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NATIONAL LABORATORY

What technologies might improve building system integration?

January 28, 2020

Michael Poplawski
DOE Lighting R&D Workshop

Acknowledgements: Jessica Collier, PNNL; Josh Lowe, AkitaBox

U.S. DEPARTMENT OF ENERGY BATTELLE

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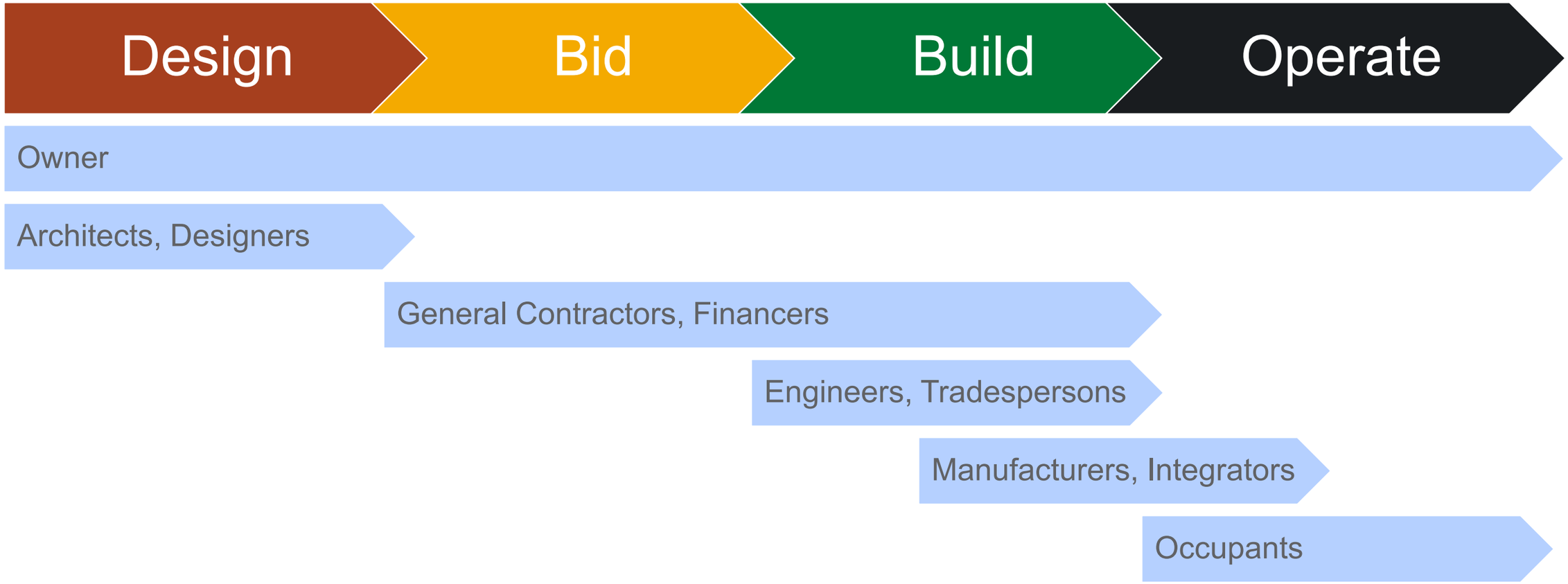
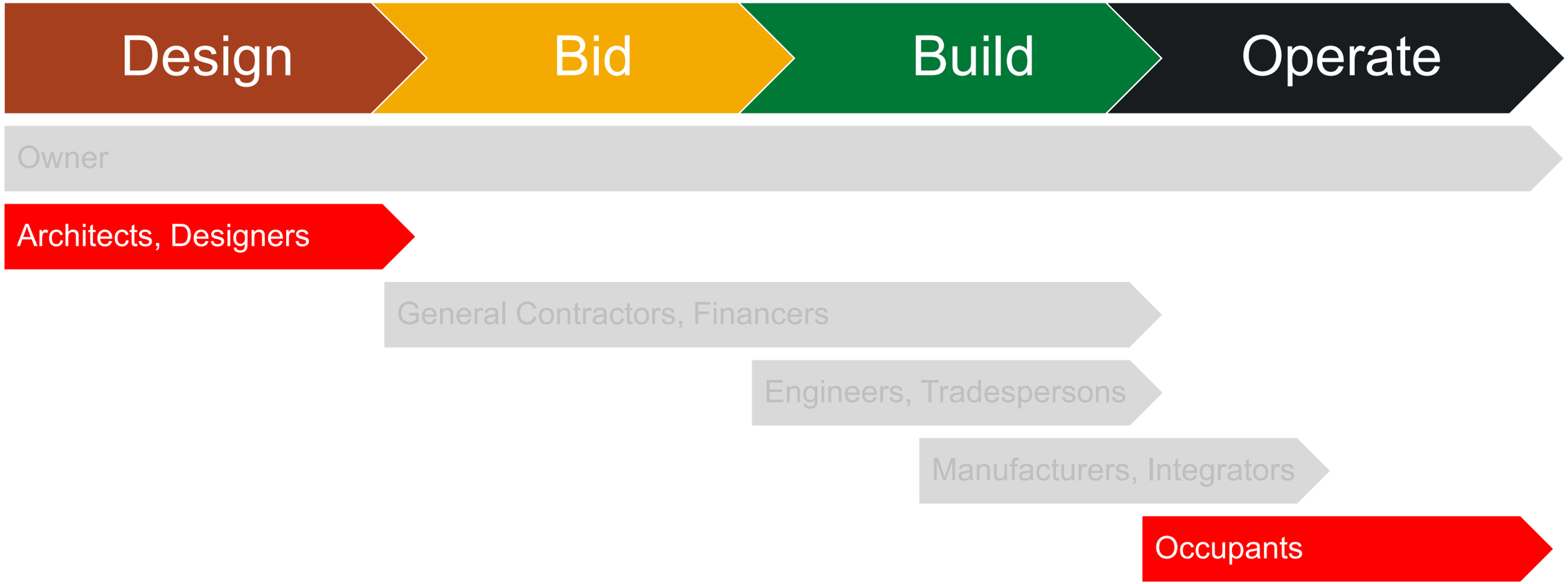
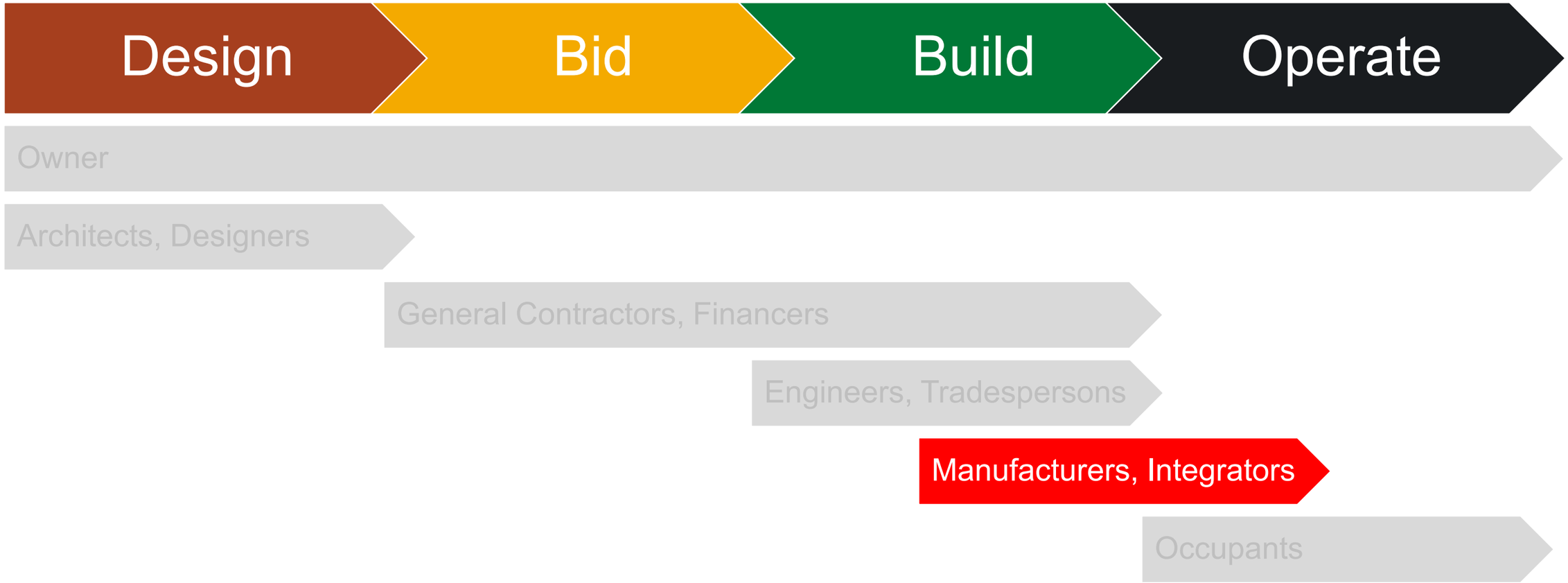
The Design-Bid-Build process often prevents the best lighting system for a building and its occupants from being installed and integrated with other building systems



