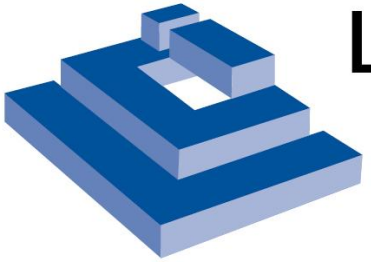


# Lean Construction Institute

Building Knowledge in Design and Construction

LEVERAGING VIRTUAL DESIGN & CONSTRUCTION FOR LEAN PROJECT DELIVERY

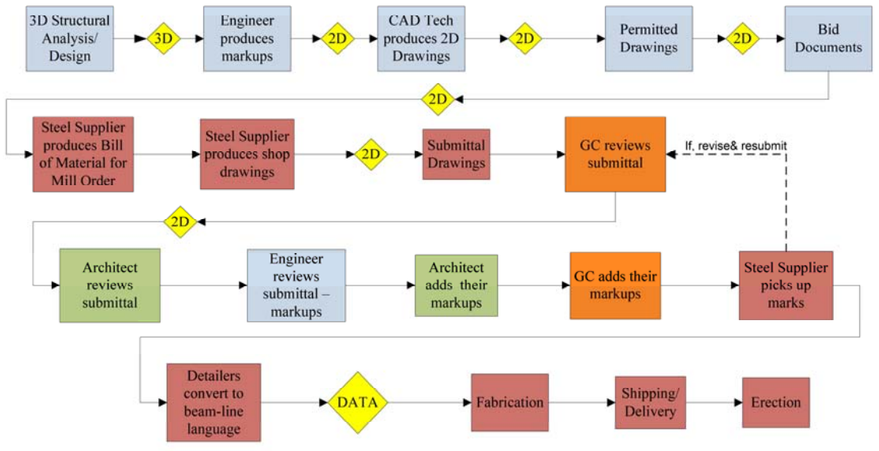
| Order | Presenter | Responsibility | Organization | Topic |
|---|---|---|---|---|
| 1 | Ron Migliori | Structural Engineer | Buehler & Buehler Structural Engineers, Inc. | Leveraging Virtual Design and Construction for Lean Project Delivery through Integrated Steel Design |
| 2 | Bryan Johnson | Mechanical Engineer | Capital Engineering Consultants Inc. | Mechanical Systems Virtual Design and Construction |
| 2 | Zach Sargent | Superior Air Handling | Healthcare Division Manager | Mechanical Systems Virtual Design and Construction |
| 3 | Saurabh Tiwari | BIM Engineer | DPR | Models based estimating to support Target value Design process - Lessons Learned |
| 4 | Bruce Cousins | National Manager of VDC / BIM | The Weitz Company | Leveraging VDC Lean / Last Planner to reinvent the delivery of AE services |
| 5 | Samir Emdanat | Director, Virtual Design & Construction | GHARARI Associates | Design to Fabrication: Using BIM to Re-conceive the Construction Supply Chain |

**ISSUE: Reducing waste in designing and fabricating structural steel through Integrated Steel Design**

**Customer: Owners, General Contractors** **Version: 2** **Date: June 16, 2009**

## BACKGROUND / CURRENT CONDITIONS

The current process for designing and fabricating structural steel is very linear, with parties working separately with product moving between parties at discreet points only using multiple copies of 2D drawings stamped and marked by hand. Each step usually does not begin until the previous one is complete. Each party must review and understand 2D documents, interpret them and then create more, very similar 2D documents for the next party to review and interpret. The submittal and approval process usually occurs sequentially, with each reviewer completing their review, marking the submittal by hand and passing the submittal on the next reviewer. After the review is complete, the steel supplier must address the comments and, if required, resubmit the revised portion of the submittal for re-review.

