

The Commissioning Process

An Introduction

For

Unitec Final year Construction Management Students

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MARK CRAWFORD LTD.

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Interesting Facts

- ▶ The average person in developed countries spends 90% of their life in buildings.
- ▶ These same buildings are responsible for 40% of the energy consumption in the world and for 30% of global CO2 emissions.



What is Commissioning?

Dictionary definition:

- ▶ Commissioning is the process of advancing an installation from the point of static completion to full working order, operating to the specified requirements.

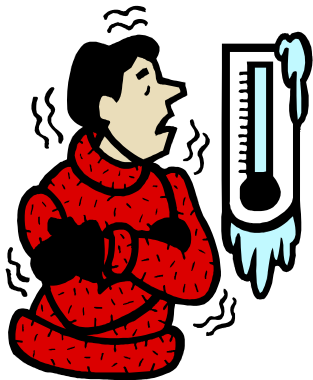
Real world meaning:

- ▶ Making things work.....**Correctly!!!**



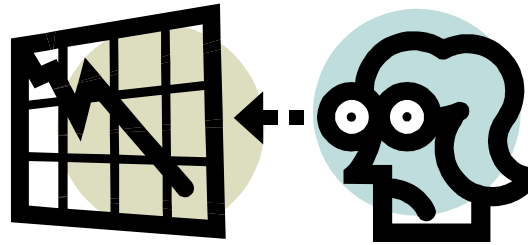
Why is commissioning so important?

- ▶ What does poor commissioning lead to?
 - ▶ Systems not functioning correctly
 - ▶ Higher energy costs
 - ▶ Dissatisfied building occupants
 - ▶ System failures
 - ▶ More frequent maintenance
 - ▶ Unreliable monitoring systems



A badly commissioned building results in:

- ▶ Low productivity
- ▶ Poor morale
- ▶ Absenteeism
- ▶ Medical claims
- ▶ Litigation



My Philosophy

- ▶ Why go to the expense and effort of designing and installing a system if it is not set to work properly?



What could be the reason?

- ▶ **Timeframe for commissioning - Whatever time is available between the system installation being finished and the Practical Completion date.**
- ▶ **Appreciation of commissioning**
- ▶ **Contractors get away with not commissioning thoroughly - no one managing the process**
- ▶ **Contractors bidding work low so need to cut corners**
- ▶ **Inexperienced contractors**
- ▶ **Legacy approach of completing commissioning during DLP, after complaints are made.**

Examples of what can go wrong

- ▶ Have your heating and chilled water systems been correctly flushed and cleaned?



Examples of what can go wrong

- ▶ How thorough has the electrical contractor been with his QA procedures?



What do we, the industry, need to do???

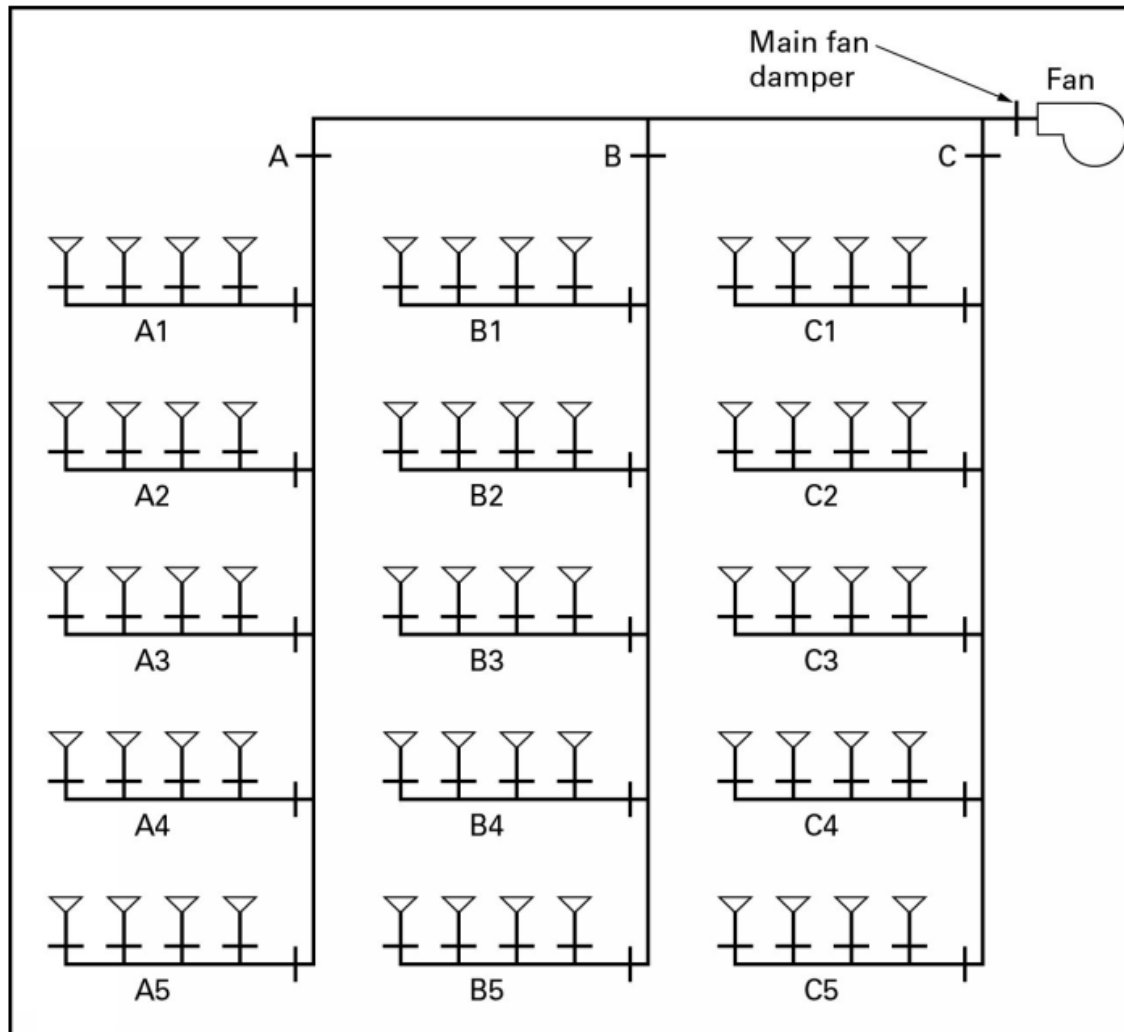
- ▶ Understand the importance of correct commissioning
- ▶ Demand correctly skilled commissioning engineers are used
- ▶ **Allow sufficient time for the commissioning process**
- ▶ Allocate a resource to be responsible for commissioning, e.g. a Commissioning Manager
- ▶ Do not accept buildings unless there is documented evidence the commissioning process has been correctly performed.