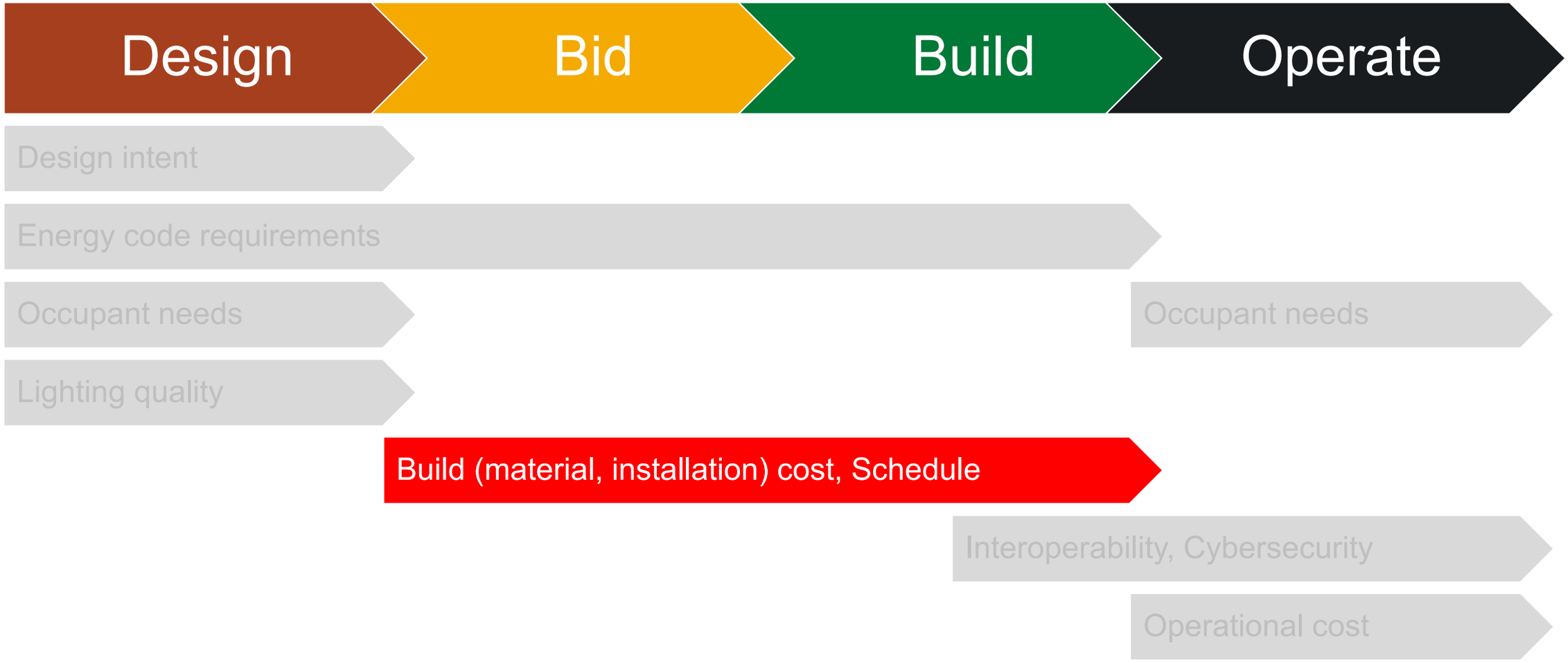
Occupant needs are not sufficiently addressed throughout the project