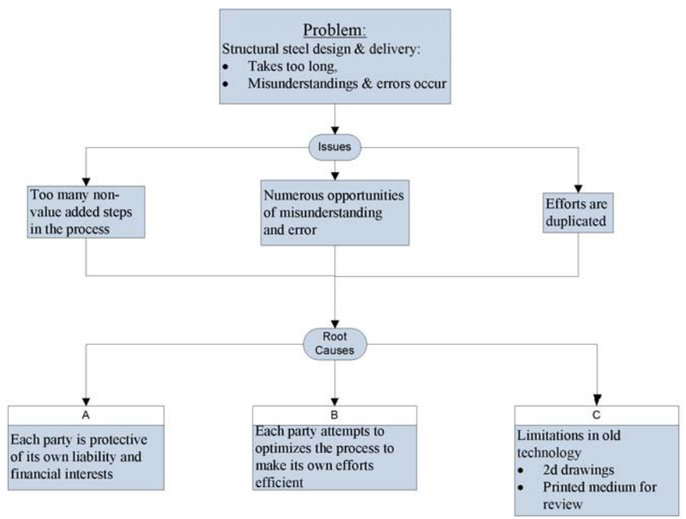



## PROBLEM STATEMENT / ROOT CAUSE ANALYSIS

The issue is the time required to design, fabricate and deliver structural steel to the job site and the field work that is required to correct steel fabricated incorrectly due to misunderstandings at all of the steps in the process. The process takes so long, in part, because of all the steps involved, many of which add no new value, such as reproducing great volumes of paper copies. Many steps involve duplicating effort, such as preparing very similar 2D drawings of the same plans. Misunderstandings arise from visualizing and interpreting 2D drawings of a 3D structure.

The root causes for these issues are found in the reasons why the current state process evolved as it did.

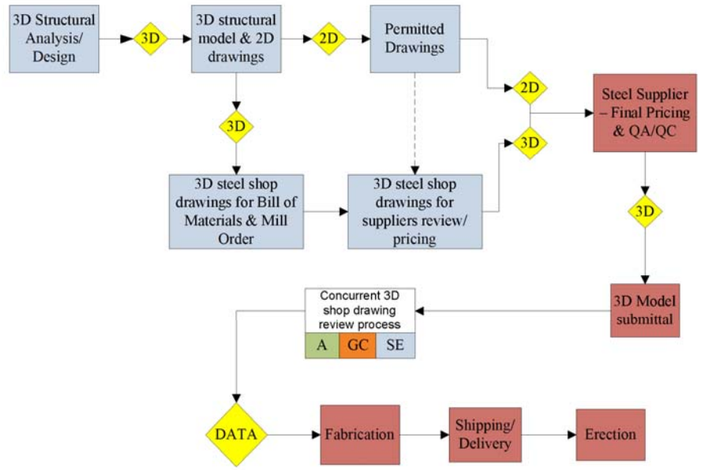
A. Risk/Liability Management – Businesses must manage their risk to survive. They do this by controlling their individual product and accepting liability only for their own work. This has resulted in efforts being separated rigidly into packets by discipline that can manage the risk.
B. Efficient parts – Each party attempts to modify the whole process to optimize their portion because that's how their profits are determined.
C. Technology limitations – CAD software and internet capabilities were limiting the industry to 2D drafting and delivery of a physical, paper product.




## PROPOSED SOLUTION / FUTURE STATE

Integrated Steel Design (ISD) attacks each of the root causes by creating a new process where the design, review and fabrication efforts are broken apart and re-integrated to promote the overall value to the project and to allow efforts to occur concurrently. This will reduce the overall time required to deliver steel. Further, ISD utilizes the latest in modeling, detailing and review tools to allow designs to be visualized, reviewed and re-used all in 3D. This will make interpretation and understanding of the designs and the detailing much easier and less prone to error. Some features include:

