Three Pre-Occupancy Interventions to Lower Recurring Costs of Capital Projects

Building a Total Cost of Ownership Mindset, Part II

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Facilities Forum

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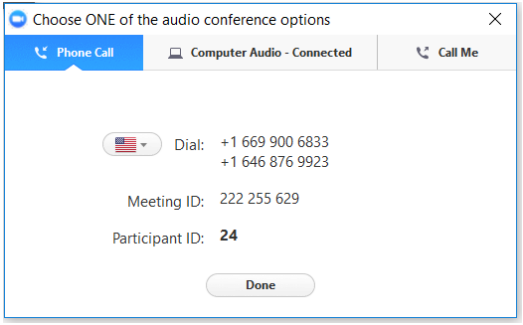

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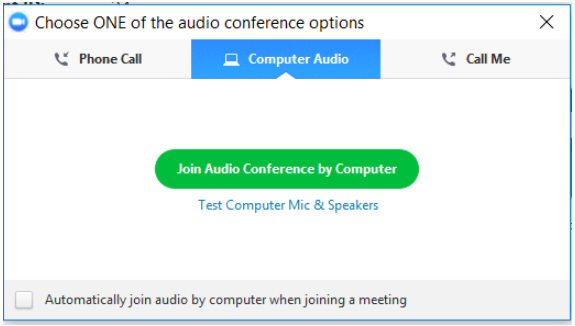

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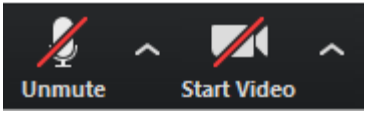

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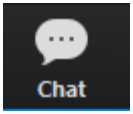

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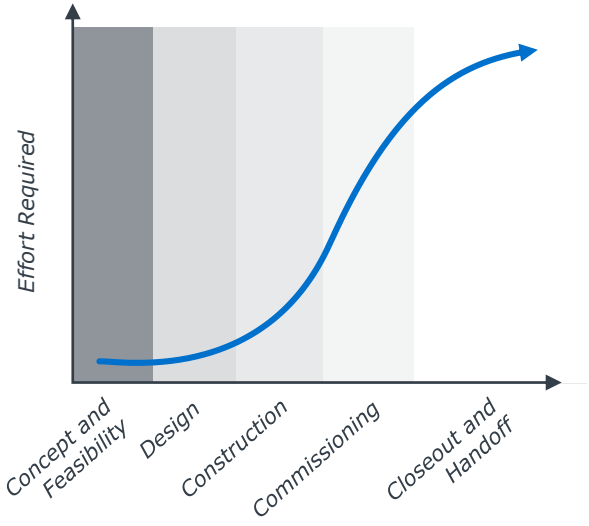
1) Operations and maintenance.

Source: EAB interviews and analysis.

For Greatest Impact, Start Early

First—and Lifetime—Costs Easiest to Manage in Initial Project Stages

Difficulty of Inflecting TCO Increases Across Capital Project Stages



> The more decisions you've made, the harder it is to undo them. I'd love to make better decisions sooner, but it sometimes feels like there's just too many cooks in the kitchen. And we're all following different recipes.
>
> **Senior Facilities Officer**
> Liberal Arts College

Source: EAB interviews and analysis.

In Search of the Big Picture

Siloed Decision-Making a Major Driver of Inflated TCO

Project Stakeholders	Representative Push-Back
Academic Leaders and Project Sponsors	*"Why should I give up more office space for a custodial closet?"*
Design Team	*"We gave maintenance a thumb drive with the plans—it's not my fault if they didn't review them."*
PMs and Contractors	*"I trust our contractors to install our systems correctly. What's the worst that could happen?"*
General Contractors	*"This res hall needs to be ready for move-in in two weeks—we just don't have time for everything."*

Facilities Intervention

- Charrettes
- Materials demonstration
- Cost review

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Source: EAB interviews and analysis.