Air System Commissioning

What is air system commissioning?

- ▶ The process of advancing the completed installation to a fully functioning system, operating to the design parameters
- ▶ This process includes:
 - Pre-commissioning
 - **Balancing the air distribution**
 - Providing information to the BMS
 - Providing test documentation
 - Successfully demonstrating the commissioning to the engineer (witnessing)

Simplified air system schematic



- ▶ This air system consists of:
- A fan
- Ductwork distribution, including risers and braches
- Terminal diffusers
- Volume control dampers (on risers, branches and terminals)

System pre-commissioning

- Fan / AHU checks
 - Transit bolts removed
 - Filters installed
 - No blockages or debris in the unit
 - System installation complete
- Ductwork integrity
- Dampers
 - Correctly located and installed as shown on the drawings
 - All dampers to be open prior to balancing
- Grilles / Diffusers
 - Correct types installed in the correct locations
 - Direction blades set correctly



System pre-commissioning (cont'd)

- **Building conditions**
 - All necessary doors and windows installed
 - All necessary ceiling tiles are installed with access provided
 - Area free from obstruction and ready for commissioning
- **BMS / Controls**
 - Controls pre-commissioned to allow plant to run
 - VAV and FCU operational
- **Environmental conditions**
 - If in a cold climate check that running the fans will not freeze coils
 - Check the ductwork is clean prior to running fans, esp. in finished buildings
 - Be aware of the affects of the heated or cooled air on the building finishes (e.g. timber features)
 - Be aware that uninsulated ducts may cause condensation issues when the fans are run

Methods of air measurement

- Pitot Traverse



- Anemometer scan



- Capture hood / Balometer



Commissioning procedure

○ Witnessing

- Prove that all instrumentation used is in current calibration - issue calibration certificates
- Allow the person witnessing to select what needs to be demonstrated
- After successful witness ensure test sheets are signed
- Issue signed documentation to the client for inclusion into the O & M manuals

Typical problems encountered

- Insufficient dampers

- Designer often decides what will be the index run and not fit all dampers on that run - this is normally a false economy as dampers are often retro-fitted and systems re-commissioned.

- Dampers in wrong locations

- Position does not allow correct regulation
- On open ended ducts to FCU's the dampers are often at the end of the duct - this makes it very difficult to achieve accurate & repeatable measurements.

