



Introduction to Cx

Key EBCx Skills

1. Be able to benchmark and perform utility analysis
2. Be able to scope a facility for obvious indicators of opportunity
3. Be familiar with fundamental principles and building systems
4. Understand and apply the system concept
5. Be able to perform data logging and trend analysis
6. Be familiar with functional testing techniques
7. Be familiar with data analysis techniques
8. Be familiar with basic HVAC and energy calculations
9. Be familiar with cost/benefit and return on investment calculations
10. Be familiar with implementation strategies and techniques

Key EBCx Skills – Skill 3 is a BIG ONE!

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Key EBCx Skills – Skill 3 is a BIG ONE!

3. Be familiar with fundamental principles and building systems

- i. Saturated systems
- ii. Loads, psychrometrics and envelopes
- iii. Centrifugal machines
- iv. Refrigeration and cooling equipment
- v. Heating equipment
- vi. Piping systems
- vii. Variable flow water systems
- viii. Duct systems
- ix. Air and water side economizers
- x. Make up air systems and exhaust systems
- xi. Variable air volume systems
- xii. Control systems
- xiii. Electrical systems
- xiv. Life safety systems



Bottom Line

There's a lot to learn!



What Is Building Commissioning?

Dictionary Definition



Com·mis·sion

kə'miSHən

Verb; Gerund or present participle: Commissioning

1. Give an order for or authorize the production of (something such as a building, equipment, or work of art).

The portrait was commissioned by his widow in 1792

synonyms: order, authorize, bespeak

2. Bring (something newly produced, such as a factory or machine) into working condition.

We had a few hiccups getting the heating equipment commissioned

3. To put a ship into commission

Dictionary Definition

An analogy to a ship's sea trials or "shake-down" cruise

3. To put a ship into commission

Industry Definition

Commissioning is a systematic process of ensuring that all building systems perform interactively according to the contract documents, the design intent and the Owner's operational needs

- Begins in predesign
- Documents the design intent
- Continues through construction, acceptance, the warranty period, and through the building's life cycle
- Includes functional testing
- Includes training
- Documents performance

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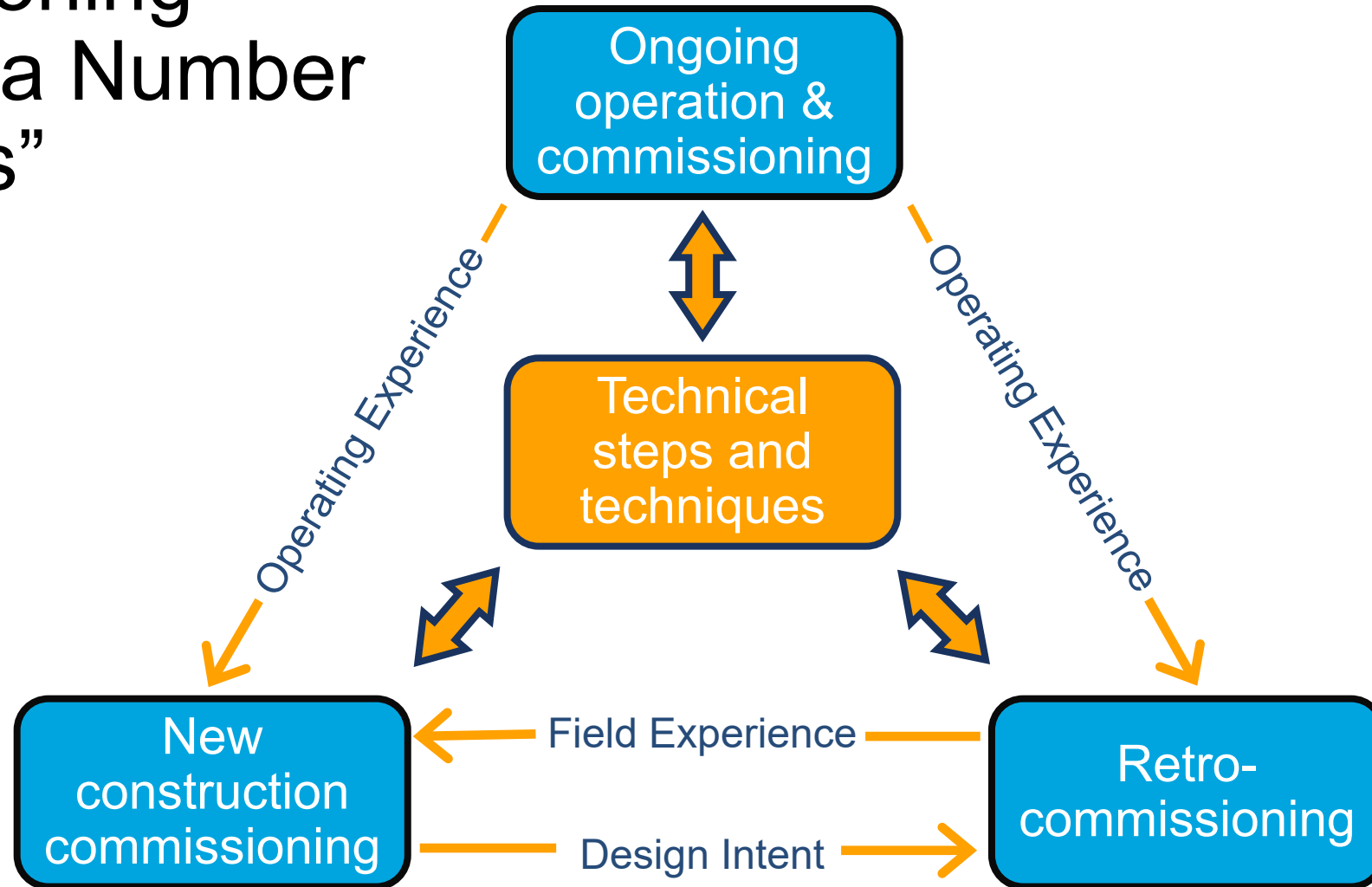
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Commissioning is about performance and integration