Dial Communication Up to 11 with Charrettes

Charrettes Drive Toward Stakeholder Consensus Across Frequencies

REI Co-Op: One-Time, Single Day

- One day, led by Rocky Mountain Institute
- Stakeholders integrate workforce and business concerns into net-zero energy building plan
- **Participants:** Developers, corporate representatives, builders

UNC Asheville: One-Time, Multi-Day

- Two days, 55 people
- Participants discussed incorporating green design into new building
- Four sub-groups identify follow-up action items
- **Participants:** Students, faculty, design team, contractors, O&M staff

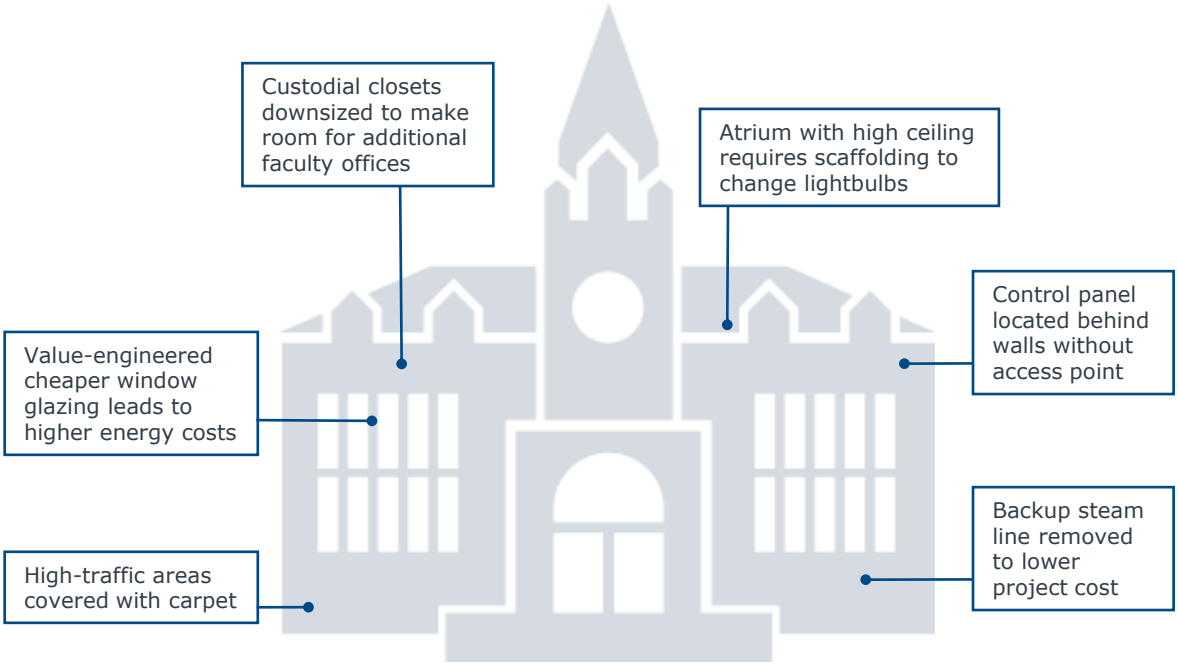
University of Alberta: Recurring Sessions

- Held regularly throughout project, one to three days each
- Designed to keep stakeholders engaged with project and incorporate feedback in dynamic setting
- **Participants:** Design team, administrators, select faculty, O&M staff

Source: L Stone, "REI Takes Its Stewardship of the Outdoors to the Next Level: A Net-Zero-Energy Distribution Center," Rocky Mountain Institute, February 1, 2017; University of Alberta, Edmonton, Alberta; University of North Carolina Asheville, Asheville, NC.

Tactic 4: Amplify the O&M Perspective in Project Design (as an Antidote to "Value Engineering")

The House That O&M Didn't Build



Source: EAB interviews and analysis.

