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Best Practices of Building Commissioning

The "The Total Building Commissioning Process" for Delivery of Quality Constructed Projects

Total Building Commissioning Process (TBCxP)

- A process that improves the delivery of constructed projects
  - Time
  - Cost
  - Owner's Project Requirement
  - Clear design and basis of design
  - No Punchlists
  - No change orders
  - Achieve new challenging goals
  - Everyone's profit
  - Continuous Improvement

Best Practice of the Building Commissioning Process

- is a quality delivery process for constructed projects
- that improves owners defined project requirements,
- eliminates waste and reduces rework,
- speeds construction and decisions, and
- improves operations and maintenance of the facility

Best Practice of TBCxP

- Further it makes the planning, design, construction and operations more FUN!
- Improves everyone's profit and satisfaction
- Allows and provides continuous improvement
- Benchmarks whatever is important, including productivity of the facility!!

Must Know Your TBCxP Mission

- Do not go into the **Total Building Commissioning Process** blindly
- Define it's **mission** for you
- Adopt ***a process*** that you can evaluate
- Do not just add another **"expert"** to your team, without knowing or defining the benefits and expectation

Is this the new concept?

The TBCxP is an **"expert" system**

Not a

System of **"experts"** !!!™

TM by Chad Dorgan

First Steps in Implementing

- Define the Mission of the TBCxP
- Define benefits
- Define barriers
- Define benchmarks

What is Total Building Commissioning Process (TBCxP)?

A ***quality process***

to VERIFY and DOCUMENT

that ***building systems***

meet the <u>needs</u> of

BUILDING OWNERS and OCCUPANTS.

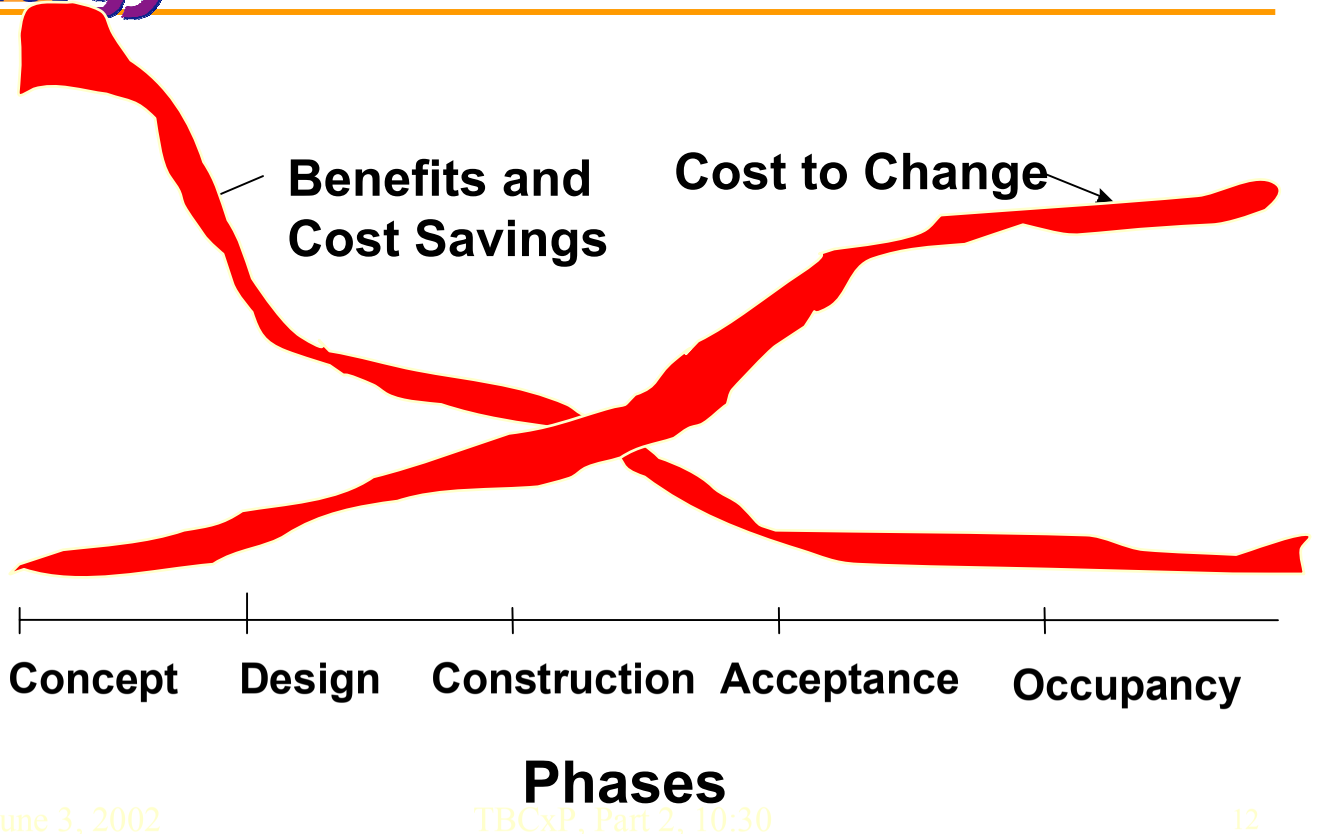
Why Should YOU be Interested in TBCxP?

