

Analysis I

*“Measuring the Benefit of
Constructability Reviews”*

1.1 Executive Summary

Initially the goal was to quantify the benefits of constructability reviews during the design process. However, after discussing this topic with several people it was found to be impossible, because when a mistake is found while in the design development and early construction document phase, it is simply corrected. Documentation of the possible effects of the mistake if left uncorrected is not maintained. This led the research to taking a look at reviews of the plans at a later phase, just prior to being released for bids. It was found that although it is commonly accepted knowledge that at this point the design is final and there is very little ability to change the cost of the building, there is still an opportunity to save a substantial amount of money by reducing change orders caused by errors in the construction documents. On average, for a \$15,000,000 project it is possible to save over \$100,000 of change orders, avoid nearly half of the RFI paperwork, and avoid claims almost entirely.

1.2 Overview

As part of the annual PACE Roundtable held last fall there was quite a bit of conversation related to the increase in change orders caused by incorrect or inadequate design documents. It is believed that the designers, architects and engineers, are being given less time than they were in the past to create plans for more complex projects. This causes them to feel rushed and increases the number of errors they do not see or have time to correct. Because every error on the part of a designer has the potential to become a change order during construction, these mistakes can cause an unexpected increase in

the cost of the project. This is especially true on hard bid projects such as government work.

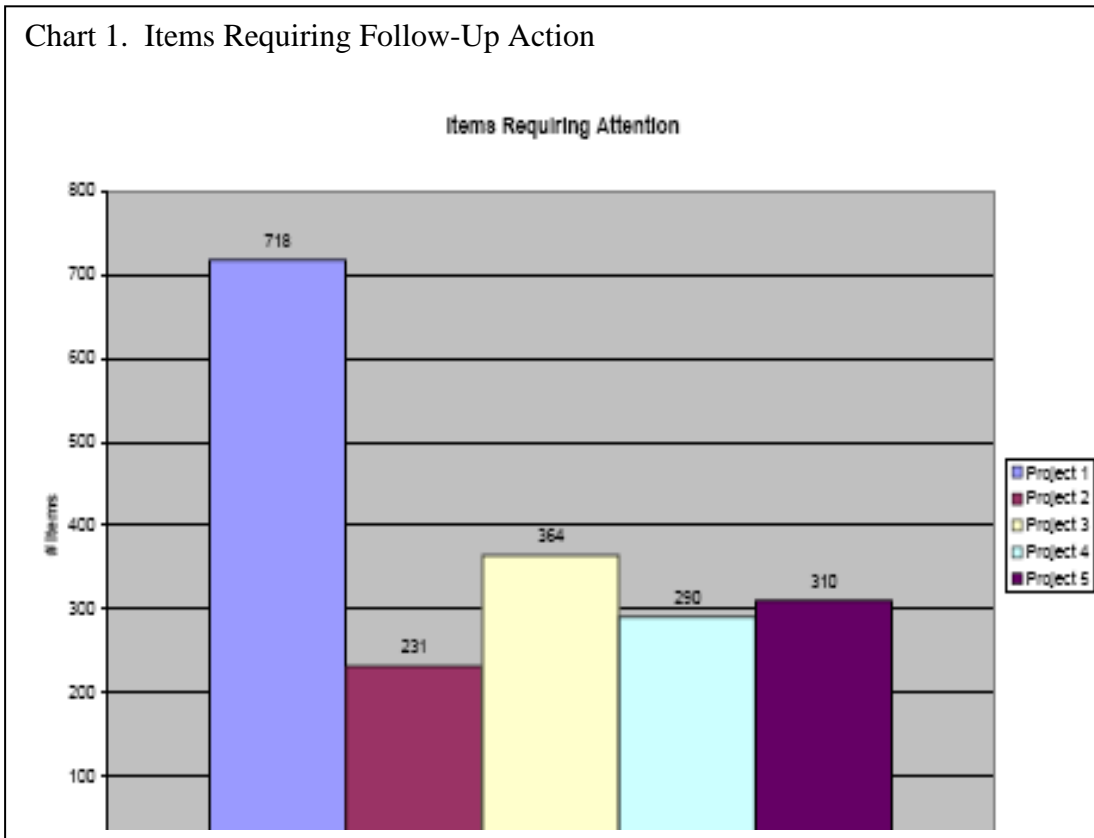
In order to avoid the unexpected price increase some construction managers and consultants are offering a design check service. By having a third party review the construction documents, mistakes can be fixed before the project is bid, or corrected by an addendum during the bidding process. To measure the benefits of conducting the review, data was obtained from one of the leading companies in this field, The Foreman Group. They began providing a design check service two years ago and recently began tracking the effect of their efforts.