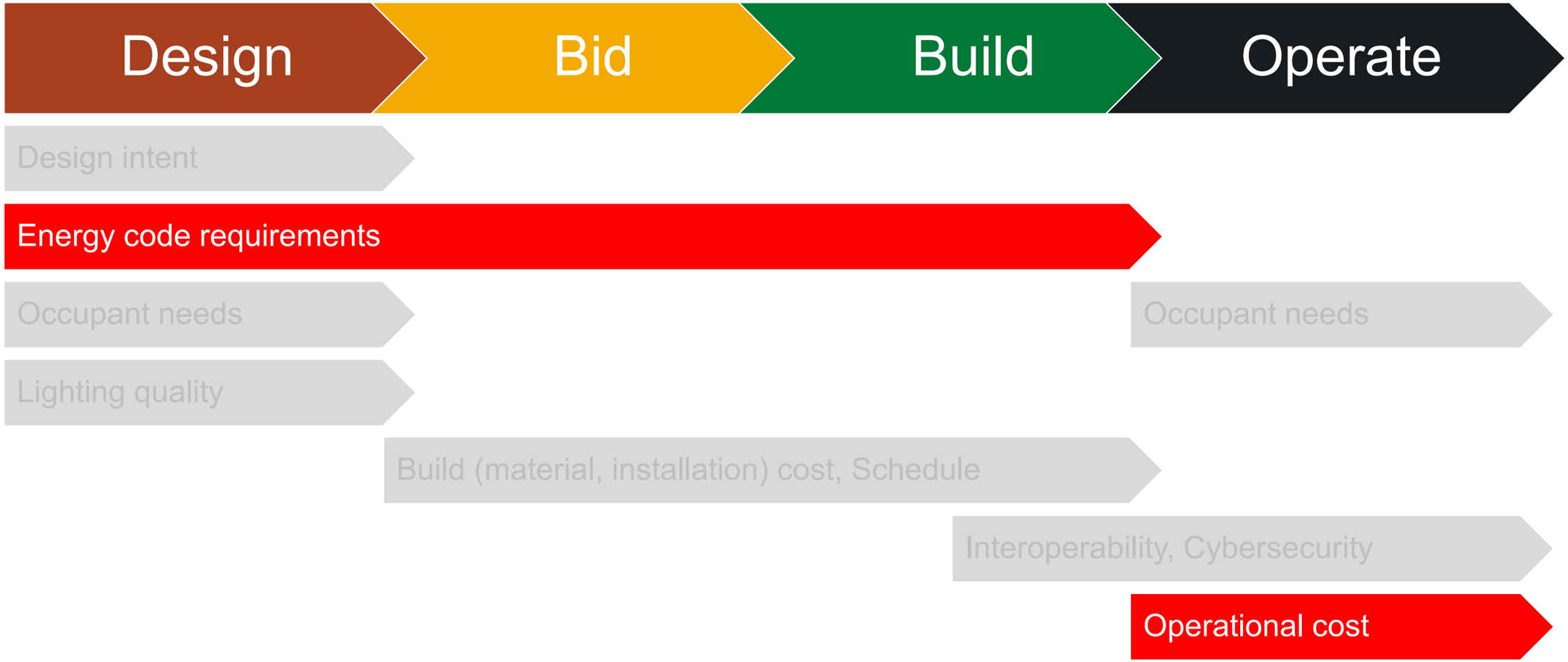
System integration is not a focus until too late in the project cycle