- The best can always get better.
- The old can get younger.
- Profitability can always improve.
- We can do more with less.
- More management is not better.
- Quality works!

Why Should You be Interested in TBCxP?

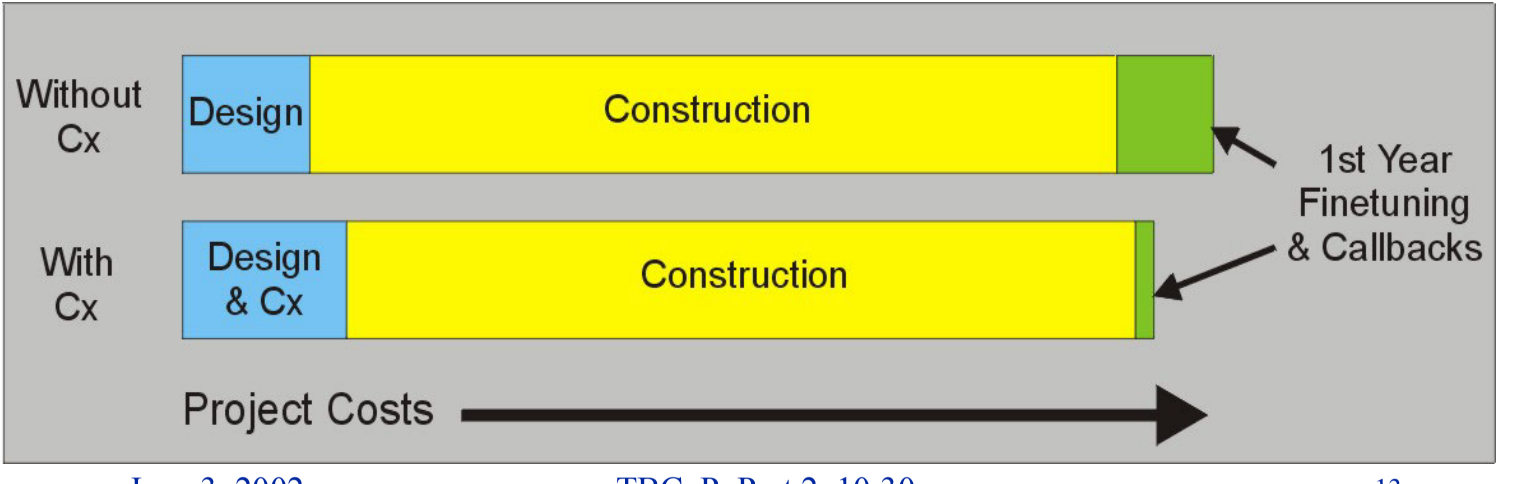
- We love to change!!!,
- Please, no status quo!!!!
- Change is easy!!!!!!
- We have the current process down pat, time to change!!!!!!!!!!!!!
- LET'S HAVE FUN and go to a conference and learn about TBCxP- - - -

Benefits and Cost Savings Potential Vs. Cost to Implement or Change



A Shift in Project Costs?

- CxP shifts cost from the end of the project to the beginning
- Reduces overall investment



The Commissioning Authority
A New Entity

- Owner's advocate
- Primary focus is on the process
- Background
  - Design
  - Construction
  - Operation
  - Quality process control
- Augments, but does not replace programming, architect, engineers, construction manager and operators