1. Integration in the preparation of steel shop drawings either directly into the Structural Engineers' (SE) scope or indirectly though close alliances with steel detailers.
2. Agency review in parallel with model and detailing model preparation.
3. Electronic, concurrent review and markup by all parties of a 3D detailing model instead of paper shop drawings.
4. Establish a direct process of 3D communication between parties and software
5. Develop team atmosphere and trust through Integrated Project Delivery (IPD) and integrated contractual relationships (IFOA)




## IMPLEMENTATION PLAN

| No | Cause | Plan | Result |
|---|---|---|---|
| 1 | A | Establish an Integrated Team through contractual arrangements or other methods. | Reduces risk and liability while developing trust and incentives |
| 2 | B | Determine the 3D BIM strategy and responsibility of each team member. | Provides the basis for inter-operability and coordination |
| 3 | C | Discuss software needs of the steel supplier to insure operability between the design model software, the steel detailing software, and the fabrication beam line software | Insures that the appropriate detailing software is incorporated for direct communication all the way to the beam line. |
| 4 | B | Discuss the fabricators special detailing preferences with preferred vendors. | The fabricators detailing preferences incorporated into the design early creates detailing and fabrication efficiencies. |
| 5 | C | Verify or arrange for staff training and license procurement, including 3D submittal review. | Facilitates a paperless submittal review process. |
| 6 | B | Create the appropriate procurement batch size to optimize the process, for example:<br>a. Primary structural steel b. Misc plates, mech. screens, blocking beams, etc. c. Miscellaneous metals | Aligns the design process, the material procurement and the fabrication process with the project schedule for on-site delivery. |

## CHALLENGES / FOLLOW-UP

Challenges

1. ISD works best in an IPD, IFOA or design build format.
2. Steel supplier must be willing to participate in the integrated process
3. Team members must be adept at the latest 3D software, their inter-operability and understand their limitations.
4. The learning curve associated with the integrated process
5. Flexibility in the design process to allow the batch sizes of the design to optimize the fabrication and construction process.

Follow-up

Monitor the:

1. Delivery time from design to erection
2. Design time and cost
3. Number of structural steel RFI's
4. Steel erection fit up
5. Submittal review time
6. Number of documented errors

**CHAMPION: Ron Migliori, SE** **COLLABORATORS: Larry Summerfield, SE** **SPONSOR: Dean Reed** **APPROVER:**

**ISSUE:** *(in the eyes of the customer)* **– PROVIDE THE MECHANICAL DESIGN, FABRICATION AND AGENCY REVIEW DOCUMENTS IN THE MOST EFFICIENT MANNER WHILE PROVIDING HIGH QUALITY SERVICE AND PRODUCT**

**Version:** **Date:**

## BACKGROUND / CURRENT CONDITIONS

- Design → Bid → Build
- Design Assist
- Integrated Project Delivery, IPD (early development)

## PROBLEM STATEMENT / ROOT CAUSE ANALYSIS

- The current systems lend them selves to re-work, lack of communication between Engineering and Construction, the relationship can be contiguous, there is a low level of cost control and a level of un-certainty of constructability until after shop drawings are complete.

- Design → Bid → Build
  - A lot of re- work, Engineer design the design then Trade Partner does shop drawings.
  - Risk of different interpretation of documents
  - The Engineer can not optimize the design to the Trade Partner's strengths.
  - Contractor's constructability knowledge is not taken advantage of.
  - Low Cost Control

- Design Assist
  - Brings the Trade Partner into Design, but often input is limited to;
    - Cost control, value engineering, constructability reviews
  - Usually very defined hand offs,
  - Often still Engineered drawings re-drawn and developed into shop drawings.
  - Depending on Team there can be little to no Trade Partner direct Input into the design, to a high level.
  - Can still be contiguous
  - Not necessarily any more efficient, unless the Trade Partner's shop drawings can be incorporated into the Agency Review Documents.
  - Does save time by starting Shop Drawings sooner in process.