The data examined included some background of 13 projects they have provided design checks for, and the full report created for five of the projects. All projects involve multiple prime contractors with hard bids. At the request of The Foreman Group, no project names will be released in order to protect client information. Instead the projects will simply be referred to generically as Project 1, Project 2, etc. Data derived directly from the reports can be found in Appendix A.

1.3 Method of Plan Checks

The method used by Foreman to conduct the plan checks is to take the plans when they are considered 100% complete and have a team of five to ten people fill out a check list containing approximately 500 items. The list is broken down into several categories covering general, site, architectural, structural, HVAC, electrical, and interiors. There are usually many other questions and conflicts that are project specific or confusing that are caught by the team members and added to the end of the check list.

Chart 1. Items Requiring Follow-Up Action



The usual team members include a site superintendent who is between projects, an architect, a project manager, and structural, electrical, and mechanical engineers. Because these are professionals who usually are working in their fields, rather than always consulting, they are up to date on current developments in the industry and all have significant experience. One of the benefits of having a company with both design and construction management experience conduct the plan checks is that if the team would like the advice of a specialist in an area with which they are not familiar, they usually have one in the office.

The effectiveness of this method becomes clear when looking at the five reports provided by Foreman. As shown on Chart 1, the minimum number of items requiring

further action was 231, and on Project 1, 718 items were identified that the reviewers believed should be corrected or clarified. The possible effect of these errors was estimated and is shown on Chart 2. It was estimated that the possible change order cost for the items found on Project 1 was \$550,000. Because of the varying total project costs, the cost of the possible change orders found is represented on Chart 3 as a percentage of the entire project cost. This shows that because Project 1 was a much larger project, having the most possible change orders would result in a smaller percentage cost increase for the project. On Project 5 the amount of the change orders saved could potentially have increased the value of the project by 20.5% (see Chart 3). This is twice the typical 10% contingency applied to most projects and could have led to problems in financing the completion of the project even if there were no other problems during construction.