Typical problems (cont'd)

- Ductwork leaks
- System incomplete but commissioning started due to insistence from others
- Dust protection left in ducts (should be found during pre-commissioning)
- Noise
- Drafts
- Suitable positions to take pitot traverses

Water System Commissioning

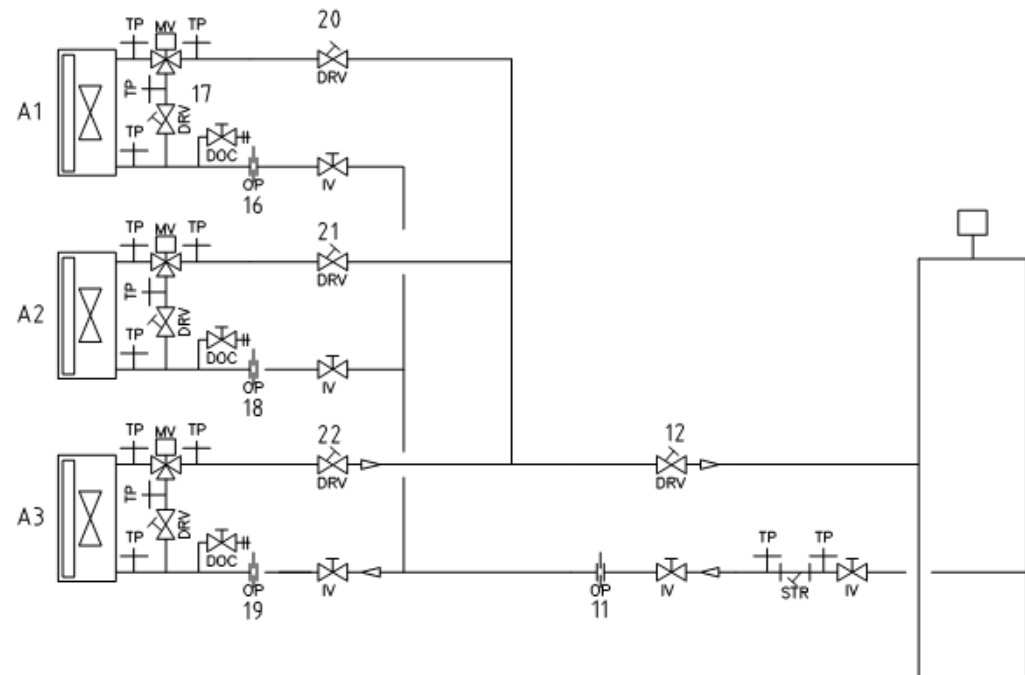
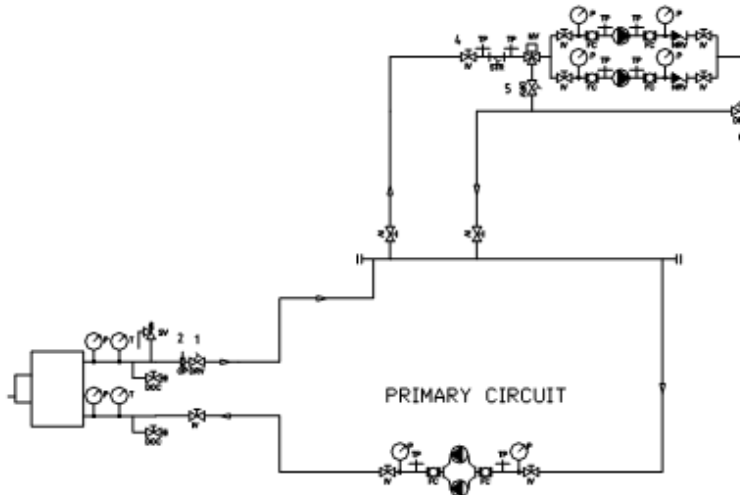
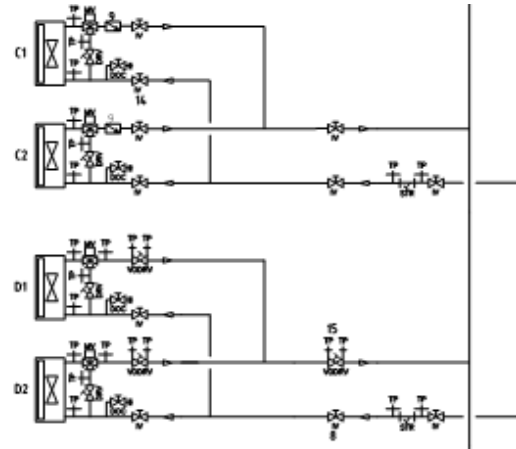


What is water system commissioning?

- ▶ The process of advancing the completed installation to a fully functioning system, operating to the design parameters
- ▶ This process includes:
 - Pre-commissioning, including flushing
 - **Balancing the water distribution**
 - Providing information to the BMS
 - Providing test documentation
 - Successfully demonstrating the commissioning to the engineer (witnessing)



Simplified water system schematic



System pre-commissioning

- Pump checks
 - System installation complete
 - Vibration mounts free (where fitted)
 - Strainer clean
 - Static head sufficient, make-up water available
- Valves
 - Correct type installed in the correct locations shown on the drawings
 - Fitted the correct way around
 - All valves to be open prior to balancing
 - All valve parameters available

System pre-commissioning (cont'd)