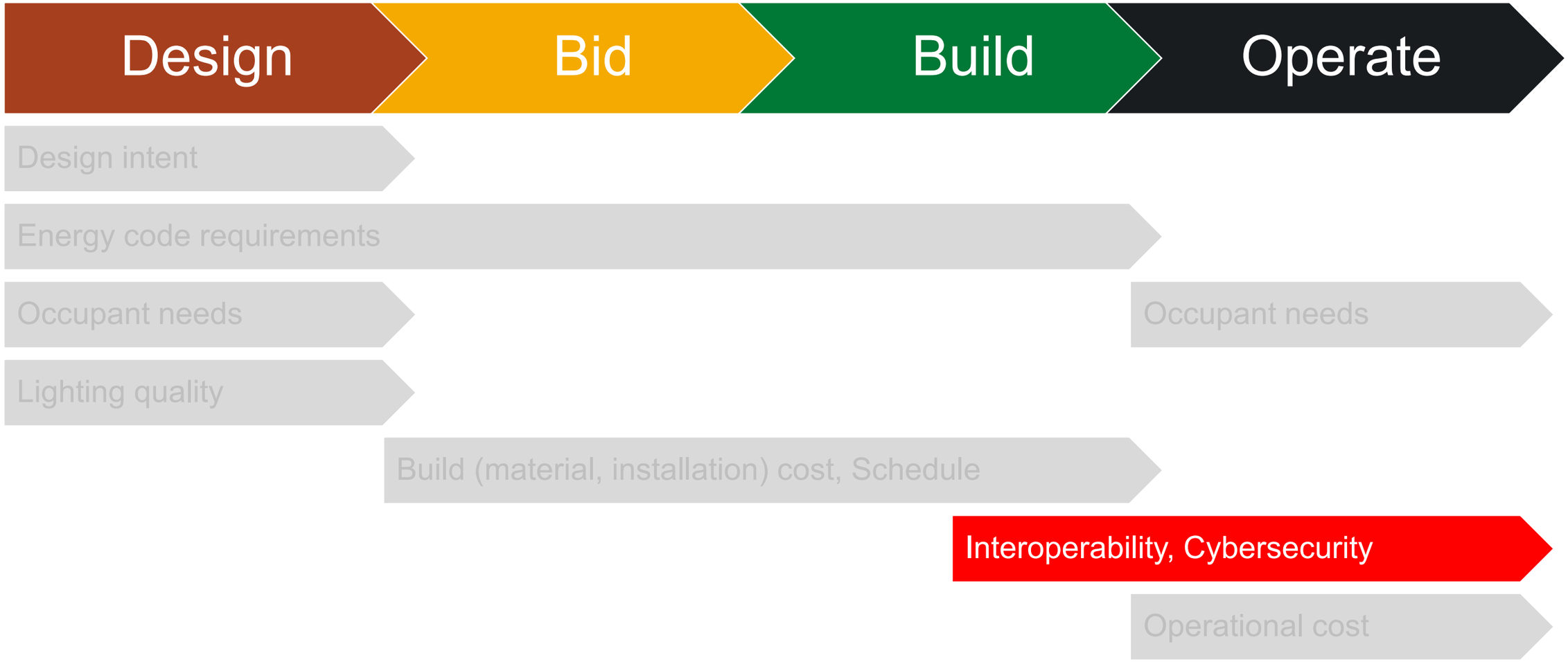
Value engineering to reduce build cost reduces system capabilities and potential performance



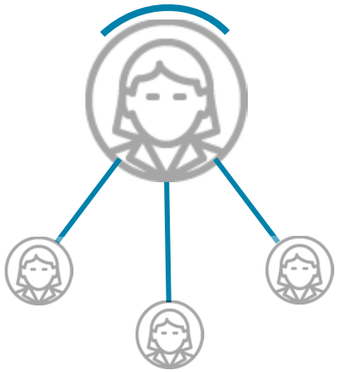
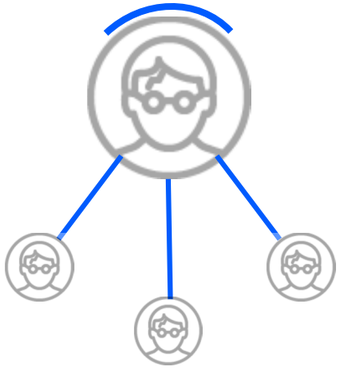
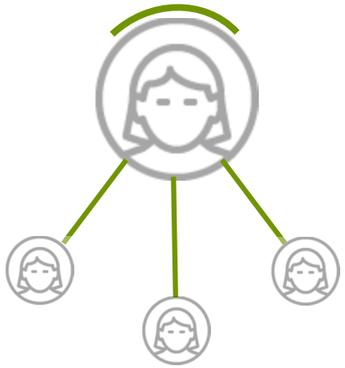
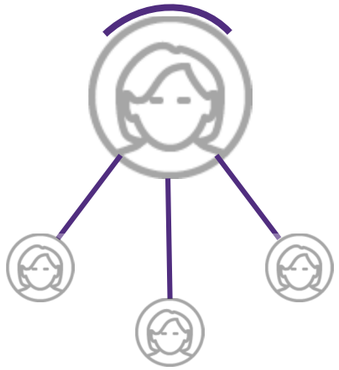
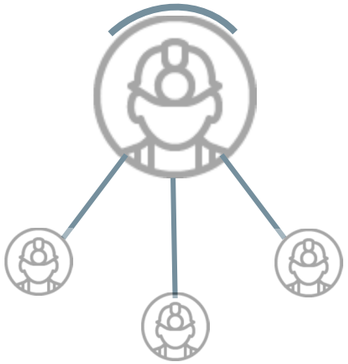
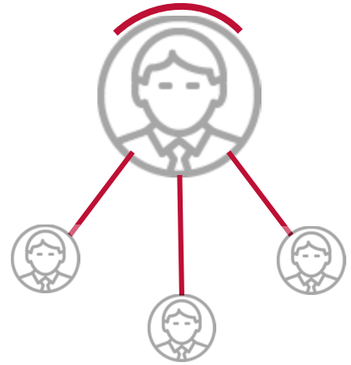
Operational costs are largely a guess based on meeting energy code requirements



Interoperability and cybersecurity are not a focus until too late in the project cycle