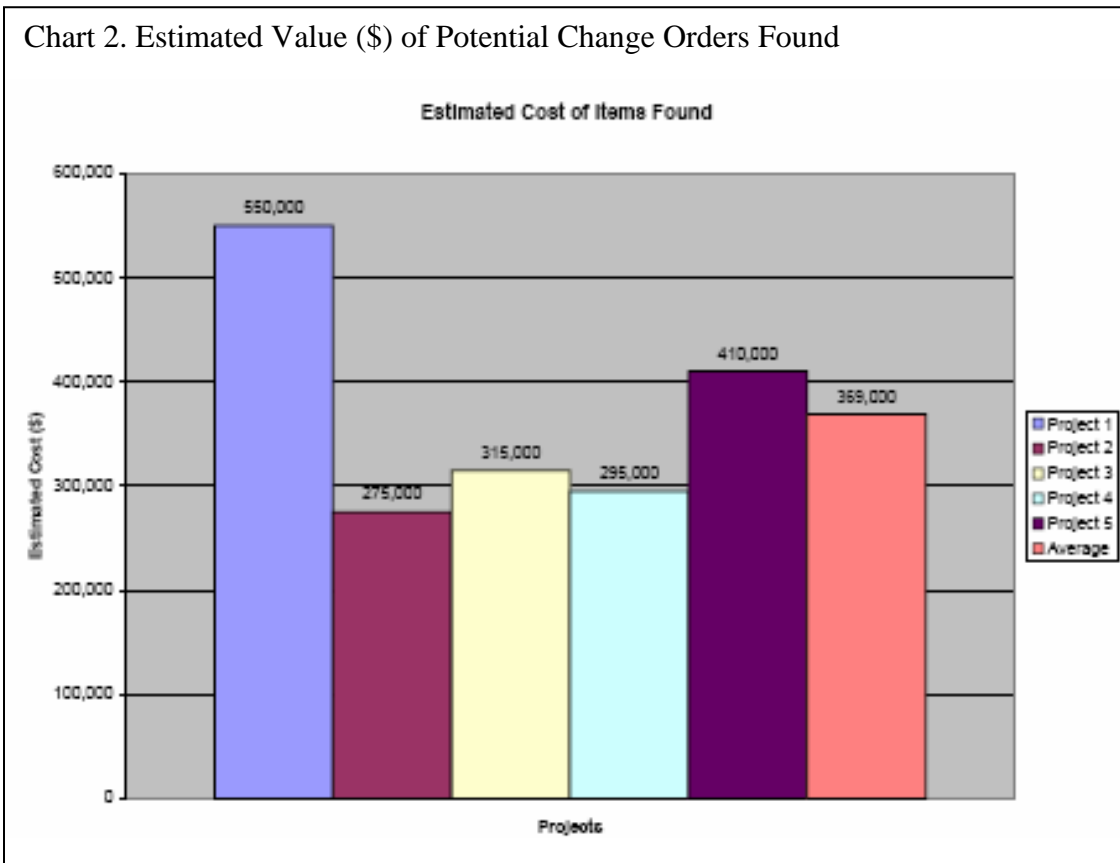
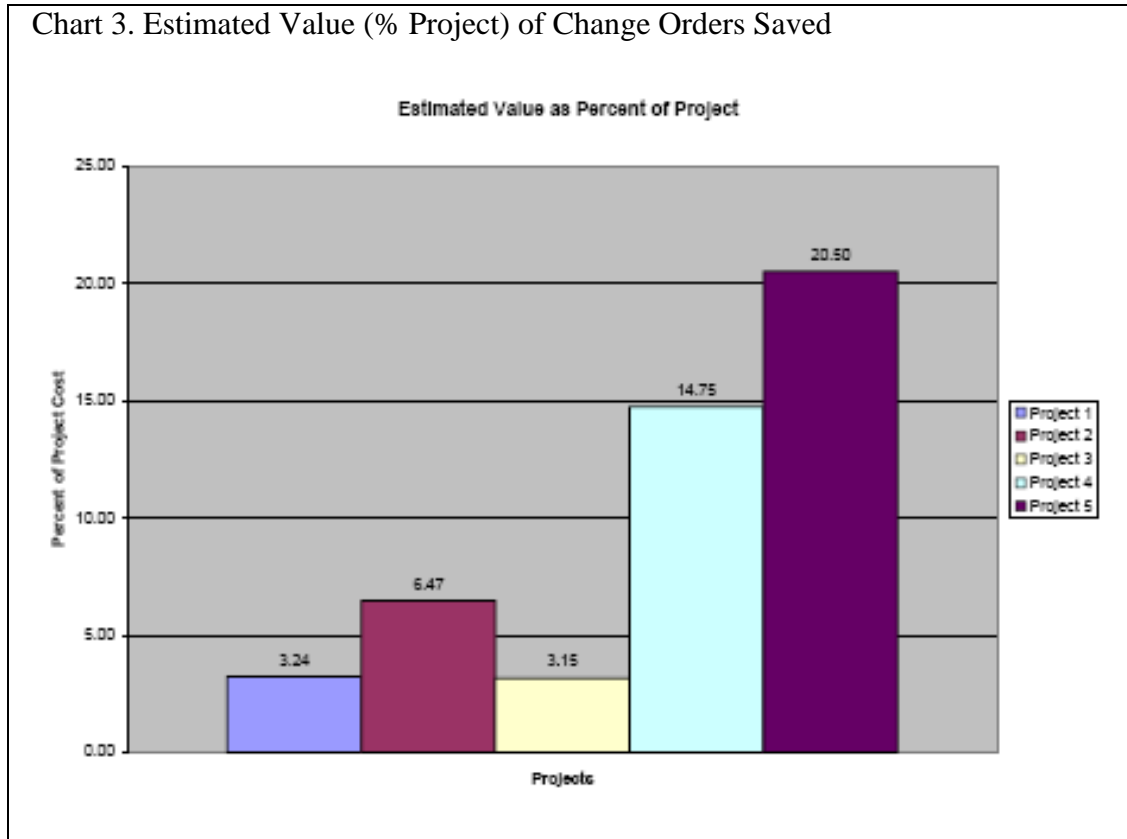


