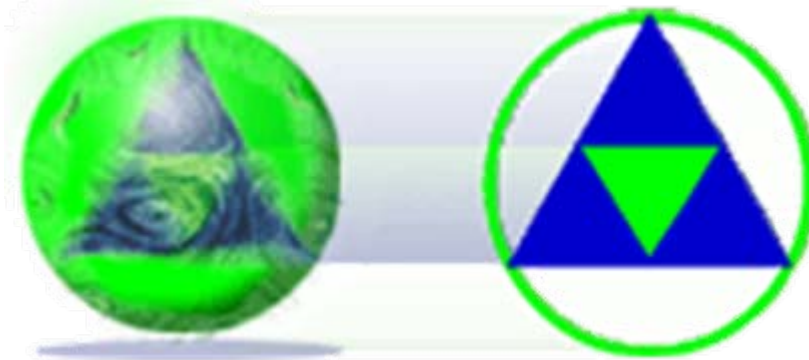


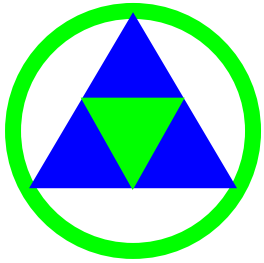
Sustainability and Capital Projects: Modeling the Emergent Property of Total Cost of Ownership



Dr. Annie R. Pearce

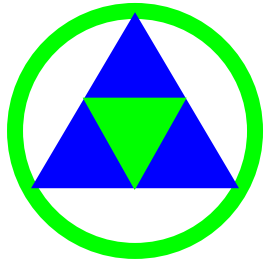
Dr. Kristen Sanford-Bernhardt

Dr. Michael J. Garvin



Challenge

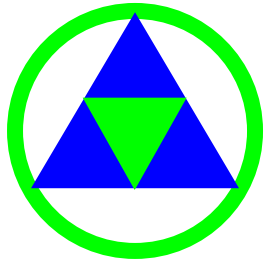
- Measuring sustainability in a way that can be incorporated as part of decision making for capital projects
- Linking investments to *outcomes*
- Total cost of ownership:
 - LCC = proxy for external resource demand
 - First cost = feasibility criterion
 - Externalities can also be incorporated



Total Cost of Ownership

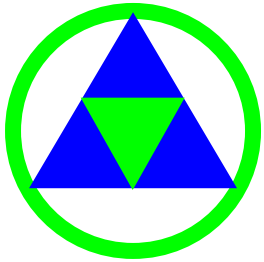
- “[T]he sum total of the present value of all direct, indirect, recurring and non-recurring costs incurred or estimated to be incurred in the design, development, production, operation, maintenance of a facility/structure/asset over its anticipated lifespan.”