Commissioning Comes in a Number of “Flavors”



What is Retrocommissioning?

In general terms, it's the same thing as:

- RCx
- Existing Building Commissioning
- EBCx
- Recommissioning
- Building tune-up

What is Ongoing Commissioning?

Continuous Commissioning™

A Trademarked Process Developed by Texas A&M

Operating the Building Properly

What folks called it when I started doing this stuff (1976)

You May Not Fully Comprehend the Situation

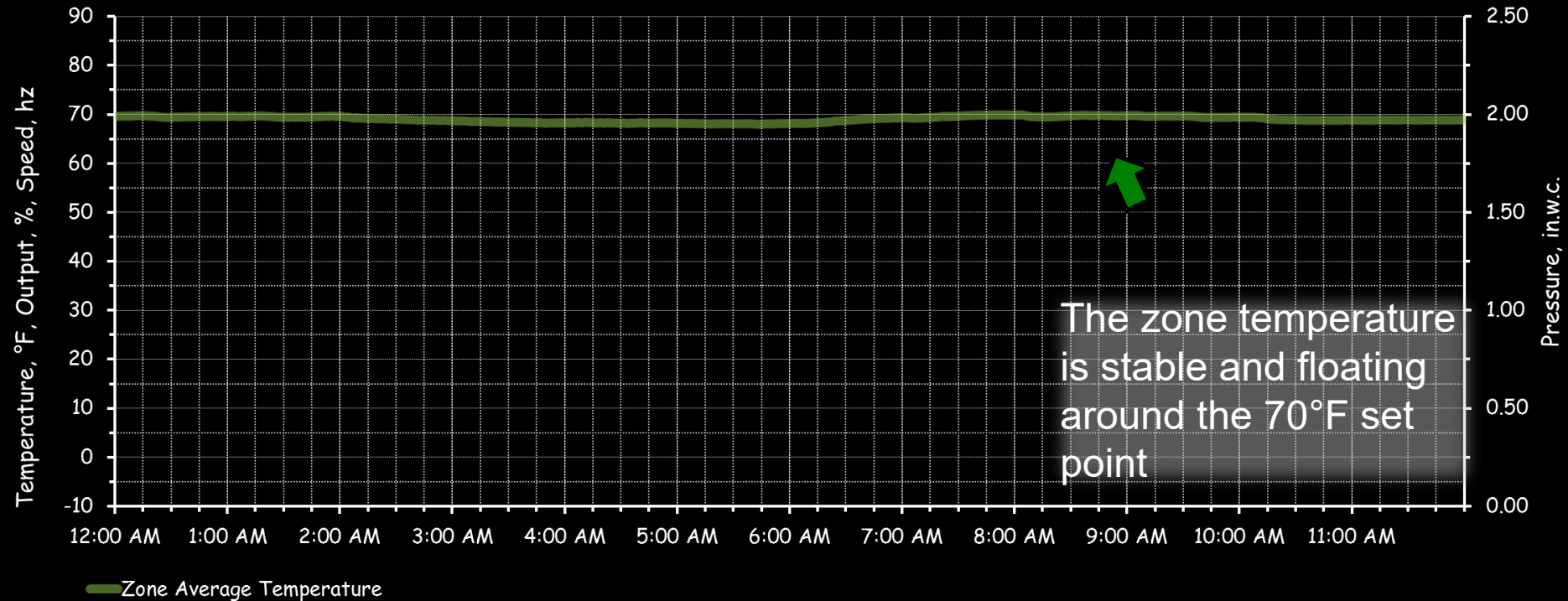
“... If you are piloting an untested vehicle on it's first test flight and that vehicle contains more propellant than was ever placed on a launch pad before and the vehicle was assembled by the low bidder and you aren't a little nervous, then you don't fully comprehend the situation”