Million-Dollar Mindset

O&M Input Guards Against First-Cost Bias via TCO Mindset

Whitaker University[1] Encounters Usual Value Engineering Challenges

500-bed residence hall project approved at $80M budget

Project scaled back to offer less expensive housing option to students

Design team instructed to find $30M in "value engineering" opportunities

SFO turns to O&M to vet and veto proposals that fail TCO test

Design Team Proposal:
Install individual PTAC[2] units in each room

$5M upfront savings

$7M additional costs over 10 years

O&M Counter-Proposal:
Hardie Board siding to replace stone facade

$2.5M upfront savings

$200K additional costs over 20 years

1) Pseudonym.
2) Packaged Terminal Air Conditioning unit.

Source: EAB interviews and analysis.

Incorporate O&M Feedback Early and Often

COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

Columbia Solicits O&M Feedback in Project Design at Regular Milestones

1. Design reviews scheduled at end of schematic design, design development, and construction document phases
2. Design documents circulated to shops and commissioning team with at least two weeks to review
3. O&M staff aggregate written comments in a spreadsheet
4. Design team reviews, discusses, and responds to O&M feedback
5. Feedback reviewed and verified in subsequent design iterations to ensure incorporation

Common Questions from Facilities Leaders About O&M Design Feedback

- How should I structure and schedule design reviews?
- How do I make sure staff attend (and engage in) the sessions?
- What are the most important issues to look for?

Source: Columbia University, New York, NY; EAB interviews and analysis.

Alternative Review Frequencies and Formats

DEPAUW UNIVERSITY

Staff Training and One-on-One Meetings

- Design process recently revised to include O&M staff, who initially struggled to participate effectively due to lack of experience
- SFO implemented comprehensive training to teach O&M staff design review tactics
- Additionally, SFO sat down one-on-one with staff to gather input on design features in a lower-stakes setting

UNIVERSITY OF CALGARY

Regular Cross-Functional Charrettes

- A&E team, O&M staff, and others participate in 6-8 design charrettes across project stages
- Each charrette focuses on a specific design problem that requires consensus
- Charrettes also serve as venue for quickly updating all staff about key developments and for facilitating cooperation at major decision points

ASU ARIZONA STATE UNIVERSITY

Meetings Triggered by Variance Requests

- Contractors occasionally perceive the need to deviate from design guidelines
- Project manager submits variance request justifying the substitution
- Approval requires heads of construction and maintenance both to agree that variance serves Facilities' short- and long-term interests
- Download ASU's variance request form here

Source: Arizona State University, Tempe, AZ; DePauw University, Greencastle, IN; University of Calgary, Calgary, AB; EAB interviews and analysis.

Protect O&M Staff Time to Ease Participation

Two Strategies to Ensure Engagement While Avoiding Burnout

1 Schedule (and Track) Staff Involvement in CMMS[1]

Use CMMS to create work orders for design review sessions to reserve time and recognize value of O&M contributions

Work orders can also be used to track other capital project-related work of O&M staff, such as construction site walkthroughs

> "We open up a work order for every design review to make sure we allocate the necessary time and underscore the value of the task to our O&M teams."
>
> *Craig Short, Former SFO*
> *James Madison University*

2 Limit O&M Staff Participation to No More Than One Hour per Week

Setting a limited amount of time O&M staff are expected to review designs helps them prioritize day-to-day maintenance work

Keep meetings and design tasks short and tightly scoped to help staff stay engaged

> "When design reviews are scoped, we all win. O&M gives us quality feedback and can contribute without feeling like it's at the expense of other tasks."
>
> *Senior Facilities Officer,*
> *Regional Private University*

1) Computerized maintenance management system.

Source: James Madison University, Harrisonburg, VA; EAB interviews and analysis.