- IPD (early development)
  - All the benefits of Design Assist, different contracting strategy to encourage more corporative behavior.

## PROPOSED SOLUTION / FUTURE STATE

- Trust Each Other
- Have common Goals and have them drive the work, don't let traditional roles drive work
- Maximize the use of each Partners Strengths
- Completely eliminate waste associated with the Design/Detailing/Modeling process.
- Seamless digital exchange between the engineer and contractor.
- Engineer & Contractor both working on the same model without translation and data issues.
- Achieve transparency in engineering and fab/install related data.
- Real time deep collaboration.
- Real Time Cost of Construction Input into design and engineering – Model Based Estimating
- Conduct work so that the rest of the Team can't distinguish between Engineer and Trade Partner Value
- Constructability and Engineering Review in real time.
- Learn and grow
- Trust Each Other
- Have a good time

## IMPLEMENTATION PLAN

- Spend the effort to get to know each other, personally, professionally, and corporate, including corporate culture.
- Trust and Respect each other
- Understand what work needs to be done (Value Added), and spend time planning how to do it efficiently with built in quality.
- Utilize a common digital / BIM platform and storage platform (ProjectWise)
  - Do common training in collaborating using these tools for BIM
  - Do common investigation and training using these tools for model based cost estimating
- Early discussions and agreement on fabrication Criteria
- Early discussions and agreement on specifications and design / sizing criteria
- Regular (almost daily) communication utilizing all methods;
  - In-Person
  - Phone
  - Web Meetings
- Push this deep into the Trade Partner and Engineering project Team
- Maximize use of "standard work"
- Allow the most appropriate person to answer questions and provide information to the rest of the Project Team
- Regular and real time cost of design evaluations
- Don't be afraid to try something new.
- Laugh on a regular basis

## CHALLENGES / FOLLOW-UP

- Challenges – Technology, Technology, Technology
- Follow up – Monitor; $$ Spent, judge quality and constructability, frequent self-evaluation and correction, re-plan, review previous plans for stand work.

**CHAMPION:** Bryan Johnson, CECI; Zach Sargent, Superior Air Handling **COLLABORATORS:** **SPONSOR** **APPROVER:**

**ISSUE: Leveraging VDC Lean / Last Planner to reinvent the delivery of AE services** **Version: I.** **Date:06/18/09**

## BACKGROUND / CURRENT CONDITIONS

We are a mid size Architecture firm (20 people 3 principles) with a dwindling backlog of work. We have been examining ways that we can differentiate ourselves from our competitors.

We consider ourselves to be a "Design" oriented firm not a production oriented firm

Our work load is balanced 30% schools, 20% senior living, 10% Hospitality and 40% residential both custom and Multi Family.

We are interested in working more with Libraries, Churches and other public work.

Our firm has become fairly accomplished at using 3D software. We transitioned to 3D 5 years ago using ArchiCAD.

In this downturn about a third of our key production people and one principle are retiring and or working part time.

The markets are all declining and we will have to work smarter.

## PROBLEM STATEMENT / ROOT CAUSE ANALYSIS

1. We want to be defined as innovative
2. We need to do more with fewer people
3. We need to be able to maintain production standards that our senior staff are now providing for our junior staff
4. We would like to participate in projects that use Integrated Project Delivery IPD
5. We think that the Institutional owners like library districts, colleges and other owner occupied facilities will be the best candidates for our services
6. We want to offer a delivery method that will distinguish us from others

## PROPOSED SOLUTION / FUTURE STATE

Educate Owners (existing customers first) about the benefits of VDC and Lean Processes in the construction of their next project
Educate the firms' staff to the Principles of Lean that apply to design firms products
Add the "clash detection" capabilities of Autodesk Navisworks -
Ask the Contractor what they need from the Model and where they have found deficiencies in our past projects
Investigate new relationships with engineering consultants who understand 3D model sharing -
"Just Do It" – Start somewhere with small use cases and do imperfect BIM and Lean
Establish a office culture standard for "continuous improvement"
Offer an office SAT ( Study Action Team) Read the Toyota Way,
Join the Lean Construction Institute
Define the Innovation Team carefully and get personal commitments to grow the ideas and think outside the box.
Budget for the change
"Design" is Production –Appearance is only one criteria. See "refabricating Architecture" – Stephen Kieran / james Timberlake
Think of a " Distributed Platform" Google for example