– *International Facilities Management Association*



Total Cost of Ownership

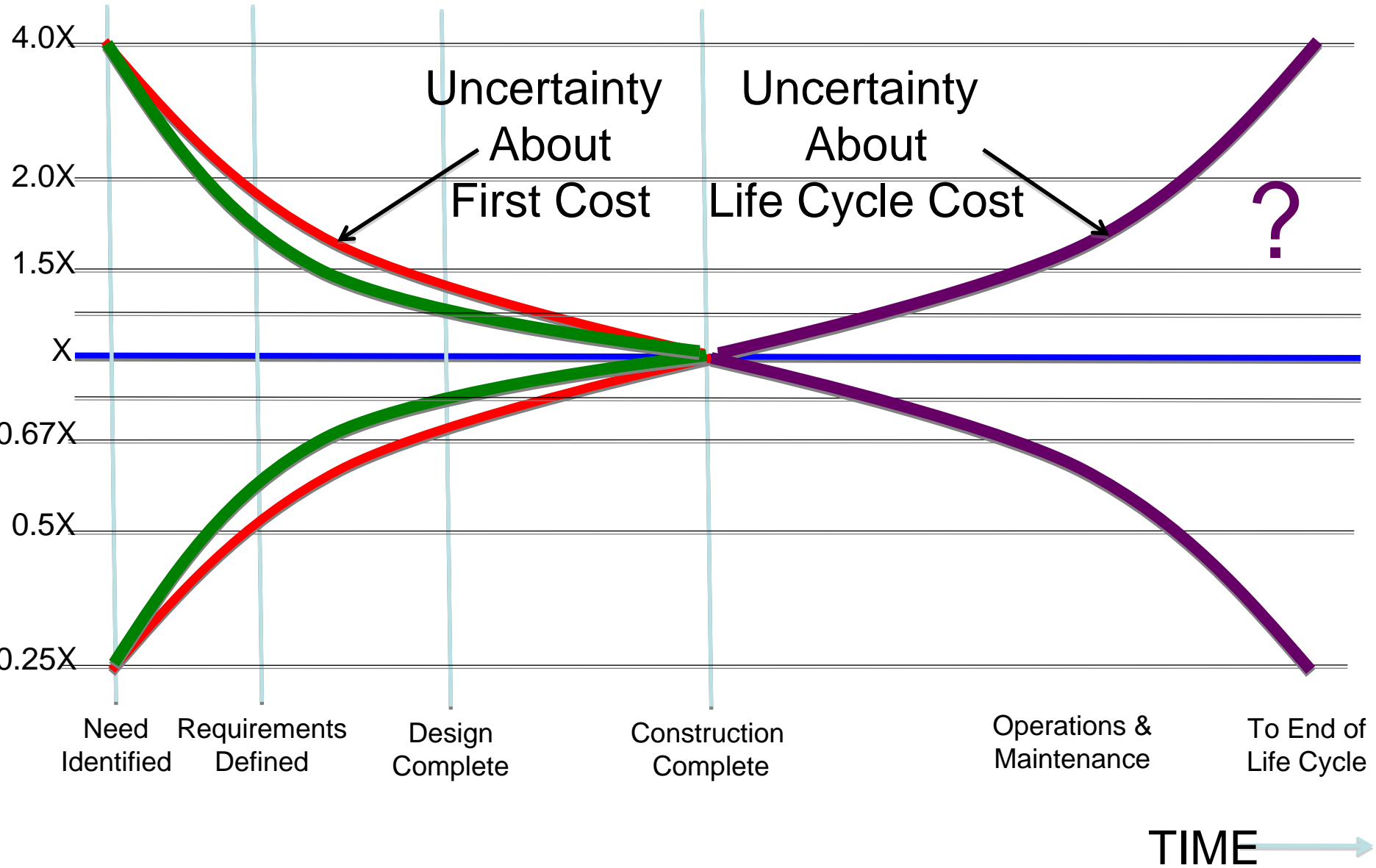
- Facility scale:
 - Life cycle cost of the facility
 - Comparing alternatives
 - Evaluating feasibility
 - Identifying cost drivers
- Portfolio scale:
 - Prioritizing repairs/replacement
 - Which facilities are costing the most to deliver required function?



