1. Information that is needed?
   1. Meaningful sequences. Must not have contradictions, must be able to be programmed, unambiguous.
   2. Systems manual (as builts, sequences)
   3. OPR documents (desired early)
   4. Lots of variation in time when agent gets involved -> Get agent involved quicker
   5. Controls often underspecified
2. Deliverables
   1. Design reviews
   2. Testing
      1. pre-function testing (equipment checks, on/off, done by contractor and installers),
      2. Point to point testing (emphasis), cannot sample pt/pt testing, must be rigorous. (initialed documents ?, can be negotiated)
      3. functional testing (testing logic constructs) – can perform a test on a subset.
   3. Anything we can do for pt/pt test to make easier/faster/more rigorous. Generate automated test sequence (pre and pt/pt)
   4. Watch for things that are eliminated because of lack of understanding (whatever isn’t understood or working goes to manual).
3. Handoff
   1. Big systems manual (delivered via training or pdf…. large cultural spectrum)
   2. Some design left for setup in field conditions / field determined – better delineation needed
   3. Operations should be involved earlier on, different disciplines not talking to each other enough
   4. Better language across disciplines & cultural (can it be solved w/software?)
   5. Exposure to ctrl system before something goes wrong
4. Key tasks
   1. Design review (some agents aren’t involved in this)
   2. Construction review
   3. Testing
   4. Handoff
5. Timelines
   1. Commissioning: Varies a lot, Pt/pt takes most time and is most critical, typically no budget for multi-seasonal or ongoing commissioning. Some elements cannot be properly conditioned until specific ambient conditions
   2. Operations: Loop tuning, commission twice (after occ & loaded). Address 2% drift.
6. Roles/titles
   1. Commissioning authority or agent
   2. Contracting coordinator (key person - rubber meets road) works for general, doesn’t always exist
   3. Controls contractor
   4. Design engineer (not usually involved but would help if they were)
   5. Operator (better understating of thermo & ctrl & data analysis would help)
      1. Expert troubleshooter (20yr senior tech, deep analysis problems operators don’t have time or knowledge to address)
   6. Maintenance
7. Quality assurance process
   1. Need for trouble shooting process & institutional knowledge
   2. Currently depends on who is doing it, their background and experience
   3. Challenge now is that commissioning and quality of operation means different things to different people.
   4. Errors made in design or boilerplate designs that don’t work so are scratched by implementers
   5. Make people comfortable ‘right now’, address energy consumption $ at longer time scale (yrs).
   6. Can CDL provide alerts regarding performance (?)
8. How to change process?
   1. Cultural issues, barriers in language
   2. Use software to make it easier to do it the right way, harder to do it the wrong way

Barriers and improvement

* Expectations are getting higher, squeezing margins of education & specialties, hiring, etc.
* Because expectations are vague, 50%-80% of job is done, accountability is grey
* Most ME’s don’t know enough about ctrl to know if seq is bad, good
* Commissioning is often done on an unloaded building, stability & performance changes once occupied
* Design and implementation are parallel before commissioning, comm has to pull it together and potentially modify as needed. Not one party is always correct.
* Should not automate the delivery of crap via CDL, although may help identify sloppiness
* Operators putting things in manual mode