## IMPLEMENTATION PLAN

1. Propose workshops for the managers of facilities that are the beginning steps of Target Value Design – include knowledgeable contractors who understand and have used lean processes, who can bring sub contractors and other resources that can define target budgets and schedules.
2. Ask Contractor's who are actively using VDC-BIM and Lean to present to Key innovators in your firm
3. Meet weekly with staff, Engineering consultants and discuss ideas, start with a SAT of Blue Ocean Strategy (Kim & Mauborgne) and then have and SAT on the Toyota Way (Liker)
4. Think Collaboratively – read the AIA docs on Target Value Design
5. Establish a **Best Practices Execution System** – Before your senior people leave see (www.sigmaflow.com/bpes)
6. Attend Conferences like the AIA TAP Conference, AGC BIM Forum and LCI
7. Invest in AutoDesk Navisworks, MindJet, and dProfiler Beck Technologies all 2.0 BIM software
8. Incentivize the learning experience – free lunches, Saturday meetings with experts, off sites twice a year.
9. Include Sustainability goals in all projects designed
10. There is no Easy Button

## CHALLENGES / FOLLOW-UP

**CHAMPION Bruce Cousins, The Weitz Company** **COLLABORATORS:** **SPONSOR** **APPROVER:**

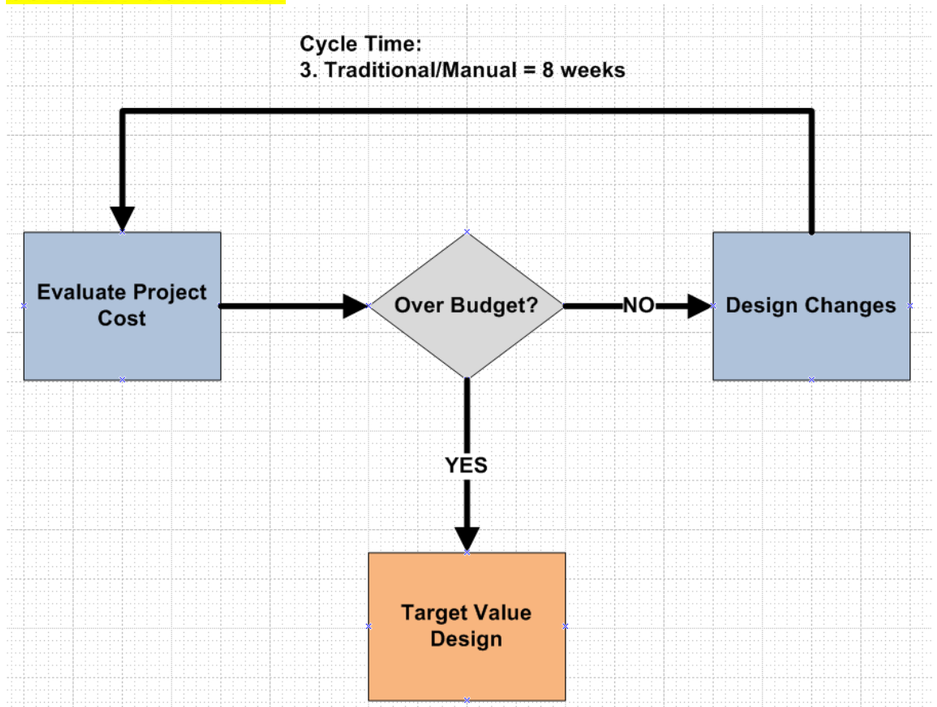
**PROJECT:** SUTTER MEDICAL CENTER, CASTRO VALLEY, CA