- BMS / Controls
 - Controls pre-commissioned to allow plant to run
 - All control valves either driven to fully open or able to be opened manually.
- Water quality
 - Flushing and chemical cleaning performed
 - System dosed with inhibitor chemical
 - System filled and vented
 - All strainers clean

Methods of water



- Commissioning valve set
 - This relies on measuring the pressure drop across the valve and using the valve characteristics to calculate the water flow

Typical problems encountered

- Commissioning valves
 - Valves not always installed on branches or risers
 - Main measurement stations not fitted on pumps to measure total flow
 - Valves incorrectly sized

Typical problems encountered

- Water condition

- System not flushed correctly (debris blocks orifices & affects valve operation, strainers can block)
- System aerated (too much chemical added)
- Air in system (not vented correctly, insufficient make-up water)
- Incorrect chemical
 - ▶ treatment

Typical problems encountered

○ Installation issues

- Pipework configured incorrectly
- Valves poorly installed with insufficient straight lengths of pipe either side to allow accurate readings
- Branch connections can lead to dirt pockets or air traps - these need accounting for
- Insufficient pressure tapping points (binder points) installed
- Bypass valves left open in the field

What is the building's control system?

- ▶ The controls system, or Building Management System (BMS), is the brain and nervous system of the modern building
- ▶ The BMS:
 - Monitors inputs from sensors and devices
 - Runs algorithms and calculations
 - Adjusts outputs to devices to maintain desired building conditions
- ▶ The BMS consists of both hardware & software:
 - Field devices (e.g. sensors, valve actuators)
 - Local control modules
 - A head-end or server
 - Inter-connecting cabling



How is it commissioned?

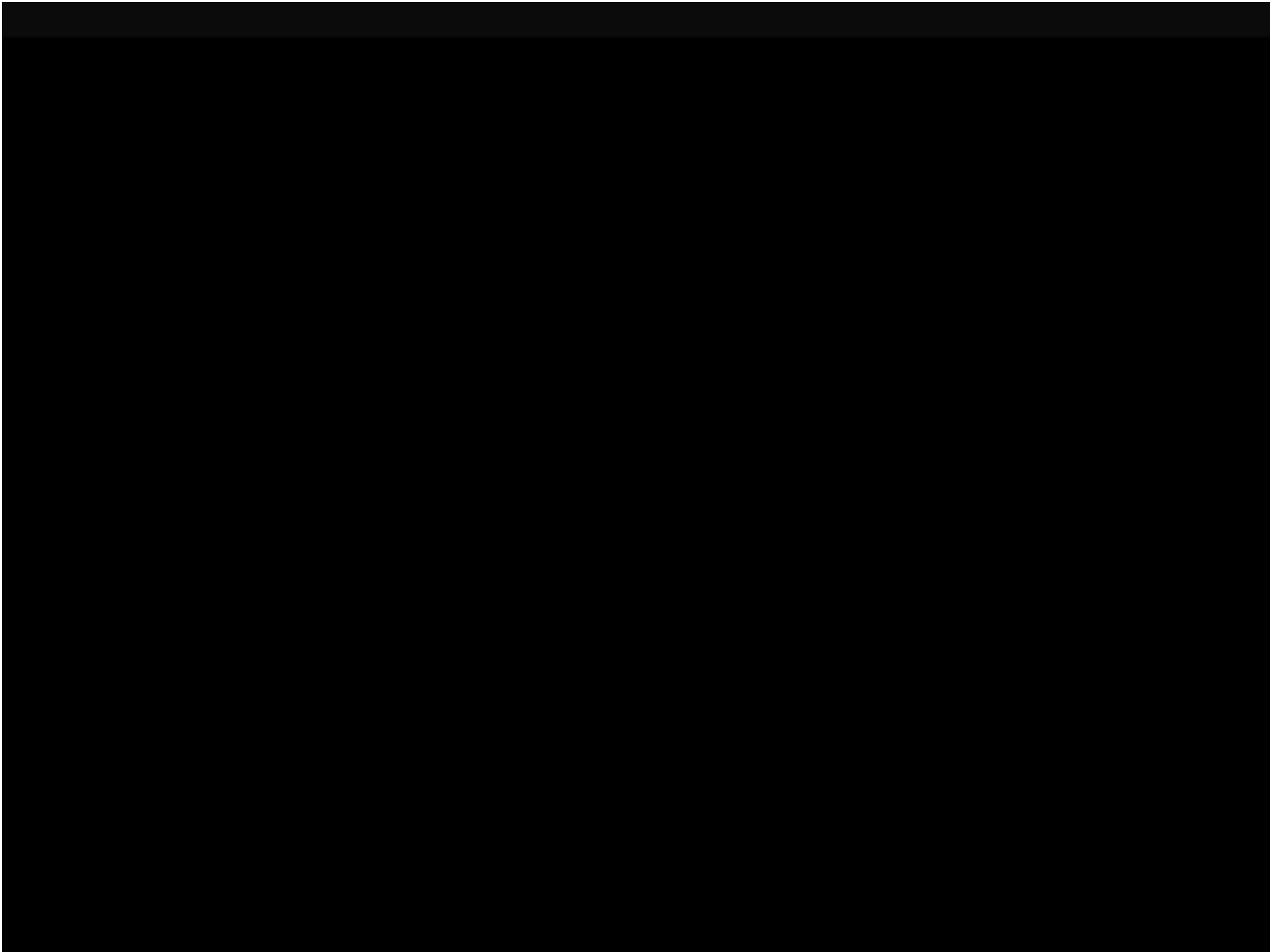
- ▶ The BMS is commissioned in phases:
 1. Point to point testing of field cabling
 2. Pre-commissioning of field devices
 3. Develop Functional Description
 4. Off-site development of controls software
 5. On-site commissioning of the software
 6. Fine tuning of control loops