Paraphrased; John Young to Barbara Walters when asked if he would be nervous as the test pilot on the first manned shuttle flight



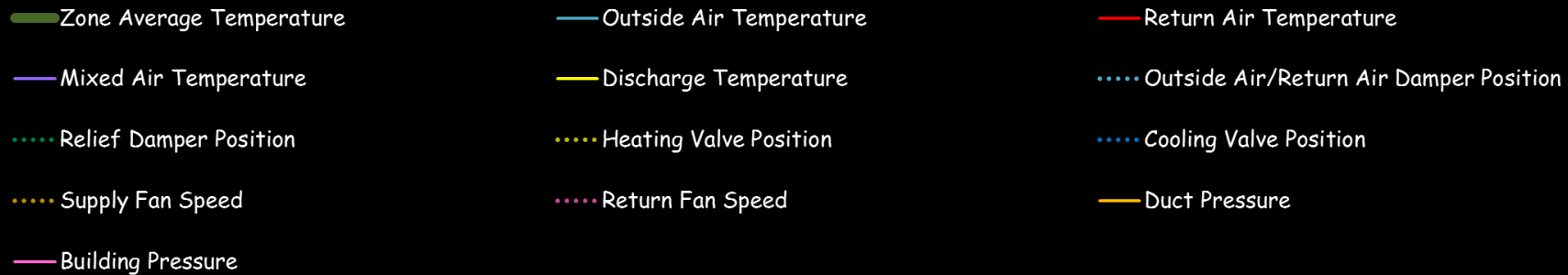
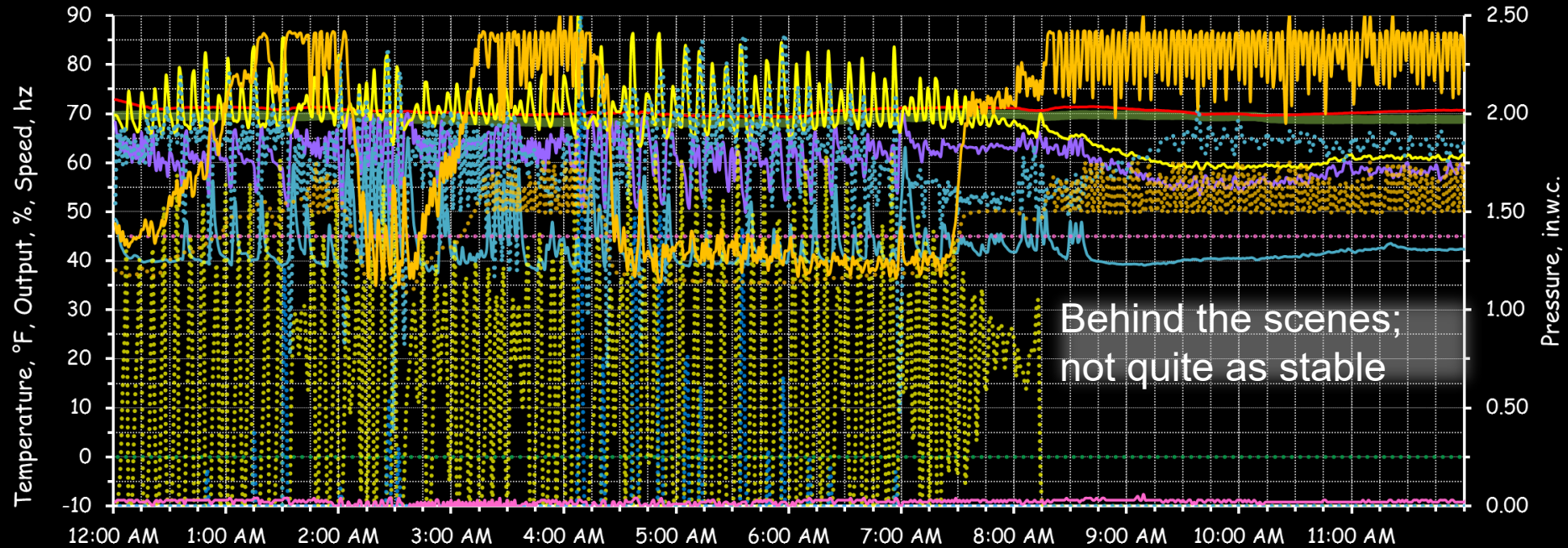
Things may seem fine at the office ...