Real projects are more even more complicated and, often, inefficient

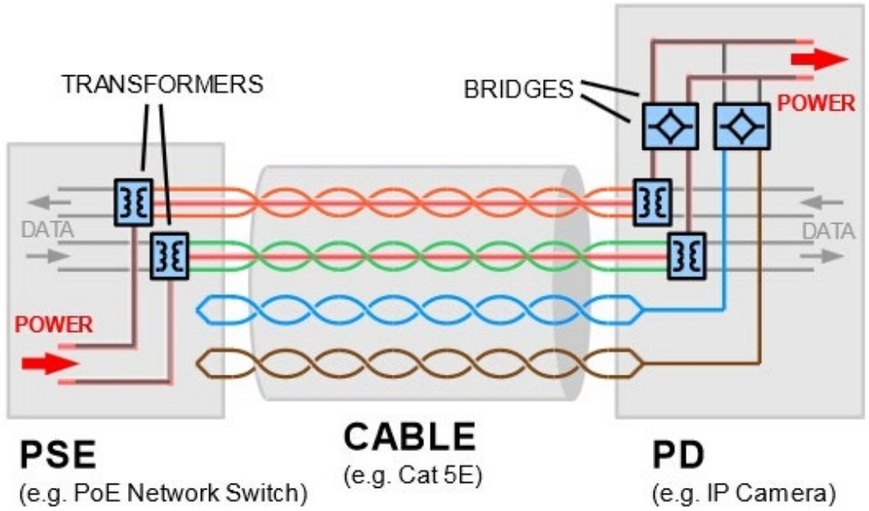
CLIENT	ARCHITECT	ENGINEER	CONSULTANT	CONTRACTOR	OPERATOR
					
Client rep, BoD, stakeholders	BIM coordinator, project managers, visualization specialists	MEP, structural, BIM coordinator	Designers, simulation/compliance, manufacturers/reps	Subcontractors, distributors, permitting	Facilities, lease owner, utilities

Limited documentation and information re-use reduces efficiency and focus as the project evolves

	PROJECT INITIATION PRELIMINARY DESIGN	SCHEMATIC DESIGN	DESIGN DEVELOPMENT	CONSTRUCTION DOCUMENTS	BID	CONSTRUCTION	OPERATION
TASKS	Initial client meeting, “big picture” ideas and needs, budget and timeline, contracts and scope of work outlined	Establish overall concepts, site visits, early drawings and engineering requirements	Develop concepts and drawings, address details, include consultants and focus on feature areas	Produce construction details and drawing, technical specifications	Obtain and evaluate bid packages, prepare contract documents, drawings and specifications, select general contractor	Excavation, foundation, core etc, shop drawings, façade construction, system installation, interior build out, periodic site monitoring	Building owner and operators assume control of constructed building for daily operation and use
DELIVERY METHOD	**2D – Napkin Sketch, Contracts**	**2D - Preliminary Drawings**	**2D – Specifications, Design Details**	**2D – Drawing Set**	**2D – Drawing Set, Specification Package**	**2D – Drawing Set**	**2D – Drawing Set and Project Notes**
DATA (RE)PRODUCED	3D Model	3D Model	3D Model	3D Model			

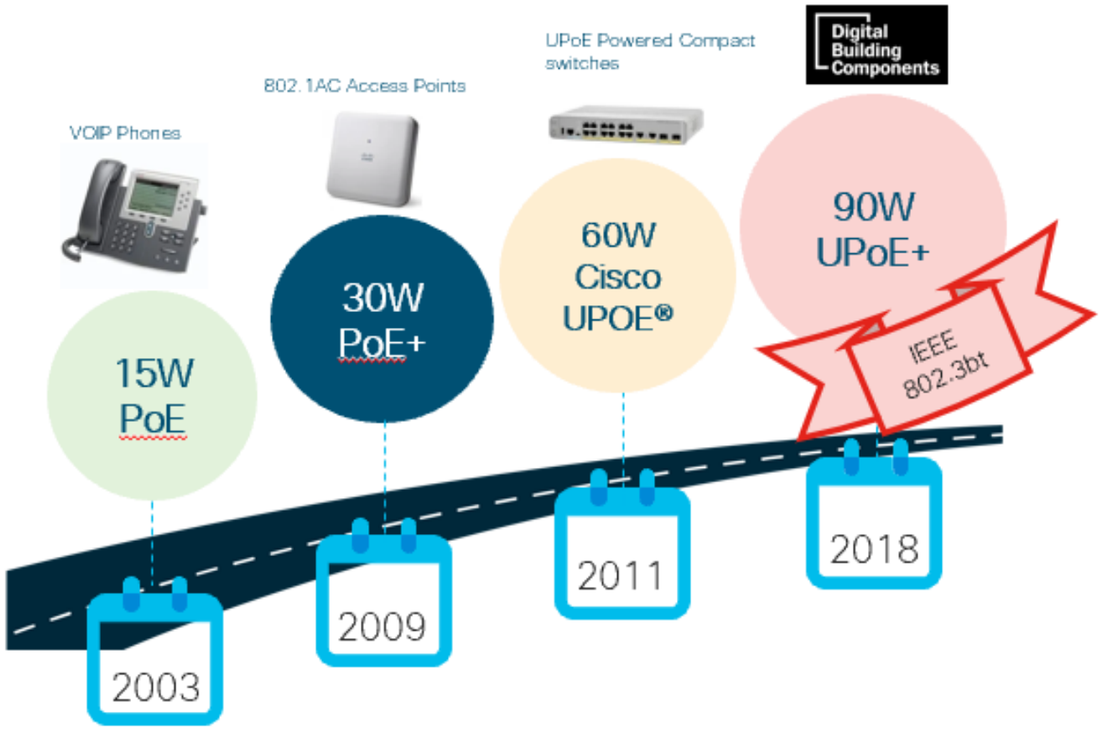
What (disruptive) technologies might improve building system integration?

Power over Ethernet



Power + data over a single cable

Power conversion and + data routing via a network switch



History of industry innovation + standardization

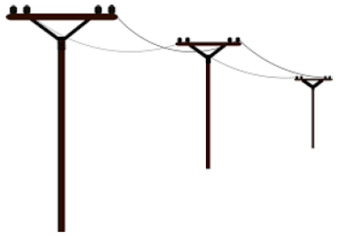
How might Power over Ethernet improve building system integration?