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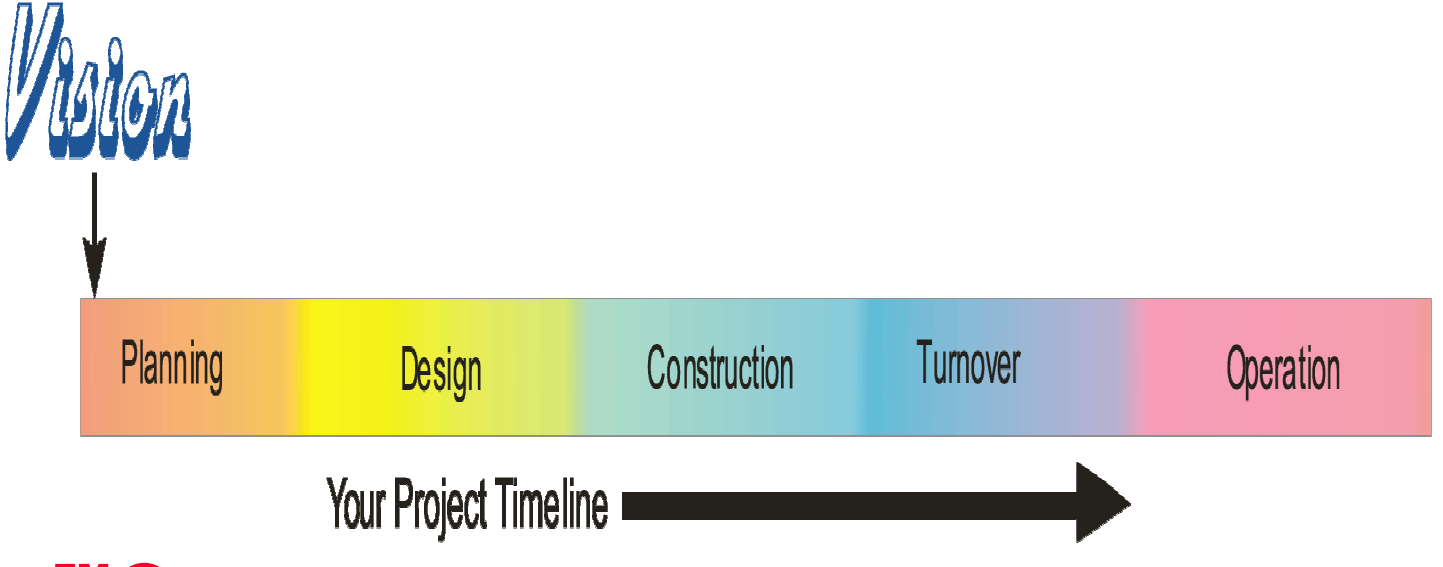
The Current Process