RTU2 Control System Operation
December 7, 2001



... but HVAC is dynamic and complex

RTU2 Control System Operation
December 7, 2001



HVAC System Fundamental Goals

- Keep the building comfortable
- Keep the people using the facility productive
- Keep the building safe
- Keep the building clean





Commissioning's Benefits

Typical New Construction Cx Issues

- Poor turn-down capabilities
- Unanticipated interactions
- Pump head is excessive
- Fan static is insufficient
- Rouge zones
- Control sensor calibration
- Control sensor location
- Control system logic
- Control system design
- Schedules missing
- Equipment missing



Typical Existing Building Cx Issues

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- Most existing building commissioning issues are unresolved new construction commissioning issues or design issues
- Existing building commissioning issues are excellent design review targets

Achieving Persistence is the Challenge

In a system, a process that occurs will tend to increase the total entropy of the universe.

- 2nd Law of Thermodynamics

- Things wear
- Heat transfer characteristics change
- Things break
- People forget
- People make mistakes



Image courtesy Jay Cmiel, San Jose Marriott

Achieving Persistence is Rewarding

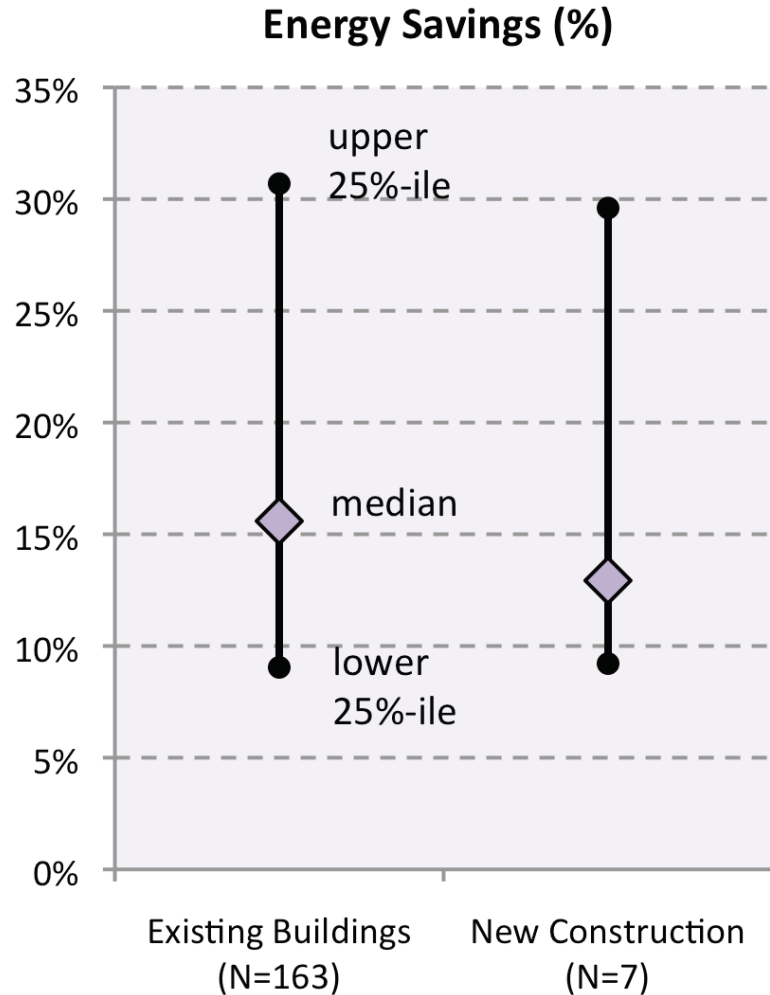
- Lawrence Berkeley National Labs published a meta-study on the benefits of commissioning in 2004
- Updated in 2009 and 2019