**DATE:** 06/18/2009 **BY:** Saurabh Tiwari

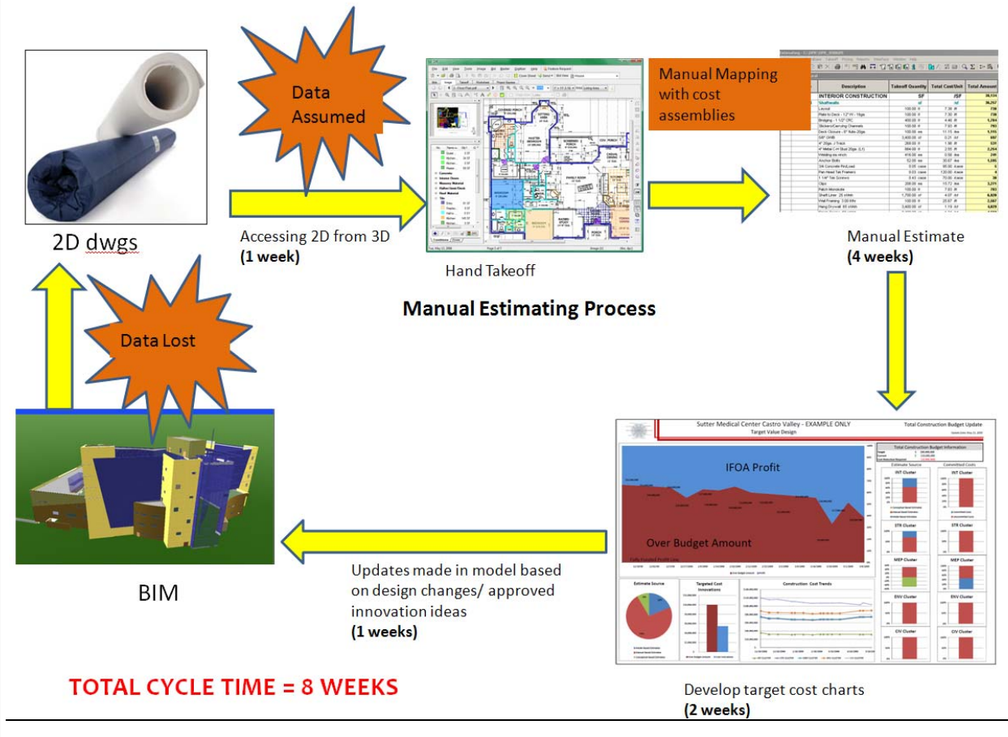
**SYSTEM/SUBSYSTEM:** TARGET VALUE DESIGN (TVD)