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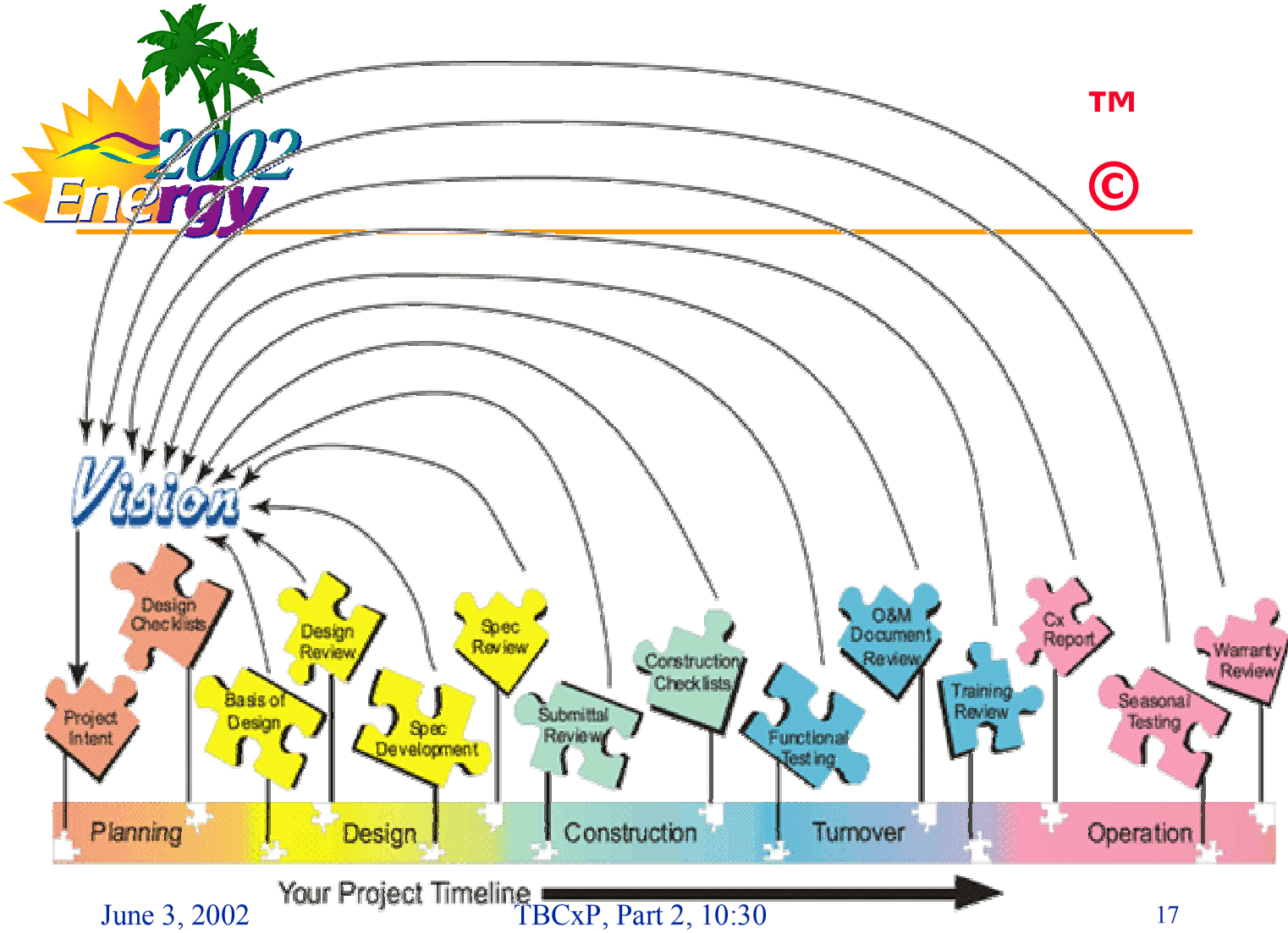
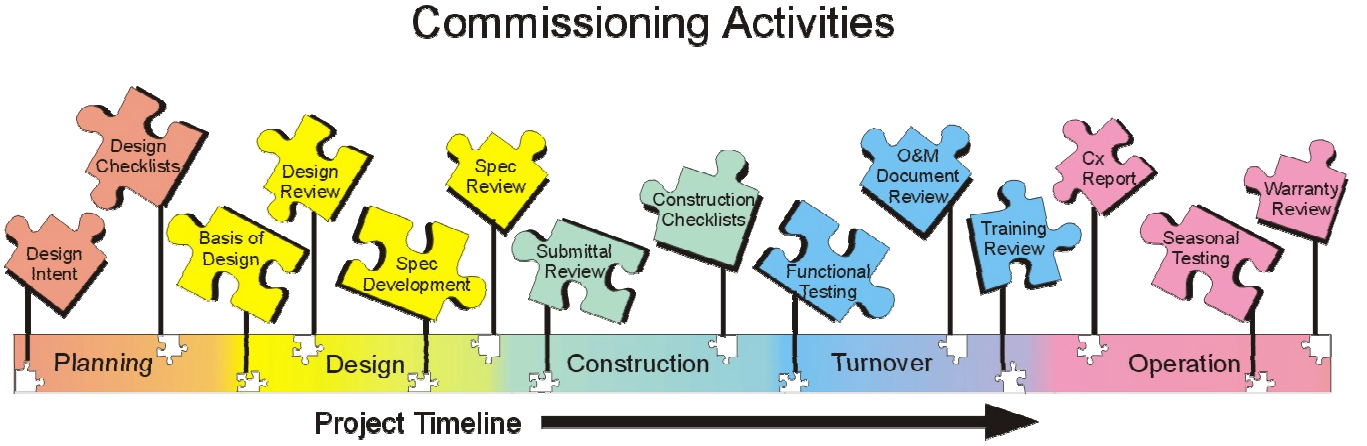

2002
Energy
TM
©
Vision
Project Intent
Design Checklists
Basis of Design
Design Review
Spec Development
Spec Review
Submittal Review
Construction Checklists
Functional Testing
O&M Document Review
Training Review
Cx Report
Seasonal Testing
Warranty Review
Planning
Design
Construction
Turnover
Operation
Your Project Timeline

Complete TBCxP, Step by Step



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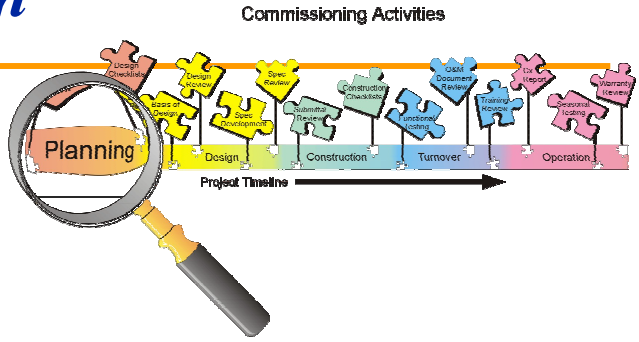
TBCxP During Planning or Pre-Design