<https://tinyurl.com/CxCostBenefitLBNL>



A screenshot of a web browser displaying the Lawrence Berkeley National Labs (LBNL) website. The page title is "BUILDING COMMISSIONING: A Golden Opportunity for Reducing Energy Costs and Greenhouse-Gas Emissions". The browser's address bar shows "cx.lbl.gov/cost-benefit.html". The page content includes a navigation menu with "HOME", "COST-BENEFIT ASSESSMENTS", "PRESS", "RESOURCES", and "HALL OF SHAME". The main content area is titled "COST-BENEFIT ASSESSMENTS" and states: "We have published the following three cost-benefit analyses of real-world commissioning projects." It lists three items: "2009 Assessment [Summary] [PDF]", "2004 Assessment [Summary] [PDF]", and "Monitoring-based Commissioning [Summary] [PDF]". Below this, there is a "Presentations" section with three items: "Building Commissioning: A Golden Opportunity for Reducing Energy Costs and Greenhouse-gas Emissions [PPT - 22mb] [PDF - 5mb]", "The Business Case for Commissioning New and Existing Buildings Presentation for Pacific Energy Center Workshop, December 6, 2005 [PDF]", and "Costs and Benefits of Commissioning New and Existing Commercial Buildings Conference on Building a Sustainable Campus Community (UCSC), June 21, 2005 [PDF]". The "Related publications" section lists several articles from "ASHRAE Journal", "Energy Engineering", and a "Newsletter of the International Association for Energy-Efficient Lighting". The footer of the page reads "©2018 Building Technology and Urban Systems Division | Energy Technologies Area".

Achieving Persistence is Rewarding



cx.lbl.gov/cost-benefit.html

HOME > Cost-benefit Assessments

BUILDING COMMISSIONING

A Golden Opportunity for Reducing Energy Costs and Greenhouse-Gas Emissions

HOME

COST-BENEFIT ASSESSMENTS

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PDFs require [Adobe Acrobat Reader](#)