Start Your Design Review Checklists Here

Areas of Focus in O&M Design Reviews

- Access to each piece of equipment for maintenance and replacement tasks
- Compliance of design with Owner's Project Requirements
- Interaction amongst building equipment and systems
- Planned redundancies
- Compliance with design guidelines and functional performance expectations
- Compliance with applicable codes and regulations
- System-specific design expectations

Additional Notes

Consider making **system-specific checklists** in consultation with shops that assess and maintain them

Rather than starting reviews on the first sheet of drawings, go through them in **order of construction**: structural; building envelope; interior architectural; mechanical, electrical, and plumbing systems; and sitework

Minimize unnecessary tasks by instructing design teams to incorporate feedback directly into plans, responding only to those items meriting discussion

Source: C Hawkins, "Commissioning Design Review, BCA Bet Practices," BCxA Conference, 2018; EAB interviews and analysis.

Tactic 5: Pull Forward Commissioning to Minimize Early-Occupancy O&M Costs

Benefits of Building Commissioning (Cx)

By integrating commissioning across capital project phases, institutions can:

- Minimize unnecessary growth of energy and maintenance costs
- Influence project planning and design
- Ensure quality and correct installation before the contractor leaves
- Confirm regulation and code compliance
- Achieve building awards like LEED, Green Globes, and Energy Star

Savings Potential Well-Documented…

13%

Median whole-building energy savings on commissioned new buildings

4.2

Average payback time in years on commissioned new buildings

…But Some Campuses Balk at Initial Cost

2–4%

of electrical system first costs

3–4%

of mechanical system first costs

Source: Lawrence Berkeley National Laboratory, *Building Commissioning*, 2009; Richard Casault, "The Building Commissioning Process," 2013; EAB interviews and analysis.

(More Than) An Ounce of Prevention

Commissioning Most Effective When Embedded Across All Project Stages

Project Phases and Corresponding Commissioning Activities

Phase	Activity Snapshot		Documentation	Prevalence
Planning	Develop Cx scope and budget	Integrate OPR[1] into building-specific Cx plan	• OPR[1] • Cx plan • Responsibility matrix	*Low*
Design	Provide input on value engineering decisions during design review	Develop Cx specs based on design elements	• BOD[2] review • Design reviews • Spec review	*Medium*
Construction	Construction site walkthrough to monitor installation progress	Prepare and execute pre- functional tests	• Submittal review • Onsite observation • Pre-functional testing	*High*
Building Handoff	Lead whole-building system training	Conduct individual asset training based on agenda template in Cx Manual	• Functional testing • O&M review • Owner training	*Medium*
Post-Occupancy	Oversee 10-month warranty review	Follow-up Cx across two seasons to account for changing temperatures	• Final Cx Report • Seasonal testing • Warranty review	*Low*

1) Owner's Project Requirements.
2) Basis of Design.

Source: Building Commissioning Association, "New construction Building Commissioning Best Practices;" D E Gregory, "Building Commissioning New and Existing Facilities;" EAB interviews and analysis.

Formally Document Commissioning Expectations

More Mature Institutions Adopting Commissioning Master Plans

Elements of Effective Commissioning Documents

- Commissioning team roster and respective responsibilities
- Systems to be commissioned for each type of project
- General Cx flowchart/timeline and procedures
- Templates for Cx documentation (e.g., Cx Status Check Sheets, Cx reports)
- Cx requirements as outlined in OPR[1] and BOD[2]
- Processes for pre-functional and functional tests, notifications of errors

Caltech

Commissioning in Design Guidelines

- Design Guidelines outline commissioning responsibilities
- Include processes for vendors
- Download Caltech's Guidelines here

American University Washington, DC

Commissioning Master Plan

- Standardizes commissioning across current and future projects
- Includes processes and sample templates, documentation
- Download AU's Commissioning Plan here

1) Owner's Project Requirements.
2) Basis of Design.

Source: American University, Washington, DC; California Institute of Technology, Pasadena, CA; EAB interviews and analysis.