Project Planning

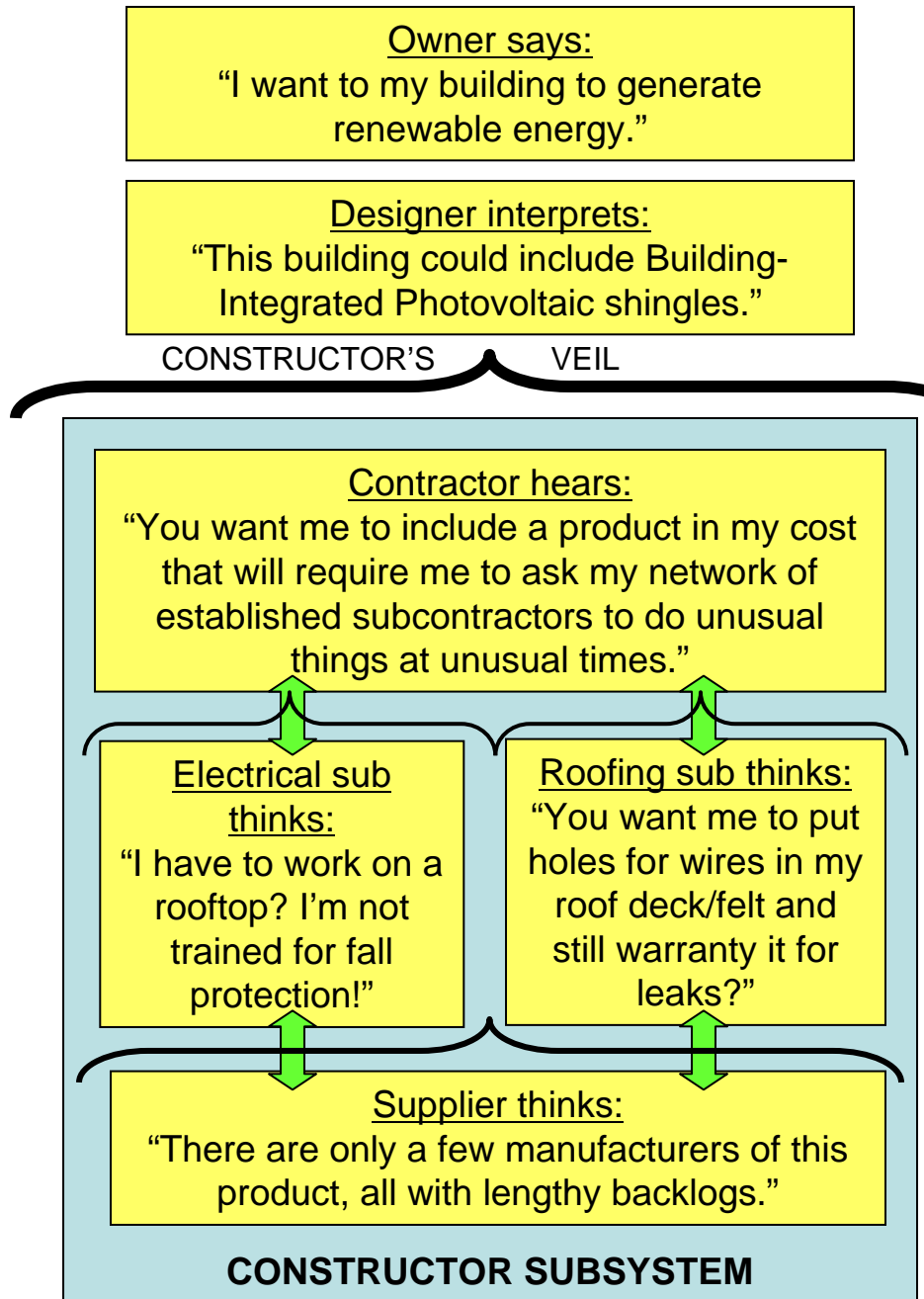
- Details are not yet known
- Parametric estimates are based on historical data
- Novel cases or innovative projects are difficult to estimate
- Many possible future states over the long facility life span – increasing uncertainty for life cycle costs

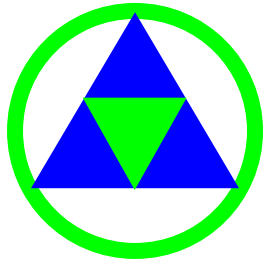
Level of Uncertainty with respect to Project Life