Presentations

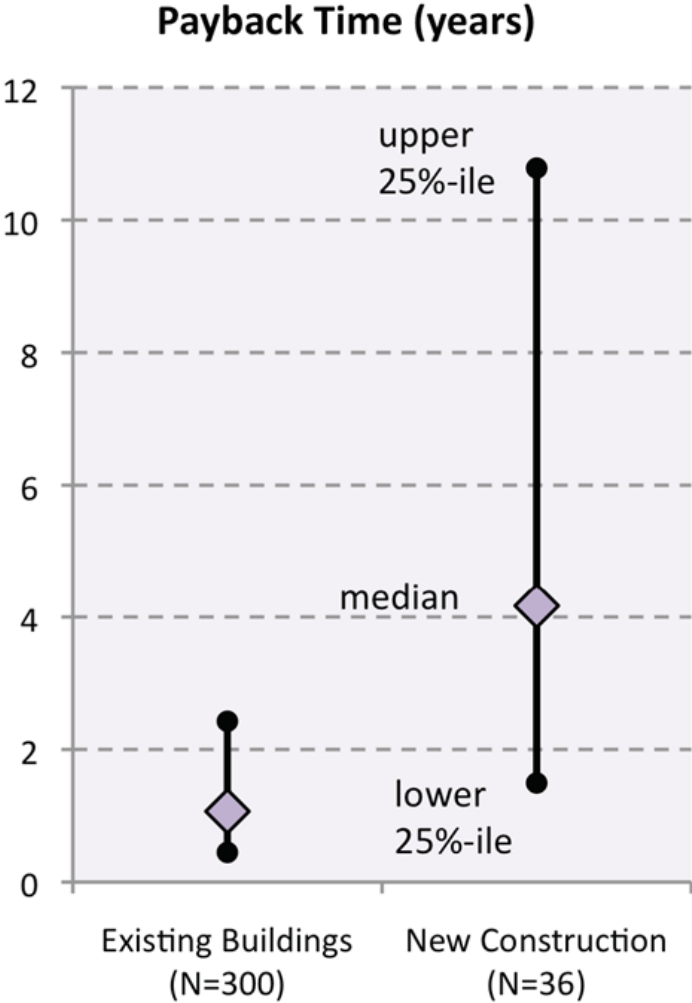
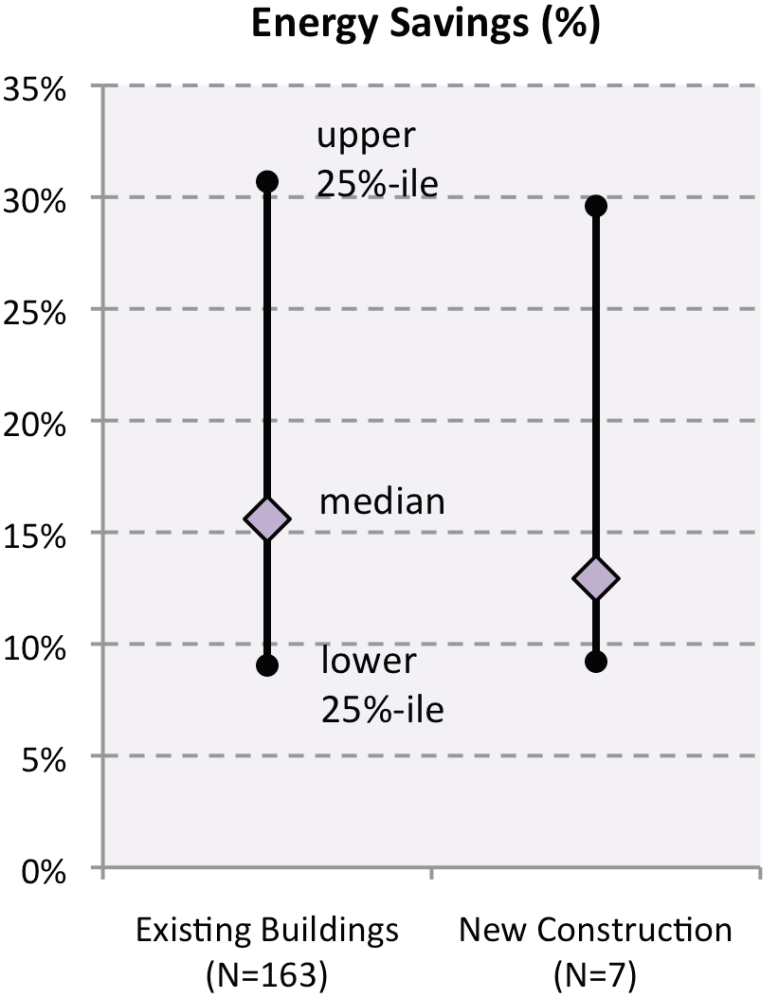
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Related publications

- Mills, E. 2011. "Commissioning High-Tech Facilities" *ASHRAE Journal*. November, p. 18. [PDF]
- Mills, E. 2011. "Commissioning: Capturing the Potential." *ASHRAE Journal*. February. [PDF]
- Mills, E. 2009. "Building Commissioning: The Stealth Energy-Efficiency Strategy," *Climate Progress*, August 12 [online] [PDF]
- Mills, E., P. Mathew, N. Bourassa, M. Brook, and M.A. Piette. 2008. "Action-Oriented Benchmarking: Concepts and Tools." *Energy Engineering*, Volume 105, Number 4, pp. 21-40. LBNL-358E. [PDF]
- Mathew, P., E. Mills, N. Bourassa, M. Brook. 2008. "Action-Oriented Benchmarking: Using the CEUS Database to Benchmark Commercial Buildings in California." *Energy Engineering*, Volume 105, Number 5, pp. 6-18. LBNL-502E. [PDF]
- Mills, E. 1994. "A Neglected Opportunity: Lighting Commissioning for Energy Savings." *Newsletter of the International Association for Energy-Efficient Lighting (2/94)*. [Online version]
 - Also in *Strategic Planning for Energy and the Environment*, Fall, pp. 25-28.