Scale Commissioning Efforts to Project Scope

Delete Systems, Not Tasks to Preserve Overall Quality

Filters to Narrow Scope of Commissioning

VANDERBILT UNIVERSITY MEDICAL CENTER

Cost and Size

- VUMC created three Cx tiers for its buildings based on GSF[1] and construction cost
- Each tier is assigned a Cx level and corresponding tasks, outlined in a matrix
- *Example:* Projects >200K GSF and/or >$10M are in the highest Cx tier
- *Use this approach when* funding for Cx is scaled to the individual project budget

VUMC's Cx Tiers

GSA

Type of Structure

- U.S. General Services Administration (GSA) chooses systems to commission based on building type
- GSA built matrix to outline which items to include in Cx for each building type
- *Example:* All HVAC systems in a lab are commissioned, but not in an office building
- *Use this approach when* energy savings are a priority (energy hogs receive the most robust Cx)

GSA's Cx Matrix

THE UNIVERSITY OF TEXAS AT AUSTIN

Risk and Complexity

- University of Texas at Austin establishes risk and complexity levels for building systems, spaces, and components
- Risk and complexity ratings are combined to determine the overall Cx intensity
- *Example:* Major lab renovations are typically high-risk, high-complexity
- *Use this approach when* an institution's most complicated buildings are its highest priority

UT Austin's Cx Matrices

1) Gross square foot.

Source: General Services Administration; University of Texas at Austin, Austin, TX; Vanderbilt University Medical Center, Nashville, TN; EAB interviews and analysis.

Commissioning Tiers at UT Austin

University of Texas at Austin's Commissioning Matrix

THE UNIVERSITY OF TEXAS AT AUSTIN

RISK		COMPLEXITY	COMMISSIONING LEVEL
High risk	OR	High complexity	Commissioning Level 1
Medium risk	OR	Medium complexity	Commissioning Level 2
Low risk	OR	Low complexity	Commissioning Level 3
Very low risk	AND	Very low complexity	Commissioning Level 4

APPENDIX A.3
COMPLEXITY EVALUATION WORKSHEET

Renovation Project Master Commissioning Plan

System ▼ / Complexity Factor ▼	Complexity Level ▶ High	Med	Low	Very Low	Reason for Change
Building Envelope:					
Changes that effect thermal or moisture performance		●			
Changes that effect finishes and furnishings				●	
Vertical Transport					
Escalators, new, or revised controls		●			
Elevators & lifts, new, or revised controls	●				
Plumbing					
Replace fixtures, no change in fixture count			●		
Revisions that change fixture count		●			
Add electronic valve controls		●			
Revise central equipment (PRV, RPBP, pump, heater)	●				
Fire Suppression					
Water, relocate or add heads		●			
Water, revise mains, risers, or FDC	●				
Dry, relocate or add heads		●			
Dry, revise mains, risers, or FDC	●				
Dry, revise compressed air equipment or controls	●				
Inert gas, relocate or add heads		●			
Inert gas, revise manifold or controls	●				

Defined Commissioning Levels
Top chart outlines tiers and organizing principles

Detailed Building Components
Descriptions communicate systems that affect Cx level

Clear Tiers and Requirements
Four pre-determined complexity levels define Cx scope

Download UT Austin's matrix and commissioning guidelines here

Source: University of Texas at Austin, Austin, TX; EAB interviews and analysis.

In-House vs. Third-Party Commissioning

Facilities Leaders Voice Strong Opinions on Both Sides of Debate

Commissioning Led by In-House Team

"In-house is the only way to go if we want to retain institutional knowledge that comes from commissioning."

- Knowledge gained through commissioning stays with Facilities staff after building handoff
- Commissioning less likely to be seen as an extra line item in project budget; protected from cuts
- Scheduling an in-house Cx review is easier than procuring services across the planning/design phases

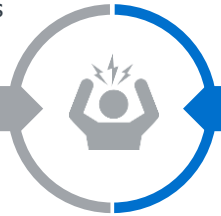
Institutional Ownership

Commissioning Outsourced to Third-Party Experts

"Cx must be done by a third party if we want a thorough, unbiased assessment of our systems by expert practitioners."