**CUSTOMER EXPECTATIONS:** RAPID COST FEEDBACK TO INFORM TARGET VALUE DESIGN (TVD)

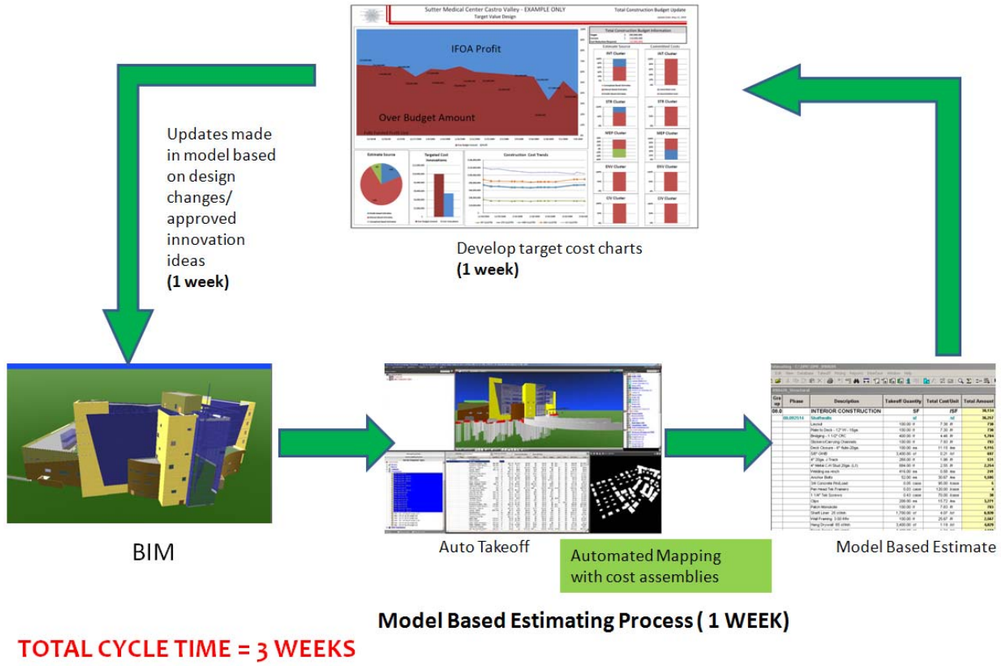
## CURRENT CONDITION



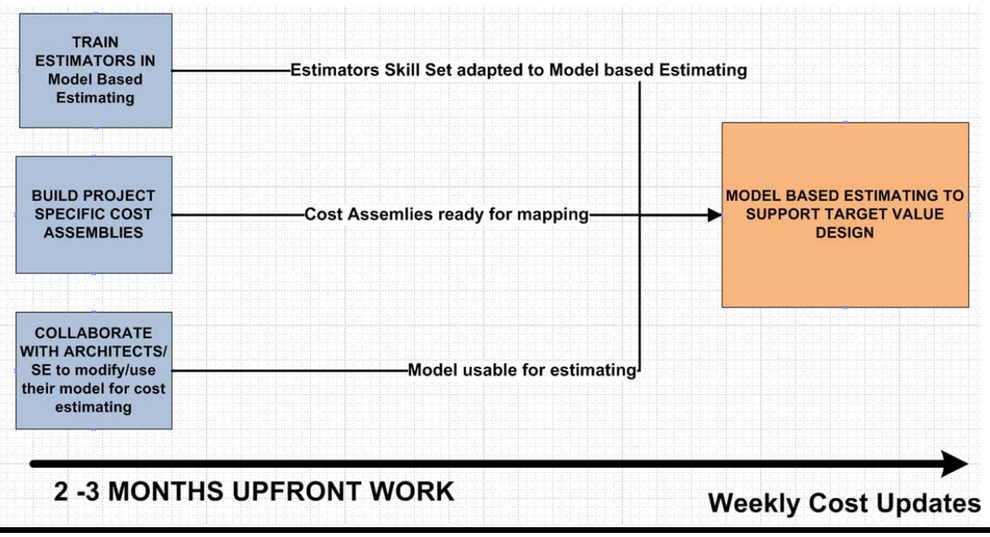

## PROBLEM STATEMENT/ROOT CAUSE ANALYSIS




## PROPOSED SOLUTION:




## 6) IMPLEMENTATION PLAN




## CHALLENGES/FOLLOWUP

| CHALLENGES | FOLLOWUP |
|---|---|
| 1. Training Estimators to use a new estimating tool | 1. Devote Model Based Estimating champion in training estimators. Setup timeframe and incremental delivery of model based estimates |
| 2. Aligning Tradtional Estimates with Model based Estimates | 2. Start dialogue with architects and setup an incremental timeframe for modifying their models. If possible, Gain Access to Designers Central File models and add cost specific parameters |
| 3. Creating Job-Specific cost assemblies | |
| 4. Adding Cost relavant information to Designers models | |