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Achieving Persistence is Rewarding





The Bigger Picture



Why This Matters

*We went to explore the Moon, and in fact
discovered the Earth*

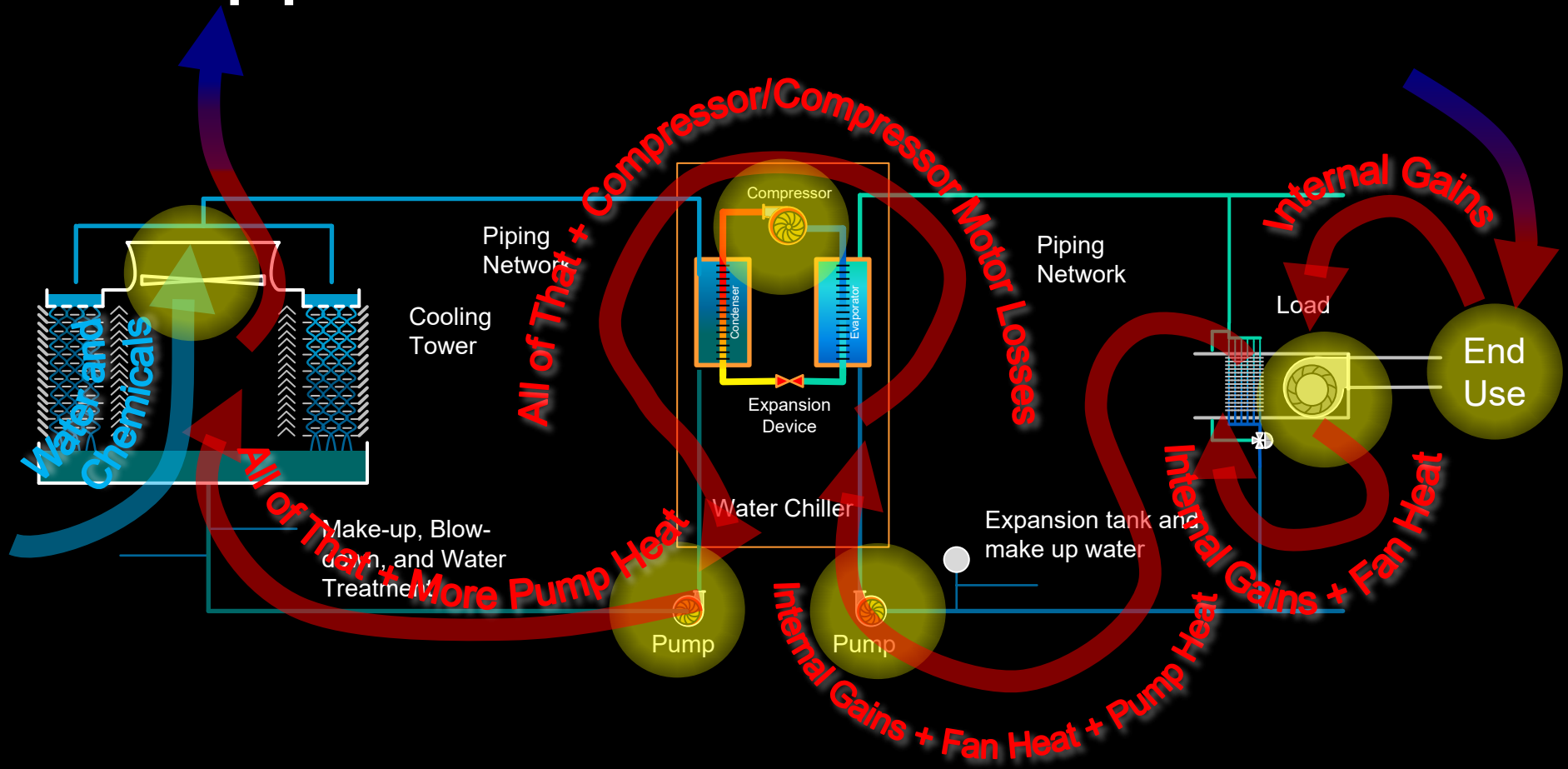
*Gene Cernan
Apollo 17 Commander*