Other services to be commissioned

- Electrical systems
- Generators
- Fire alarm systems
- Meters
- Hydraulic systems
- Lighting control
- Security
- IT Comms
- Etc....



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Definition of Commissioning Management?

- ▶ The planning, organisation, co-ordination and control of commissioning activities.

Source: CIBSE Commissioning Code M June 2003

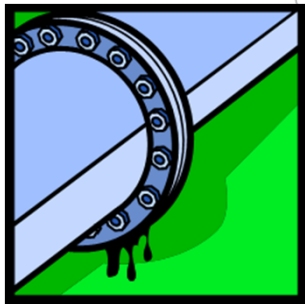
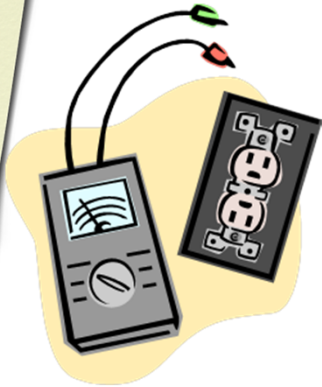
- ▶ The planned, collaborative and systematic process of review and testing conducted to confirm that a building and its sub-systems perform as designed and as expected by the building occupants.

Source: ASHRAE

- ▶ Commissioning Management is Quality Assurance in building services.