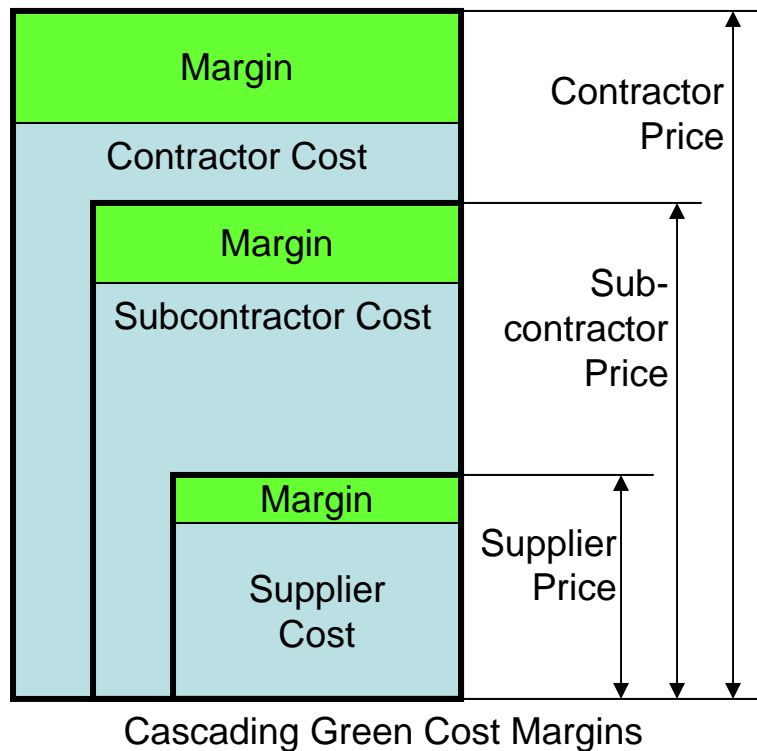
Sustainability as Innovation

- Project performance criteria are expanded
- The delivery process is different
 - Different sequencing
 - New subs/supply chains
- The delivered product & components are different
 - Unfamiliar products
 - Tightly coupled systems
- Translation problems
- Big brother is watching!

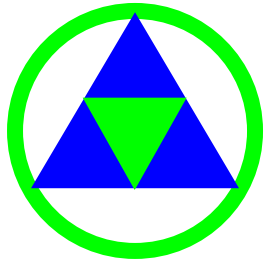




Effect on Capital Costs

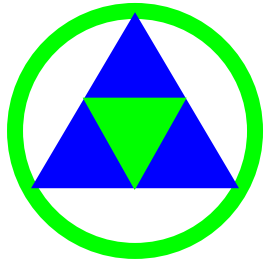


- The green cost margin gets added in at every step:
 - Procurement risks
 - Learning curve
 - Qualification expenses
 - Data management
 - Inability to use existing strategic relationships



Integrated Project Delivery

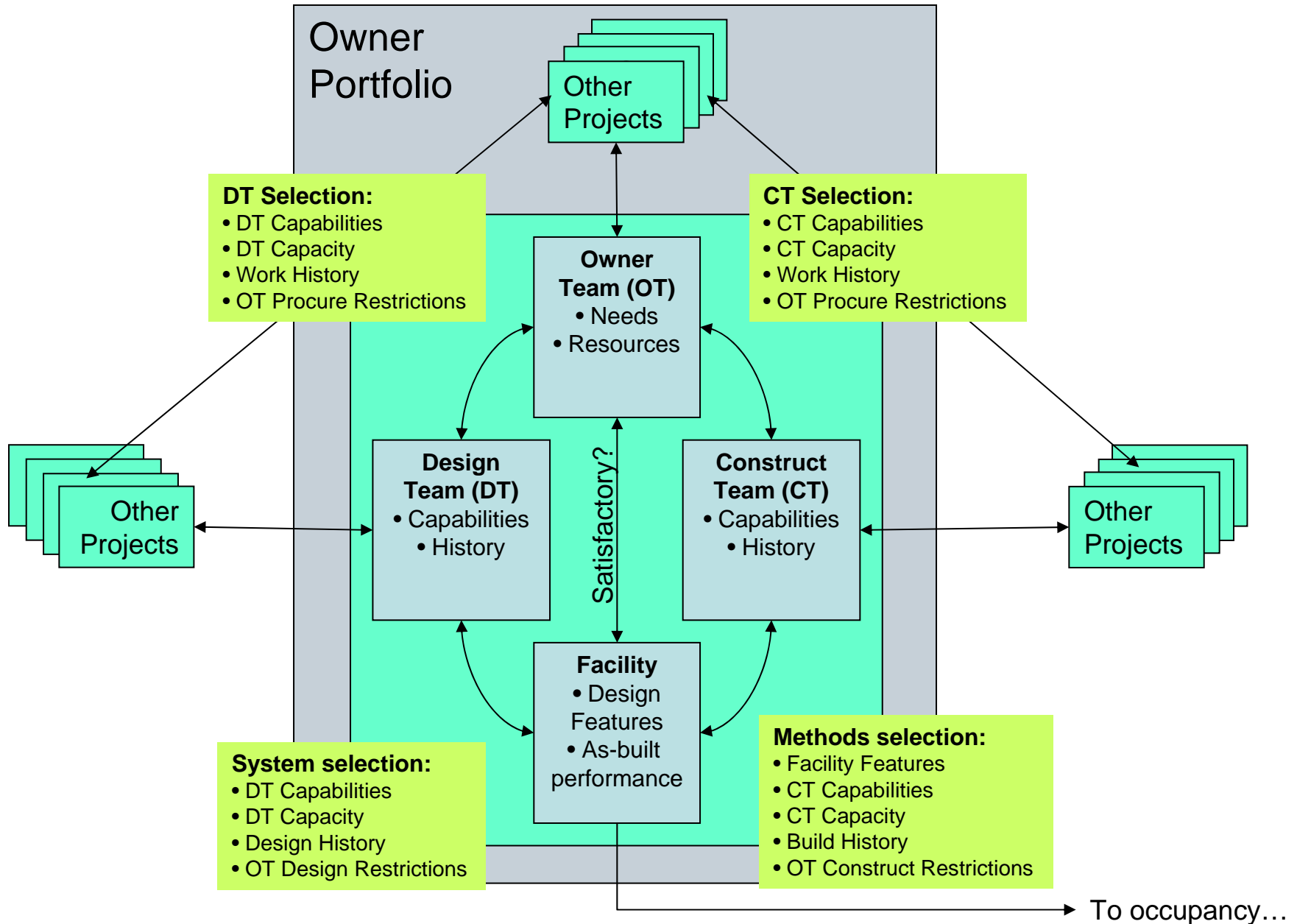
- Earlier involvement of supply chain and later stakeholders
- New agents:
 - Preconstruction services consultants
 - LEED consultants
 - Education consultants
 - Commissioning agents
- Extensive documentation/analysis
- Commissioning processes