- Market claims: faster initial installation and reconfiguration, lower initial installation and reconfiguration cost, high performance scalable and robust network communication supports any type of sensor, inherent energy reporting capability enables data-driven energy performance management
- Risks: overkill, high initial material cost, difficult and expensive to retrofit if hamstrung for any reason, requires system-level design and energy performance analysis
- (Disruptive) Opportunity: integrated design and architecture of power and data systems brings interoperability and cybersecurity earlier into the development cycle and results in improved IT-OT integration and cybersecurity

What (disruptive) technologies might improve building system integration?

Digital Electricity

Conventional Electricity | Transmitter | Wires | Receiver | Conventional Electricity



Discrete “packets” of electricity, each checked for safe transfer from transmitter to receiver. Renders electricity safe to touch.

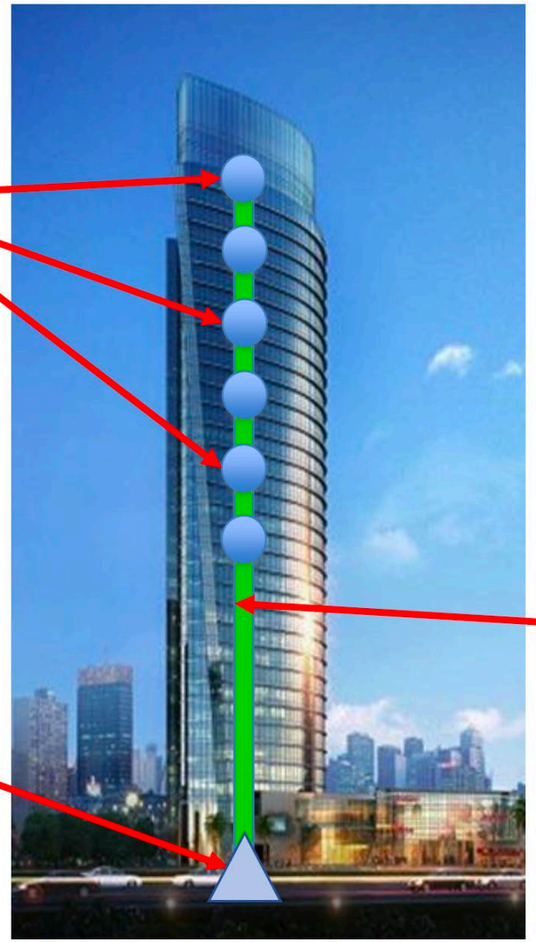
Acknowledgement: Voltserver

What (disruptive) technologies might improve building system integration?

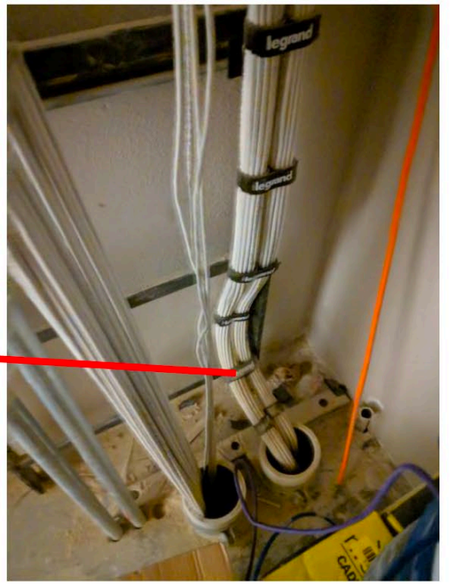
Digital Electricity

PoE

DE Receivers



DE Transmitters



Vertical Riser with
DE cables & Data

Acknowledgement: Voltserver

How might Digital Electricity improve building system integration?

- Market claims: faster initial installation and reconfiguration, lower initial installation and reconfiguration cost, data integrated with delivery enables fault detection and power management
- Risks: high initial material cost, proprietary technology, difficult and expensive to retrofit if hamstrung by manufacturer
- (Disruptive) Opportunity: building core electrical infrastructure becomes more flexible and controllable – thereby enabling the same for the building systems it powers, more flexible electrical integration breeds more flexible, and greater data integration