The roles of the Commissioning Manager

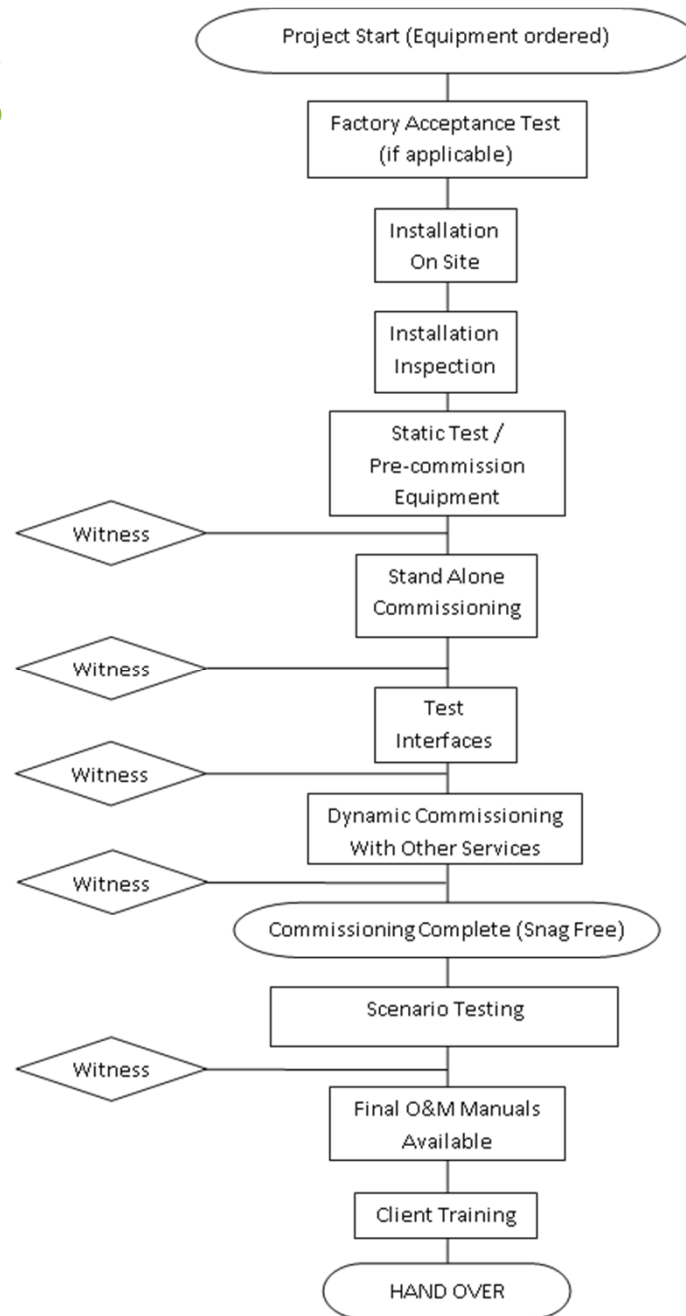


Commissioning Management Services

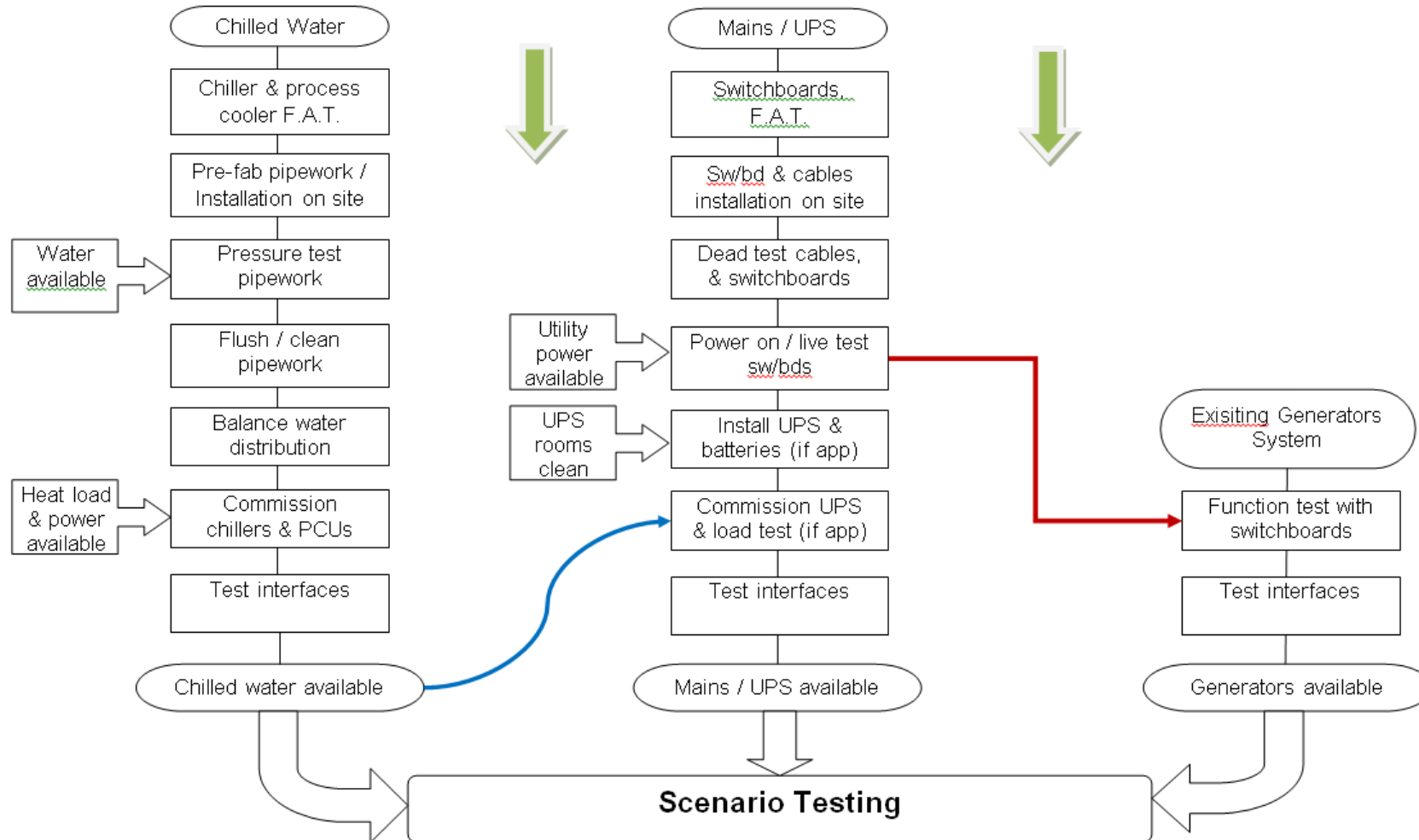
- ▶ Design review
- ▶ Integrated programming
- ▶ Commissioning data base
- ▶ Managing commissioning process on site
- ▶ Installation inspection
- ▶ System witnessing
- ▶ Scenario testing
- ▶ Regular independent reporting
- ▶ O&M reviews
- ▶ Client training
- ▶ Continual commissioning checks

The screenshot displays the Beca software interface. On the left, there is a 'Task Schedule' table with columns for 'Task No.', 'Task Description', 'Start', 'Finish', 'Status', and 'Dependencies'. The tasks listed include various commissioning activities such as 'Design Review', 'Installation Inspection', and 'System Witnessing'. On the right, there is a 'Network Diagram' showing a flow of tasks and their dependencies, with nodes representing tasks and arrows indicating the sequence. The diagram is color-coded and includes labels for different system components and phases.