- Independent agent provides a fresh, unbiased look at a project's documentation and construction
- Contractors bring a wide range of expertise from working on diverse projects
- Third-party agents can be more financially viable for schools with fewer capital projects

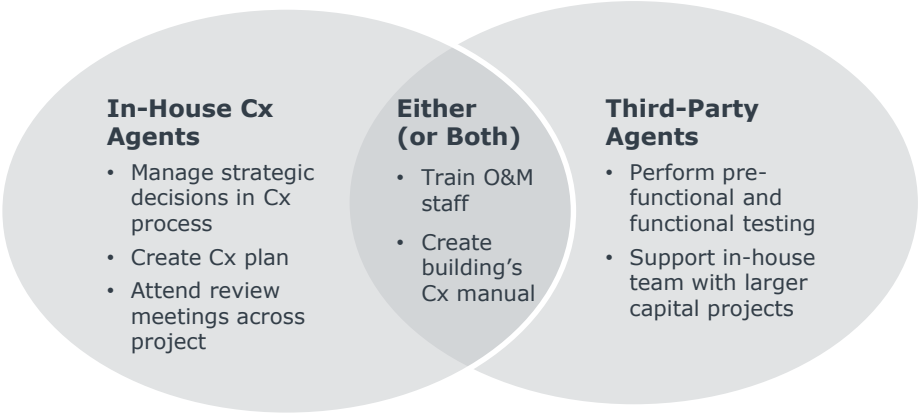
Independent Expertise



Source: EAB interviews and analysis.

Keep High-Risk, High-Impact Tasks In House

Possible Distribution of Commissioning Activities Across Staffing Options



Implementation Advice…Regardless of Structure

- Create an accessible systems manual and record trainings to preserve commissioners' building systems knowledge
- Extend commissioning beyond project closeout with functional tests in different seasons and checks on warranties during first year

Source: EAB interviews and analysis.

Tactic 6: Establish Building Handoff Expectations that Simplify O&M Activities in Early Occupancy

Typical Delivery of Handoff Documents

Dangers of Poor Handoff

8% Increase in annual maintenance budget when Facilities delays logging assets into CMMS

30% Increase in net costs of a building during first five years of occupancy when O&M training is skipped or rushed

Source: B East, "Construction-Operations Building Information Exchange (COBie)," WBDG, Oct 6, 2016; Emerson, "Operational Readiness: Bridging the Gap Between Construction and Operations for New Capital Assets," Emerson, Nov 2018; EAB interviews and analysis.

Habits of Highly Effective Checklists

Communicate Contractor Responsibilities Early—And Enforce with Incentives

Handoff Checklist Must-Haves

- O&M training schedule
- Updated as-built drawings
- Warranty information
- Commissioning documentation
- Systems manuals (including control drawings, riser diagrams and control sequence highlights)
- Expectations for transferring asset data
- Final walkthrough
- Final performance testing

Download Austin Peay State's **Project Closeout Checklist** here.

Implementation Guidance

Include incentives to complete the checklist (e.g., withholding final payment until all tasks are done, or requiring the general contractor to operate the building for a short time)

Attach hard deadlines to each task, such as percent complete or time remaining

Clarify responsibilities by assigning ownership over key tasks (designer, PM, contractor, etc.)

Pull forward conversations about turnover expectations, ramping up during commissioning

Source: Austin Peay State University, Clarksville, TN; Emory University, Atlanta, GA; EAB interviews and analysis.