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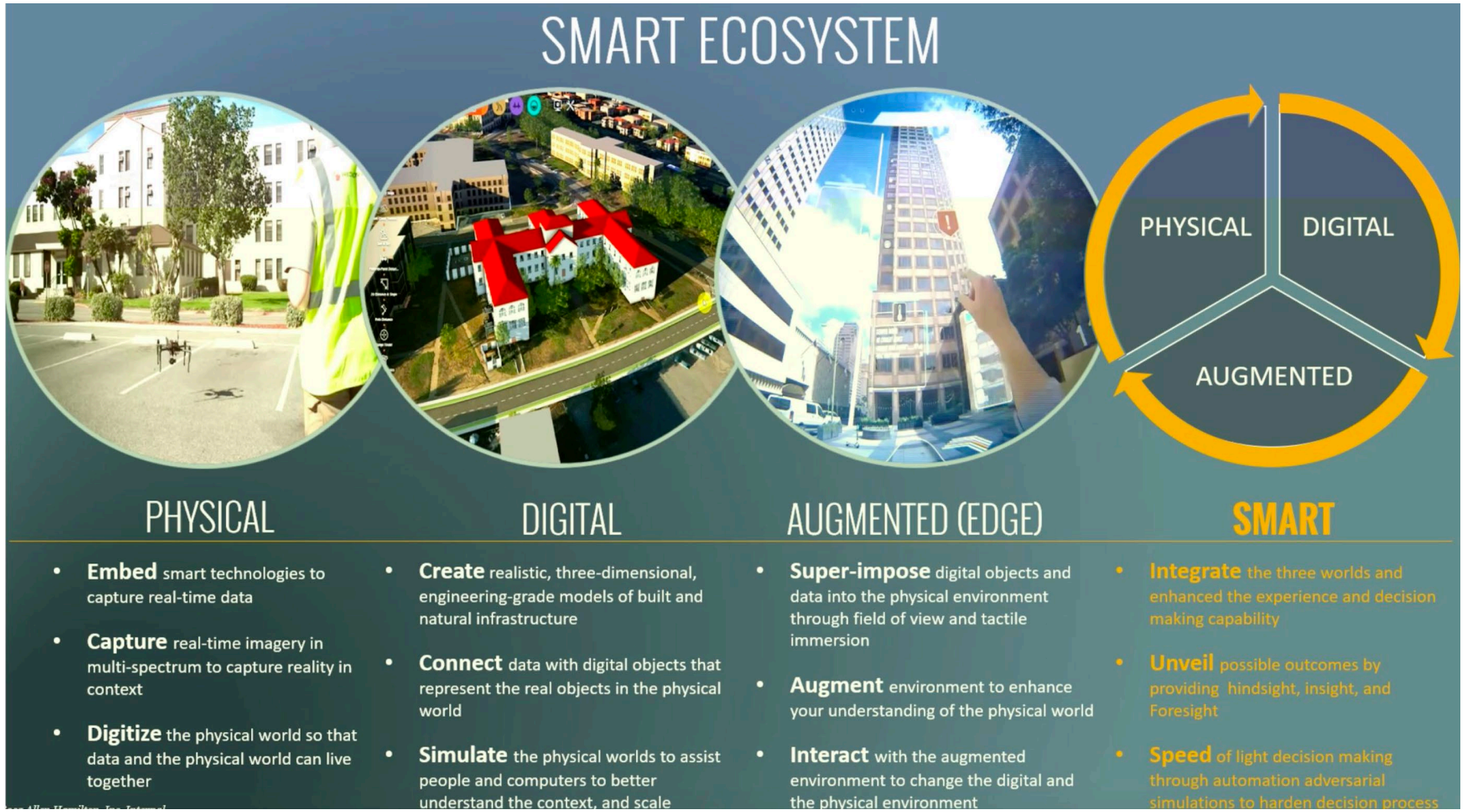
What (disruptive) technologies might improve building system integration?

A common software platform maintained throughout the project and turned over to the owner – a “digital twin”

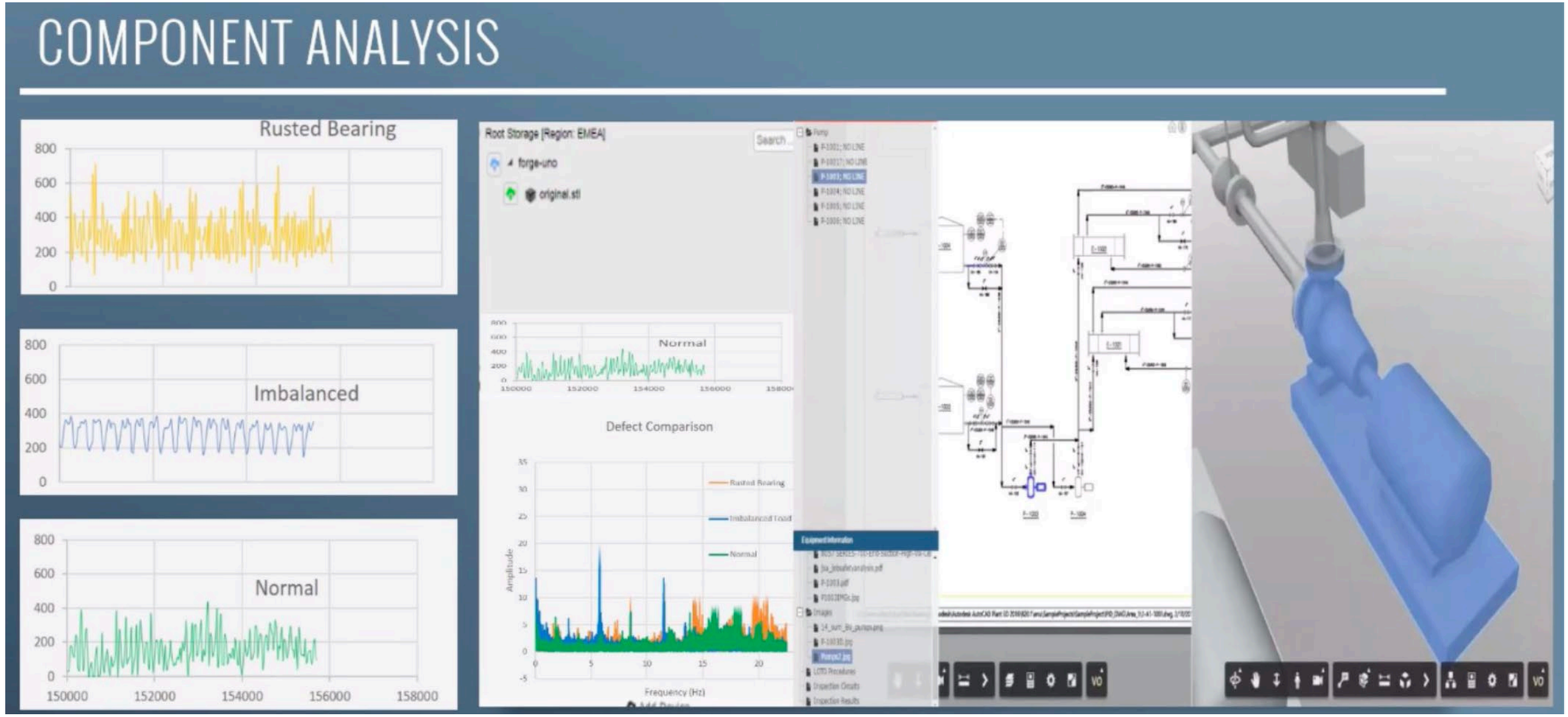


Acknowledgement: AkitaBox

How might Digital Twins improve building system integration?