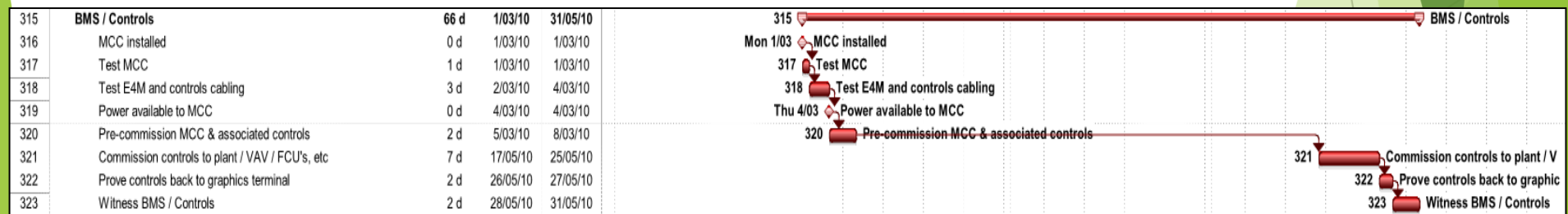
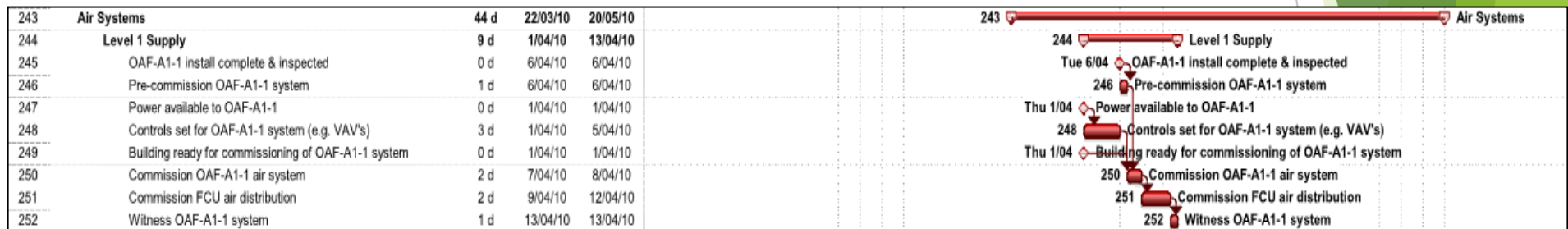
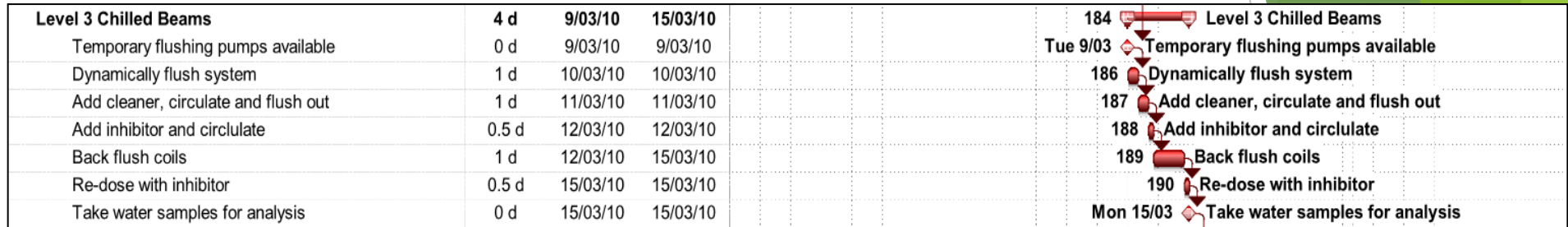
Commissioning Flow Chart



Example Project Flow Chart



Example Gantt Chart



So, what is this going to cost me?

- ▶ Studies have shown that to provide a full Commissioning Management service costs in the region of 0.5 to 1% of the construction cost.
- ▶ So for a \$20M build cost CxM is \$100-200k for a full service
- ▶ Compared to \$2-3M for the design team & project managers