- ☒Document the owner's Design or Project Intent (Owner's Project Requirements)
- ☒Develop design checklists for the designers
- ☒Develop initial Commissioning Plan

Response #	Responses	Facility Users	User Score	A/E Score	Overall Score
F-3	IMPROVED HEATING AND COOLING	0.00	**8.30**	0.00	8.30
F-1	ADEQUATE SPACE	0.00	**6.00**	0.00	6.00
F-8	WORK AREA COMFORTABLE FOR STAFF AND CUSTOMERS	0.00	**5.83**	1.00	6.83
F-2	FUNCTIONAL WORK SPACE	0.00	**5.20**	1.33	6.53
F-4	SECURITY UPGRADES	**0.90**	**4.25**	0.00	5.15
F-20	MORALE AFTER SEVERAL MONTHS	0.00	4.00	**5.33**	9.33
F-7	PRIVACY	0.00	**3.93**	0.00	3.93
F-18	CREATE A PROFESSIONAL IMAGE	0.00	2.40	**5.50**	7.90
F-6	BETTER PUBLIC ACCESS	0.00	**1.58**	0.00	1.58
F-22	SHOWCASE BUILDING	**2.00**	**1.35**	1.83	5.18
F-10	IMPROVED LIGHTING	0.00	**1.33**	0.00	1.33
F-29	MINIMAL EFFORT FOR FUTURE CHANGES	**1.13**	**1.30**	1.25	3.68
F-17	ADEQUATE STORAGE	0.00	**1.25**	0.00	1.25
F-12	USERS ARE PLEASED	0.00	0.00	**13.33**	13.33
F-15	SUCCESSFULLY BID AND CONSTRUCTED TO AVOID COMPROMISING END PRODUCT	0.00	0.00	**7.77**	7.77
F-19	ON BUDGET ON TIME	2.25	0.00	**3.47**	5.72
F-9	REDUCED ENERGY AND MAINTENANCE COST	2.33	0.00	**3.00**	5.33
F-27	DOCUMENTATION FOR LIFE OF BUILDING	1.50	0.00	**2.50**	4.00
F-23	RELIABLE UTILITIES	1.20	0.00	**2.13**	3.33
F-16	KUDOS TO TEAM	**2.00**	0.00	0.40	2.40
F-14	WORKSPACE EFFICIENCY AND COMFORT	0.00	0.00	**1.50**	1.50
F-24	MAINTENANCE STAFF LIKES DESIGN	0.00	0.00	1.50	1.50
F-21	COMMON USE AREAS	0.00	0.00	**1.13**	1.13
F-25	REPEAT BUSINESS	0.00	0.00	**0.90**	0.90

Question F: How will you determine the success of this project?

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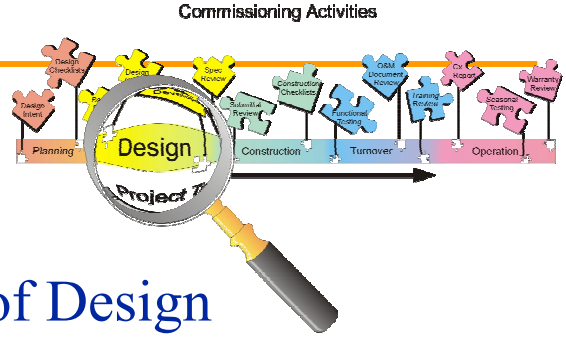
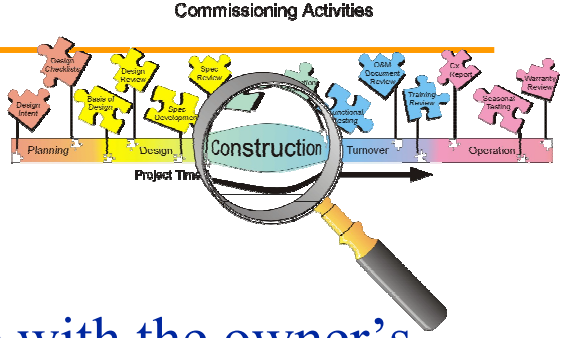
TBCxP During Design



