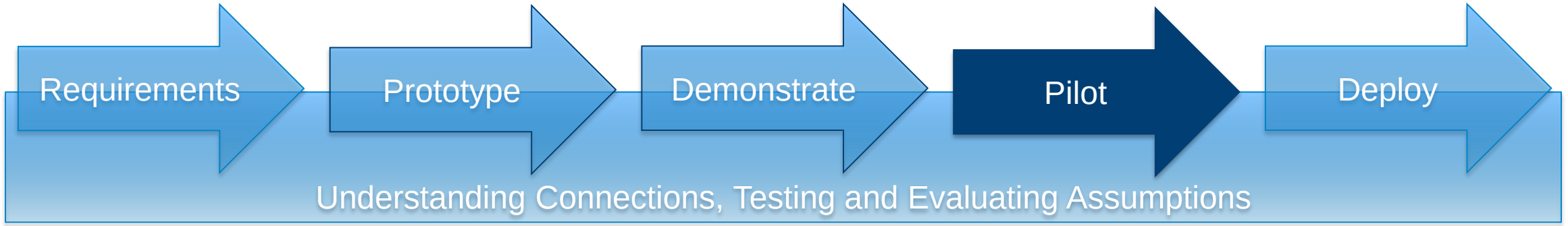

Pilot- Engineering responsibilities and reviews

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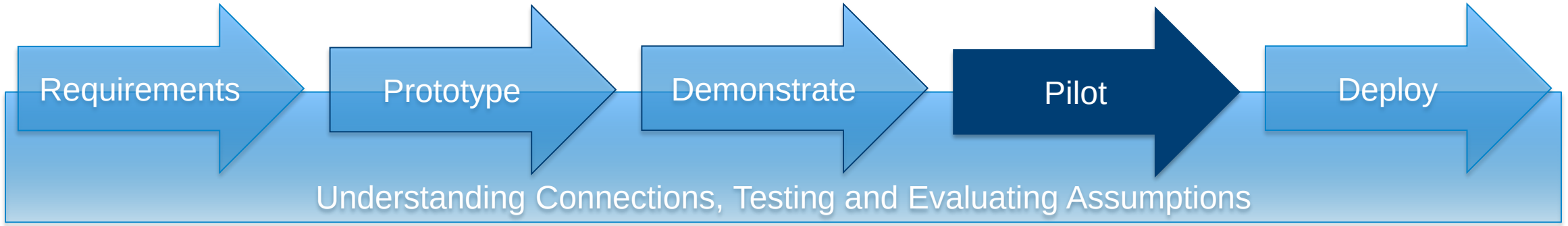

Pilot- Identification

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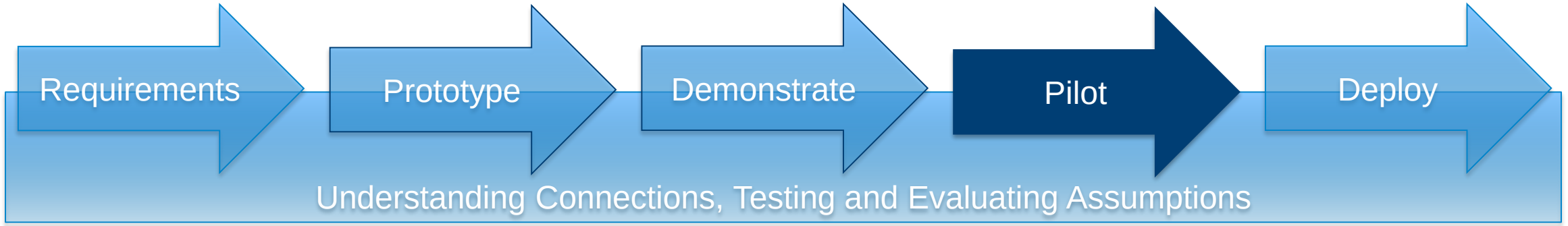

Pilot- Questions

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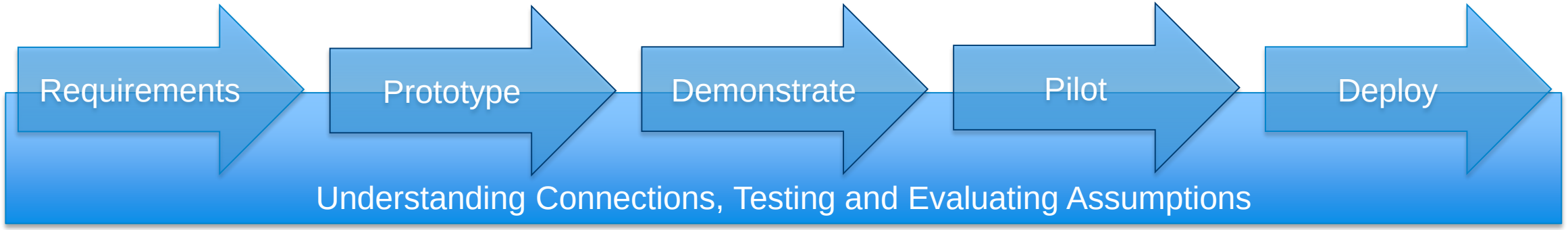