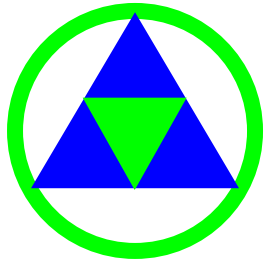


Total Cost of Ownership

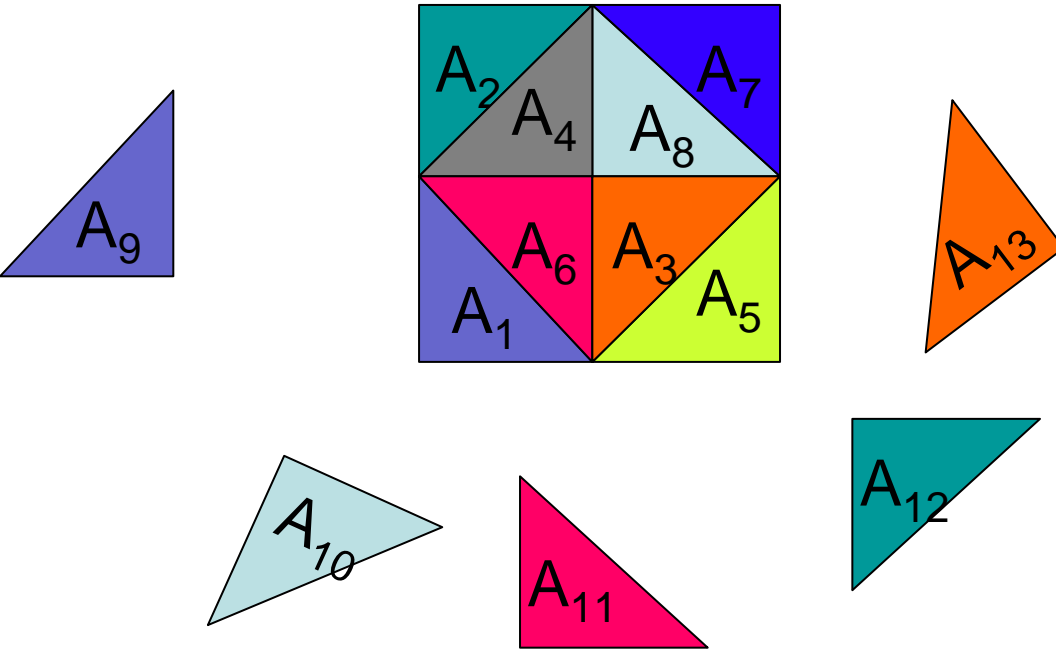
- Emergent property of a project system affected by:
 - Initial program of requirements
 - Individual decisions of agents involved with project delivery
 - Construction quality and congruence with design intent
 - New technologies applied over the life cycle
 - Interactions between facility and occupants