*We don't inherit the world from our ancestors,
we borrow it from our children*

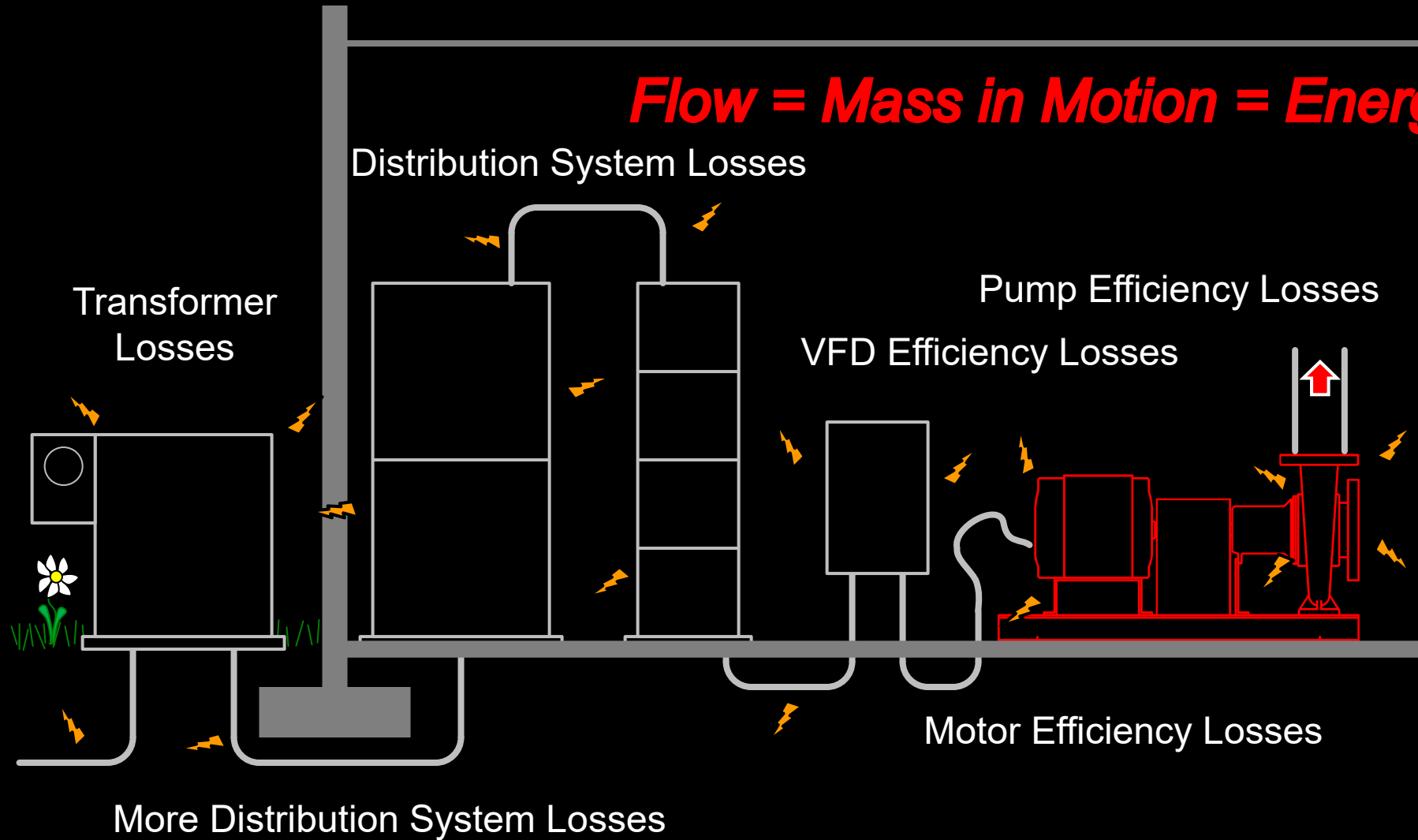
Unknown



Applying the Commissioning Tool Set can Have Ripple Effects



Flow = Mass in Motion = Energy





Question?



Together, Building
a Better California