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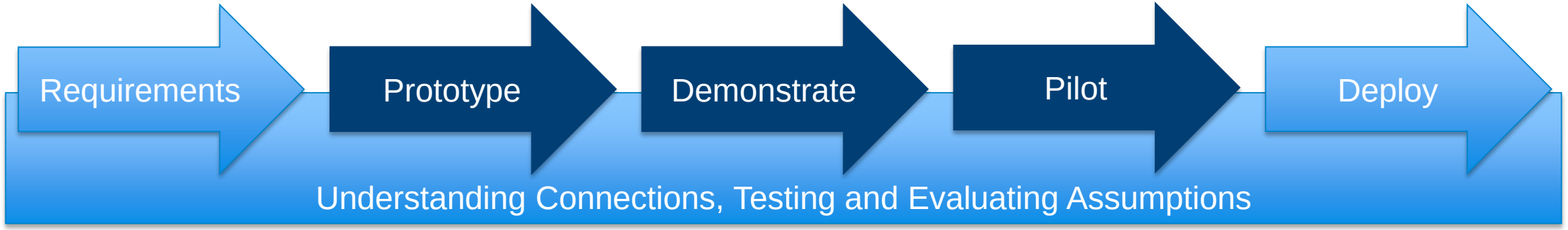
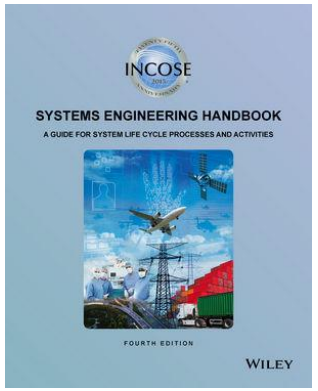
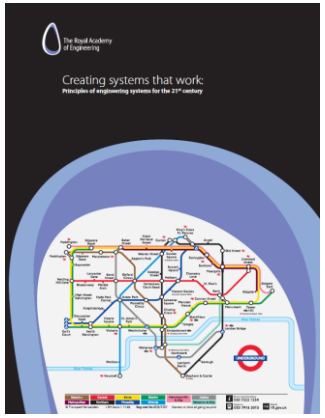
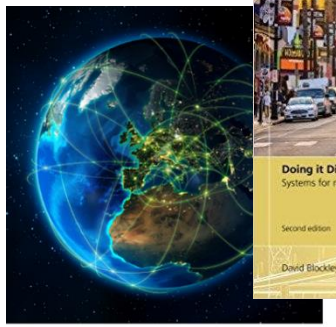


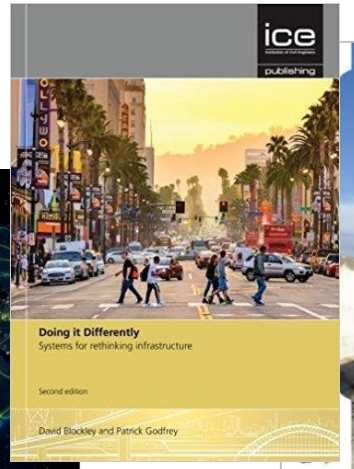
Recent research and best practice:

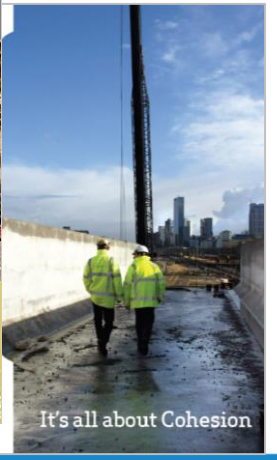
- ✓ INCOSE Handbook (2015); BoK (2017); – tools/methods per stage on the life cycle
- ✓ ProRail Guidance (2013) – tools/methods per functionality
- ✓ NASA SE Handbook (2007)
- ✓ RAEng (2007)
- ✓ Blockley and Godfrey (2017)











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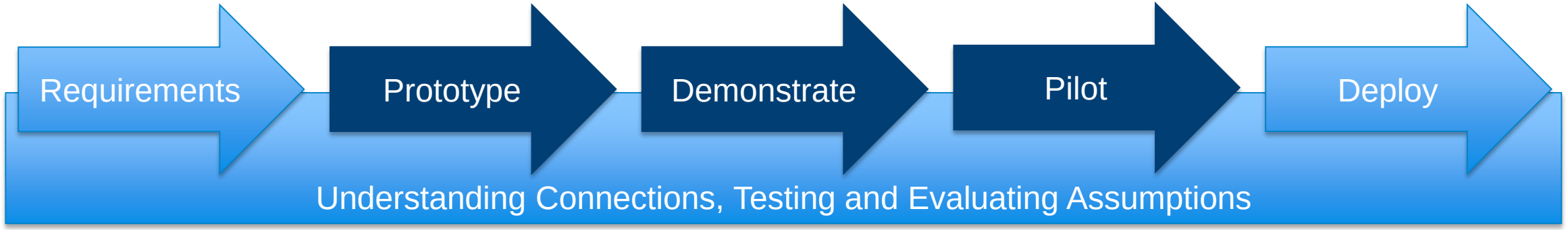

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Mikela Chatzimichailidou and Jeni Giambona,
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