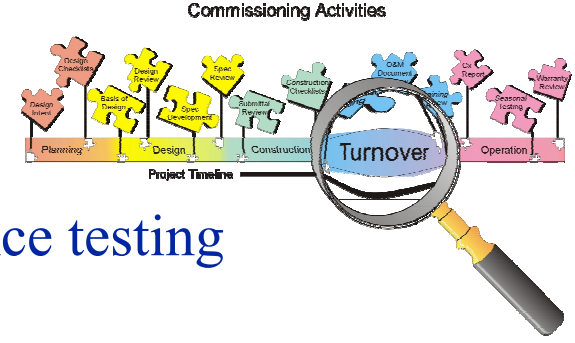
- Document each designer's Basis of Design
- Review the design for compliance with the owner's Design Intent
- Develop TBCxP portion of specifications
- Review complete specifications before bidding

TBCxP During Construction



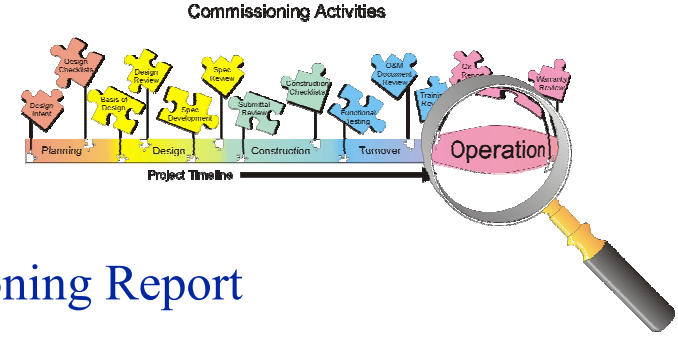
- Review submittals for compliance with the owner's Design or Project Intent
- Develop and track completion of construction checklists
- Verify all aspects of the construction process, using **statistical quality sampling**

TBCxP During Turnover



- Complete functional performance testing
- Review O&M documentation
- Review training plans
- Verify codes, project intent, and certifications have been met

TBCxP During Operation



- Complete and submit Commissioning Report
- Perform any seasonal testing
- Ensure the systems are being operated to meet project intent
- Review equipment performance prior to warranty expiration

Lessons Learned Workshop

- During first year or after end of project
- This is the "Continuous Improvement" of the TBCxP

- Lets do an illustrative workshop question?

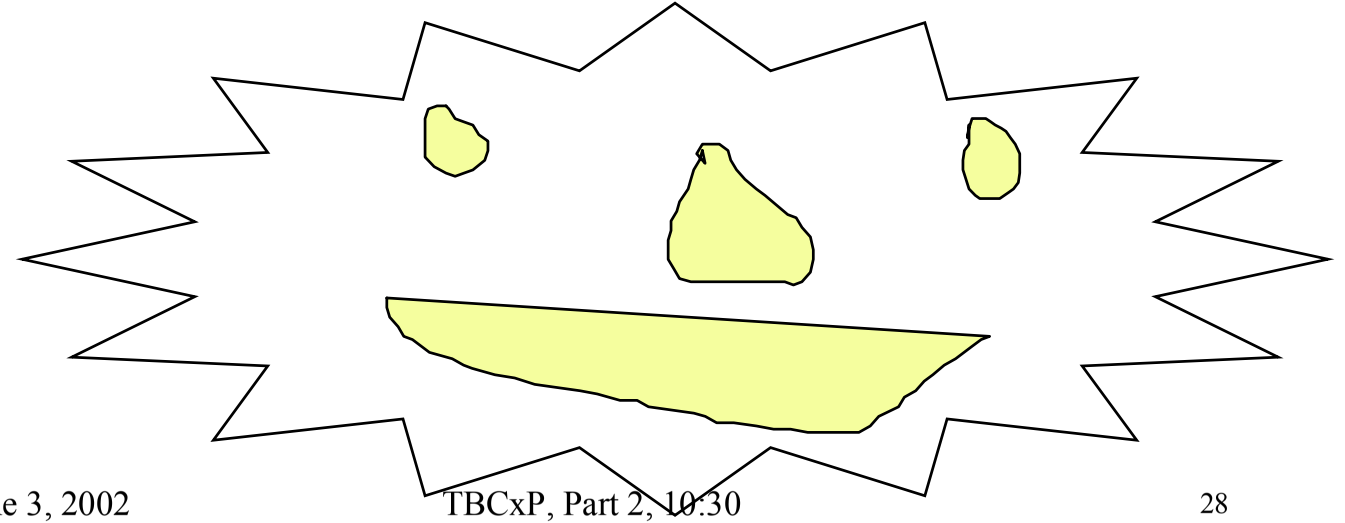
Lessons Learned Workshop

- During first year or after end of project
- This is the "Continuous Improvement" of the TBCxP
- Key input to the final commissioning report
- Lets do an illustrative workshop question?