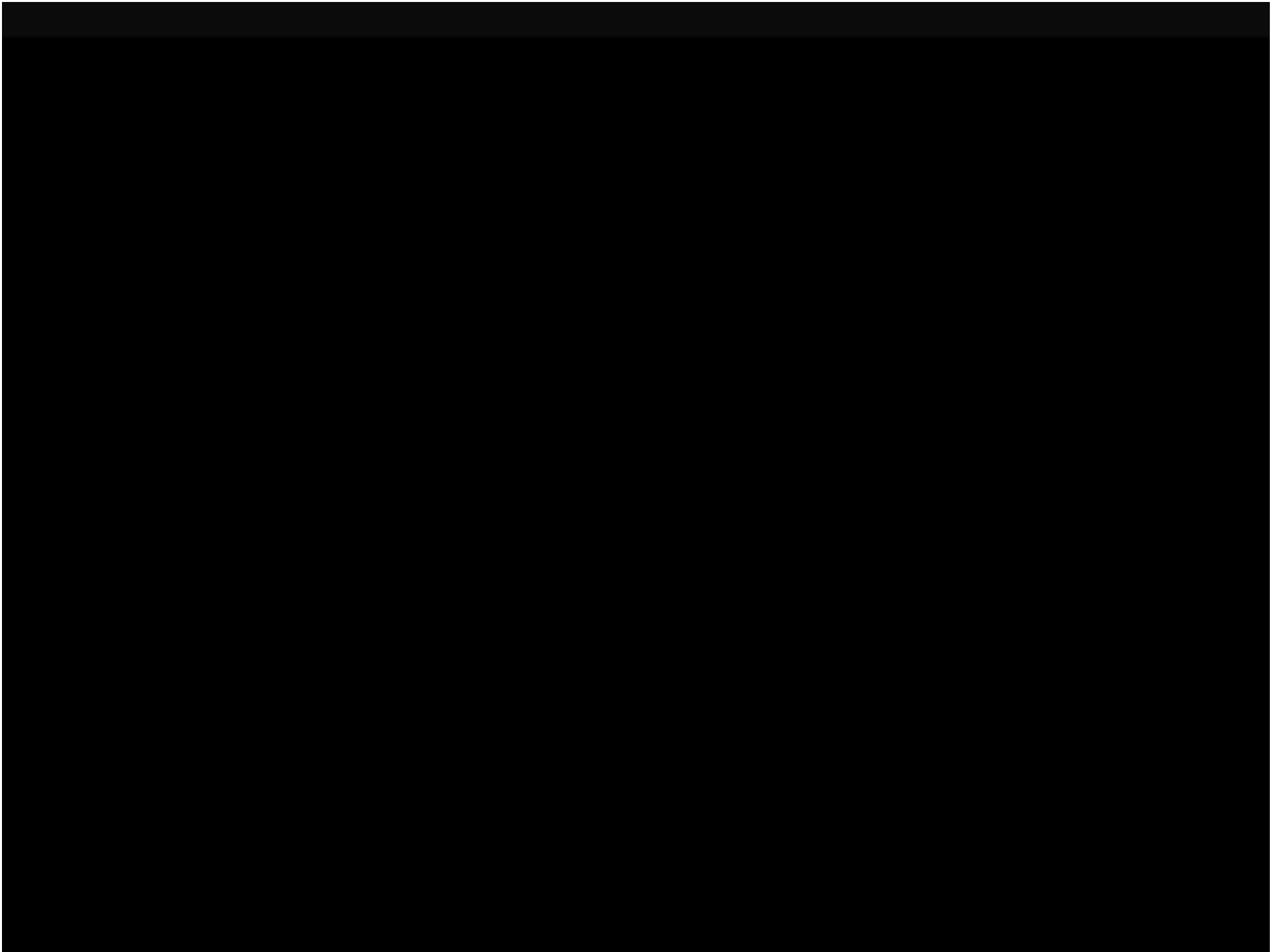


What sort of payback can I expect

- ▶ Evidence from the US has shown that payback is in the region of 3 to 5 years for a new build base on energy savings
- ▶ This is around 1.5 years for an existing building
- ▶ Note that in a typical office the total salary cost of occupants will exceed the total build cost within 1 year
- ▶ If every member of staff lost 15 minutes of productivity a week through poor environmental conditions the cost of the CxM service will be covered in 6 months

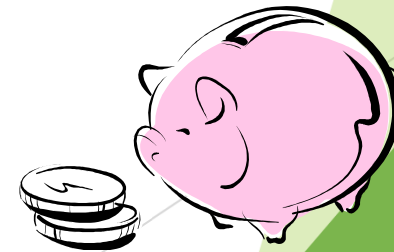
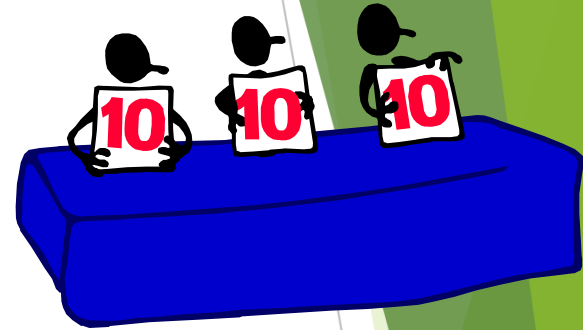
- ▶ Souce: R.J. Wilkinson, ASHRAE





So, why is commissioning important?

- ▶ Correct Commissioning = Total Quality Approach
- ▶ Delivers the building you (or your client) were expecting
- ▶ Will ultimately save money



Questions?