- Market claims: addresses all know issues and inefficiencies, delivers world peace
- Risks: no common understanding of how to build one, what it costs, what it delivers, or what they even are
- (Disruptive) Opportunity: Drives greater collaboration and coordination or project stakeholders, embeds expertise into the project rather than in select phases, improved consideration of all relevant factors during analysis and decision making, delivers a better better building and a new more open, enterprise level software framework for building operation/control that is designed to consume building system data from the ground up and delivers improved performance for owners and occupants

Digital Twins are already being developed and used to monitor devices and predict failures



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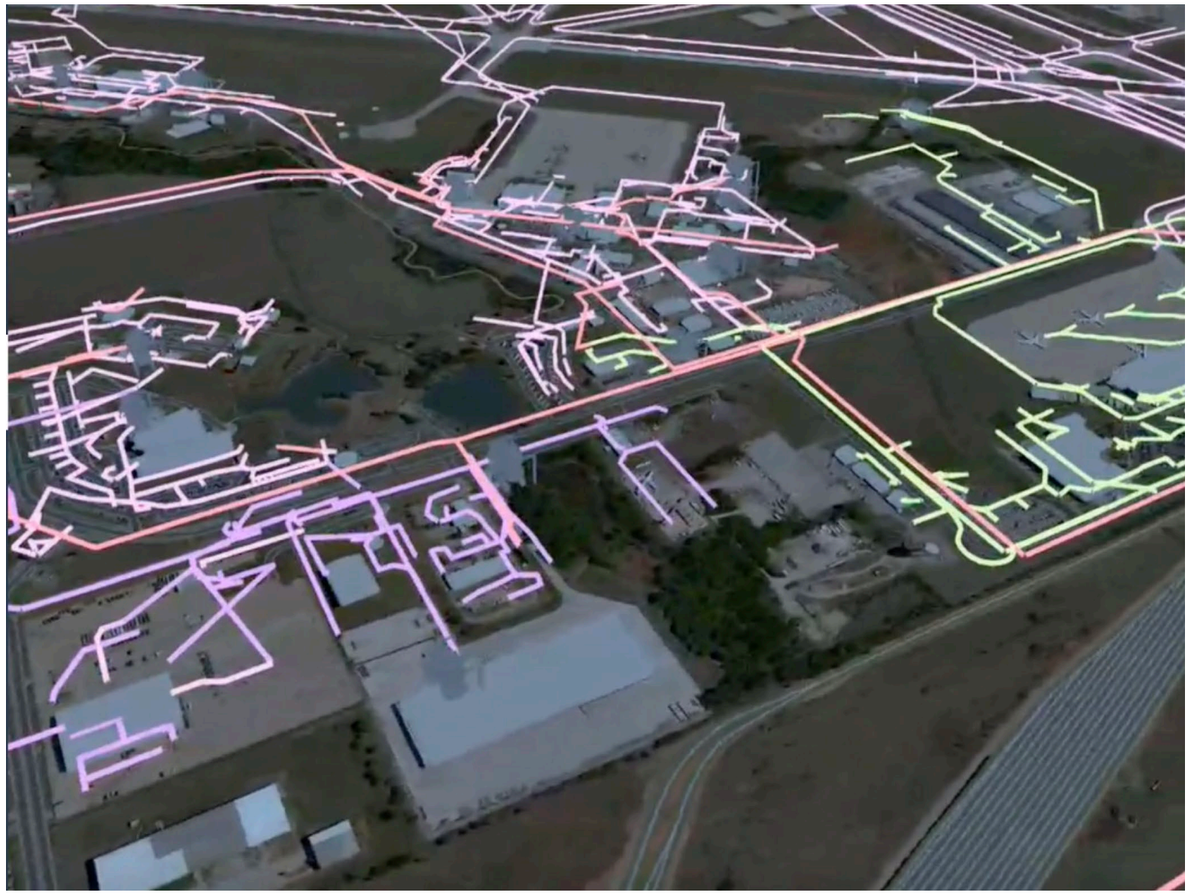
Digital Twins are already being developed and used to simulate the effects of environmental events and critical infrastructure issues

Flood conditions

Electrical infrastructure disruption



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What will it take to make this part of the standard process? Who identifies the necessary pieces and develops the workflow?

CLIENT | ARCHITECT | ENGINEER | CONSULTANT | CONTRACTOR | OPERATOR | DEVELOPER

Organization & Processing

Google Drive · Dropbox · Adobe Creative Cloud · Microsoft Office 2019 · slack · Microsoft Teams

Modeling & Simulation

SketchUp · Rhinoceros · grasshopper

Autodesk AEC Collection

AUTODESK REVIT · AUTODESK AUTOCAD · Dynamo Computational Design for BIM · AUTODESK 3DS MAX · AUTODESK INFRAWORKS 360 · AUTODESK CIVIL3D · AUTODESK NAVISWORKS · AUTODESK INSIGHT 360 · AUTODESK RECAP PRO · AUTODESK ADVANCE STEEL

Autodesk Connected Construction

AUTODESK BIM 360 · PlanGrid · BUILDINGCONNECTED · assemble

Application Specific

ElumTools · RADSITE radiance-online.org · AGi32 lighting software by Lighting Analysts

Advanced Logic or Analytics

AkitaBox · IES INTEGRATED ENVIRONMENTAL SOLUTIONS · SMARTBID A Product of JBKNOWLEDGE

"Digital Twin"

FORGE · Azure · amazon web services

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Questions?

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