WORKSHOP EXERCISE

- Write down your reaction to this question?

  "What did you learn that could have improved your preparation for this conference"?



- Turn to the 4 to 7 people around you and compare answers.
- In five minutes develop a list of 7 good answers. Or just the ask for the best from each of your members.
- Each, rank best from 7, find consensus?
- **Do not make this difficult! Just collect ideas and rank!!**

Your Input to Improving the Trip to the Energy 2002

- What answer do you want published in the LA Time tomorrow morning?

Training/Education Resources

- Building Commissioning Association
  - bcxa.org
- University of Wisconsin – Madison
  - epdweb.engr.wisc.edu
- ASHRAE
  - ashrae.org

Outpost Store

Information from a Commissioning Process Case History

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Farnsworth Group

EST. 2000
OUTPOST
NATURAL FOODS

Basis of Calculations	
Scenario 1	Higher cost option
Scenario 2	Lower cost option
Cost of Labor	$50 / hour
Cost of Professional Time	$75 / hour
Average Store Sales	$16,000 / day
Productivity Loss	5% per worker, per day
Sales Loss	2% per shopper
Employee Labor Cost	$7 / hour, 8 hour work day
Time Period for Recurring Costs	20 years, 355 working days per year (10 holidays)

Issue	Cost Avoided	Cost Avoided
	Scenario 1	*Scenario 2*
Rooftop Cooling Capacity	~~$62,160~~	~~$51,200~~
Outdoor Air Intake Location	$326,600	$5,660
Store Relative Humidity	$61,750	$26,500
Diffuser Selection	$153,360	$1,766
Total Avoided Cost	$603,870	$85,126

Cost Benefit of Cx

- Commissioning: 1.3% of project budget
- Minimum projected savings due to Cx Process: $85,000 (triple the Cx fee)
- Estimated savings could be as high as $600,000, including long term operations
- Majority of savings due to catching issues early (inexpensive fixes on paper)

1st Year Lessons Learned

- Challenges in connection between refrigeration system and HVAC
- Daylighting sensor calibration problems
- On-going team communication +/-

Participant Feedback

- General Manager - without commissioning would not have received required system and would not have known the system would not meet their goals

City Schools of Hammond

- General Benefits from six projects

Benefits of TBCxP

- Reduced Punchlist on schools at turnover from 257 to 6
- Reduced cost of change orders by 87%
- Reduced first year call backs by 90%
- Reduced cost of construction by ?, goal should be 10-20%, but currently more like 4-9%, still very good.

Benefits of TBCxP

- Received project I wanted
- Received more value than expected, and would not have known than I could get this much for our budget
- Great Documentation and Training
- Accurate Drawings

Benefits of TBCxP

- Sure, you may achieve some of these without commissioning, however you are probably doing many of the tasks of the TBCxP.
- TBCxP **formulizes** your best process and insure repeatability for quality
- Provides a cost effective quality means to delivery a constructed project or building

Air Force Academy

- Major Renovation (or reconstruction)
- For each $80,000 for the commissioning team, the project cost benefits were $500,000
- Not a bad payback and in addition there were many quality issues related to occupants and the operations and maintenance of the rehab of the building, including ESM

TBCxP Benefits

- Reduced typical startup of university research laboratories from 2-3 years to zero!! University of Washington (John Heinz, P.E.)