Capital Projects as Systems





Prototype Design Process

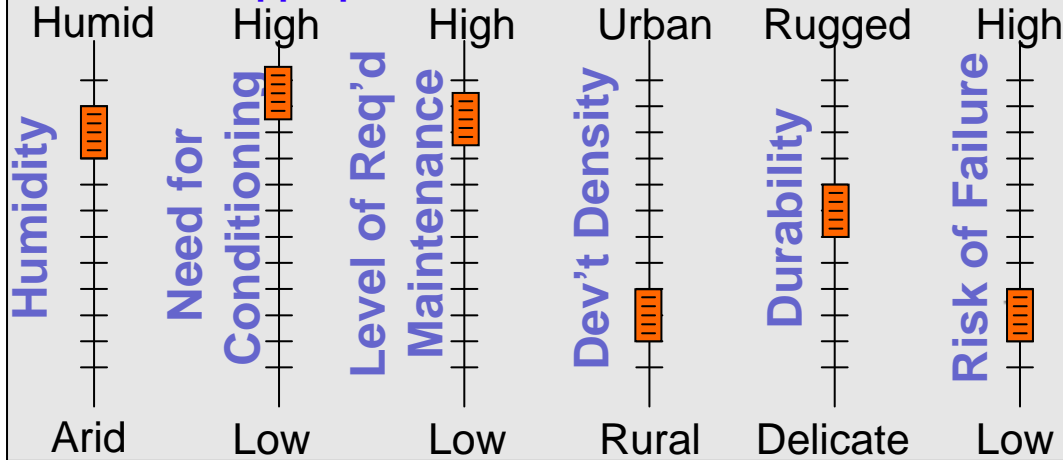


- Agents (systems) moving around in a decision space
- Feasibility, fit, and improvement
- Displacement of default systems
- Iteration until steady state is achieved

Name: Solar Hot Water Heating

Subs for: D3020

Contextual Appropriateness:



Unit cost: \$1.60 **per Unit:** sq. ft.