Beyond Checking Boxes

Ease Future O&M Efforts with Clear Training and Data Transfer Expectations

Asset Data Transfer

- Request electronic copies of all building documents, not just paper versions
- Specify a content list and file format for O&M documents (e.g., manuals, warranties)
- Select a file format for asset management data that is compatible with CMMS

Staff Training

- Schedule training at least three months before end of construction
- Jump-start staff training by scheduling walkthroughs for O&M staff
- Articulate in advance expectations for systems and content covered by training

Document Delivery Standards

- **Emory University**'s Document Delivery Standards require contractors to submit BIM data for all projects $500k+
- End product is a BIM Asset Information Database in spreadsheet form, organized by BIM categories
- Download Emory's standards here

Training Standards

- **American University** requires contractors to go beyond simple demonstration of systems and discuss emergency procedures and materials required for maintenance
- Download American University's documentation here

Source: American University, Washington, DC; B East, "Construction-Operations Building Information Exchange (COBie)," WBDG, Oct 6, 2016; EAB interviews and analysis.

A Walkthrough to Remember

Pre-Occupancy Reviews Provide Contractor Accountability, Staff Training

Guidance for Effective Building Walkthroughs

Hold multiple walkthroughs throughout construction, not just one near completion

Use walkthroughs as a quality control check on contractors' adherence to design standards

Photograph systems that will be concealed to ease future maintenance

Jump-start O&M training by familiarizing staff with systems as they are installed

Ensure that all concealed systems maintain access points for O&M staff

Track walkthroughs in CMMS to affirm their value alongside other O&M tasks

Source: EAB interviews and analysis.

Mind the Gap

Dedicated Staff Monitor O&M Needs Across Handoff, Early Occupancy

Miami University — Handoff Czar

- Single FTE focuses on quality control and warranty tracking across building handoff, reducing pressure on project managers
- Coordinates between contractors and O&M through first year of occupancy
- **Ideal for** institutions with smaller capital project workloads

The University of British Columbia — Transition Team

- Created new positions within Building Operations to oversee transitions
- Team participates in every phase of capital project, but charged with oversight of equipment, safety, and training issues in lead-up to occupancy
- **Ideal for** institutions with high volume of capital projects, experienced staff

University of Washington — Outsourced Partner

- **Transition to Occupancy (T20) program** enlists third party to coordinate handoff in collaboration with in-house project delivery team
- Focus on commissioning, data transfer, O&M staff training, and creation of maintenance strategy
- **Ideal for** institutions with very large capital workload and good financial resources

Across seven capital projects, Miami University's handoff czar realized:

Download the handoff czar job description

$450K costs avoided from monitoring warranties

$120K refunds from contractors

3x ROI on czar's annual salary

Source: Miami University, Miami, OH; University of British Columbia, Vancouver, BC; University of Washington, Seattle, WA; EAB interviews and analysis.

Laurentian's Dashboard Tracks Campus Readiness

LaurentianUniversity
UniversitéLaurentienne

Color-Coded Dashboard Keeps Units on Track in the Leadup to Occupancy

Near-Term Deliverables	Comments	Point Person	Status
Construction		**Bob Builder**	
Commissioning	On track Risk: Air conditioning will not be turned on until summer		
O&M Training	Delayed Risk: Contractor has not submitted schedule		
End User Move-in		**Helen Handoff**	
Furniture selection	On track		

Key Components of Laurentian's Handoff Efforts

- Wide range of internal stakeholders assembled to oversee operational readiness: Facility Services, IT, Marketing, Capital Projects, Campus Safety, Development, end-users, etc.
- Operational readiness planning begins immediately following project approval
- Meetings begin as early as 18 months before occupancy; used to review operational readiness expectations and assign tasks to each group
- Progress toward multiple goals across divisions managed with Gantt chart and dashboards

Source: Laurentian University, Sudbury, ON; EAB interviews and analysis.

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1) Operations and maintenance.

Source: EAB interviews and analysis.

Any Questions?

Contact Information

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Evaluating Today's Session

Please take a minute to provide your thoughts on today's presentation.

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