Retro-Commissioning Case Studies

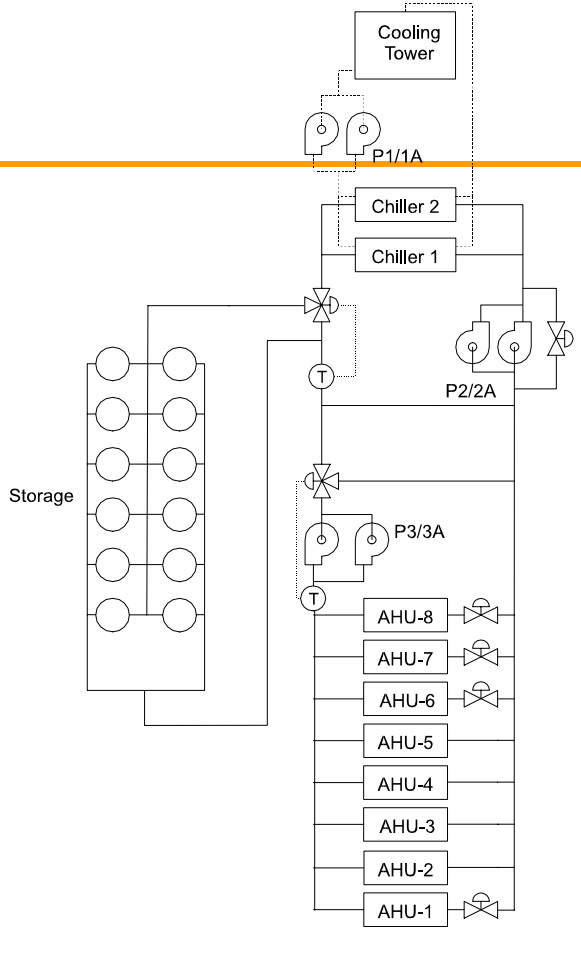
The Retro-commissioning Process

- Focus on the quality process
  - Modifications are to ensure system meets owner's design intent
  - Verification methodology uses statistical sampling
- Integrate the commissioning concepts into the daily routine (systems manual)

Case Studies

- Thermal energy storage (TES) system
- Medical facility

TES System Layout



TES System - Opportunities Identified

- TES differential temperature increase
  - Install VSD on secondary pumps and control valves on air handling units
  - $20,400/year savings at a cost of $17,500
- Control system adjustments
  - Adjust set points and control outdoor air
  - $2,400/yr. savings with in-house labor

TES System - Opportunities Identified

- TES tank piping insulation/repair
  - Insulate branch piping to tank
  - Install larger band clamps on branch piping
  - $800/year savings at a cost of $500
- Overall system improvements
  - Modify operating sequence
  - Add discriminator control (minimize reheat)
  - $10,050/year savings at a cost of $14,600

Systems Manual

- Provides overview of TES system and its interface with building systems
- Documents sequence of operation clearly showing different modes of operation
- Is a living document
- Change in personnel soon after completion of commissioning

TES System
Results of Retro-commissioning

- Increased storage capacity by approximately 40%
- Reduction in energy use by approximately 20% (reheat)
- Verified operation of system through field test
- Developed useful Systems Manual

Medical Center - Background

- New medical center with out-patient surgery and offices
- Construction was completed two years after design completed (all new people hired to operate facility)
- 60% occupied after two years
- Building was recommissioned at two year point

Medical Center - Opportunities Identified

- Modify steam system to match usage (5.7 year payback)
- Modify AHU control (1.4 year payback)
- Install active pressure control on surgery suites
- Modify lobby airflow pattern
- Implement commissioning procedures on tenant fit-out

Medical Center - Opportunities Identified

- Install computer interface with existing Trane Tracer system
- Modify hot water freeze protection procedures
- Implement smoking area policy/system

Medical Center
Results of Retro -commissioning

- Most opportunities improved the space conditions and were not energy related
- Provided system documentation which was previously unavailable

Medical Center
Results of Retro-commissioning

- Change in O&M personnel at completion of commissioning
- Would have avoided 2 years of problems if used commissioning process from the beginning
- But better late than never

TBCxP Benefits

- Successfully implements new concepts desired by owners, without trial and error
- No undone punchlist items

TBCxP Best Practice

- Cost effective
- Owner's Project Requirement orientated
- Team (commissioning process team)
- Quality tools used
- Not "expert-in-construction" driven
- Orientated on delivery of the constructed project for: owner, occupants, and O&M

Essential Concept of TBCxP

- It takes the **uncertainty** out of the delivery of a constructed projects
- Does as well as any other approach, but at a lower cost
- Has means to use statistical tools
- Has an element of continuous improvement
- Transfers knowledge from planning to operations

Essential Concept of TBCxP

- How you achieve the <u>five essential concepts</u> will vary for every organization,
- But <u>shortcuts will fail</u> and the cost and delivery needs of owners, occupants and O&M will not be achieved.
- These are <u>attributes</u> of the quality delivery process, regardless of what it is labeled!

Essential Concept of Implementing TBCxP

- Requires a change
- Change must be managed
- Time and resources must be allocated
- Need to develop a mission statement for the commissioning process
- Must have a designated commissioning authority, leader, consultant, manager?

Final Summary Thoughts

Elements of Commissioning

- Always implement early
- A process
- Specifically states the Owners Requirements
- Evaluation and Verification at all phases
- Team
- Continuous improvement
- Lower cost