LC cost per year: \$20 **Service Life:** 20 years

Possible LEED points contributed to: 3

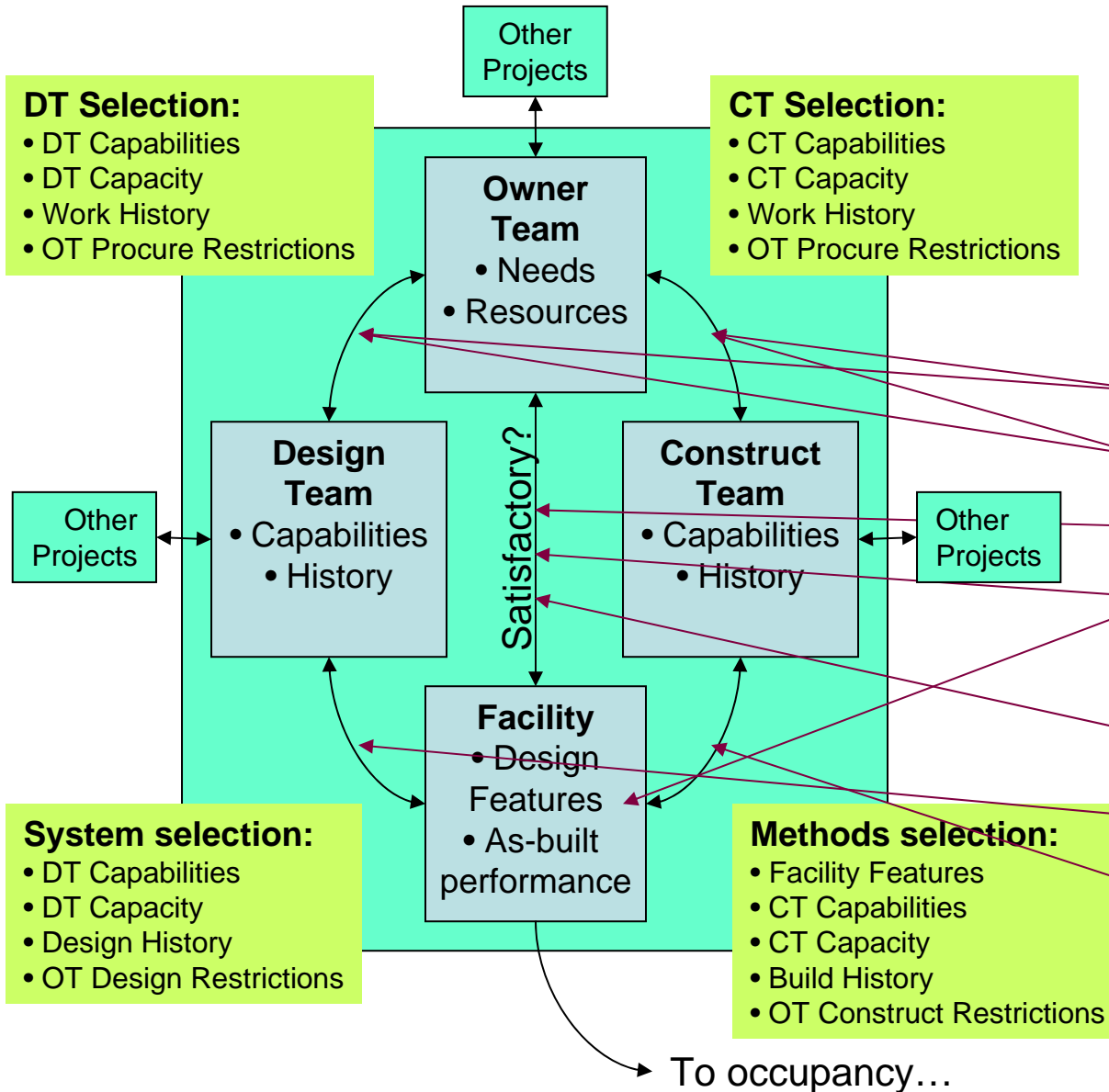
Comments:

Contributes to EA Cr. 1
Source = NAVFAC DD 1391 Worksheet

- Facility systems at the assembly level
- Context specificity
- Ability to add additional context features
- Project agents' past experience can also be incorporated

Design-Bid-Build Project

Agent Attributes and Analysis Boundary

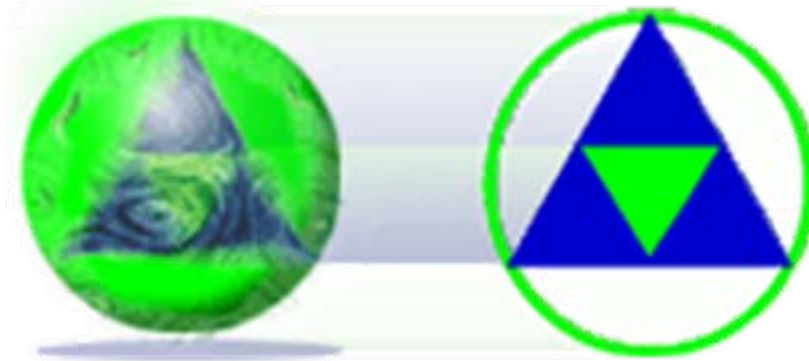


Why?

Intervene through:

- Capacity building
- Procurement policies
- Cx/Enforcement
- Performance specs for solutions
- Funding premiums
- Design guidelines
- Build guidelines

Thank you for your attention!



**Got questions?
Want to take it to the next level?**

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