Chart 3. Estimated Value (% Project) of Change Orders Saved



1.4 Change Order Comparison

Change orders can come from several different sources. They can be caused by an owner changing their mind, a contractor preference for a different method, or errors in the construction documents. Because the designer does not have control of the first two causes, we will only consider errors in the construction documents, or A/E related change orders. Of the 13 projects used for plan check data, the total cost of A/E related change

orders was \$247,578 while the total value of the projects was \$148.3 million. This gives a change order percentage of .16%. For projects in Foreman's database that did not use plan checks, A/E related change orders cost an average of .85% of the project cost. This means that for their typical project of \$15 million there would typically be \$24,000 of A/E change orders for projects that used plan checks compared to \$127,000 for projects that did not use plan checks. This is a savings of \$103,000 for the project.

As an added benefit, the clearer plans with fewer conflicts that reduce change orders also reduce RFI's. The same 13 projects had a total of 1634 RFI's, an average of about 11 per million dollars of projects. This can be compared to approximately 20 per million for projects that did not institute a plan check. This halving of RFI's will not only reduce paperwork during construction, but also avoids giving the contractor an excuse for filing a claim due to loss of productivity because of the paperwork.

1.5 Common Trends

After looking at the five complete reports, it was discovered that there were eight items that required action on all five projects. This can be seen from Charts 4 and 5 which show the number of projects each checklist item was found to require action on. These eight items are numbered below with specific comments following the bullets.

1. Reflected ceiling plans match architectural floor plans. All MEP fixture locations are coordinated with ceiling.
 - The Reflected Ceiling Plans did not coordinate lighting fixture requirements with the mechanical and plumbing needs. Another reason this item needed action was that room numbers or walls were shown incorrectly.
2. All material choices listed in the finish schedule are consistent with the materials identified on the plans and specs.
 - The finish schedule was either incomplete, missing, or in conflict with the specifications.
3. The size, location and type of foundations are clearly defined on the plans. Foundation plans include drains and tie-ins.
 - The common errors were not including foundation drains in the plans or not showing the depth of the foundation on the plans.
4. Structural drawings are clear and do not confuse bidders with respect to scope issues.
 - The structural drawings did not clearly show the scope of structural work. There were items missing from any scope of work and items that were

covered under more than one scope. Items not covered will be change orders. Items covered twice will be in both bids.

5. HVAC routing of duct and pipe does not conflict with architectural plans.
 - All of the projects had conflicts between mechanical or electrical work and the ceiling.
6. Architectural and Electrical drawings appear to be coordinated.
 - Electrical and Architectural drawings were in conflict due to missing fixtures, equipment, and specialties. They also had inadequate clearances for electrical items.
7. Specifications- Contractors scopes are clearly defined.
 - The specifications were missing work scopes, contained improperly defined scopes, or missed items.
8. Roof Drains shown and correct.
 - The Roof Plans did not show gutters and downspouts. Some did not show any roof drains or had them in locations that conflicted with architectural or plumbing drawings. Also, several Roof Plans showed roof types that differed from the specifications or other plans.

By studying the types of things that are missed on most drawings, it points to areas where a construction manager should be especially attentive. Focusing on these areas will almost always yield results in the form of future cost savings due to reduced conflict or confusion in the field.

Chart 4. Number of Projects Requiring Action for Each Item (first half)

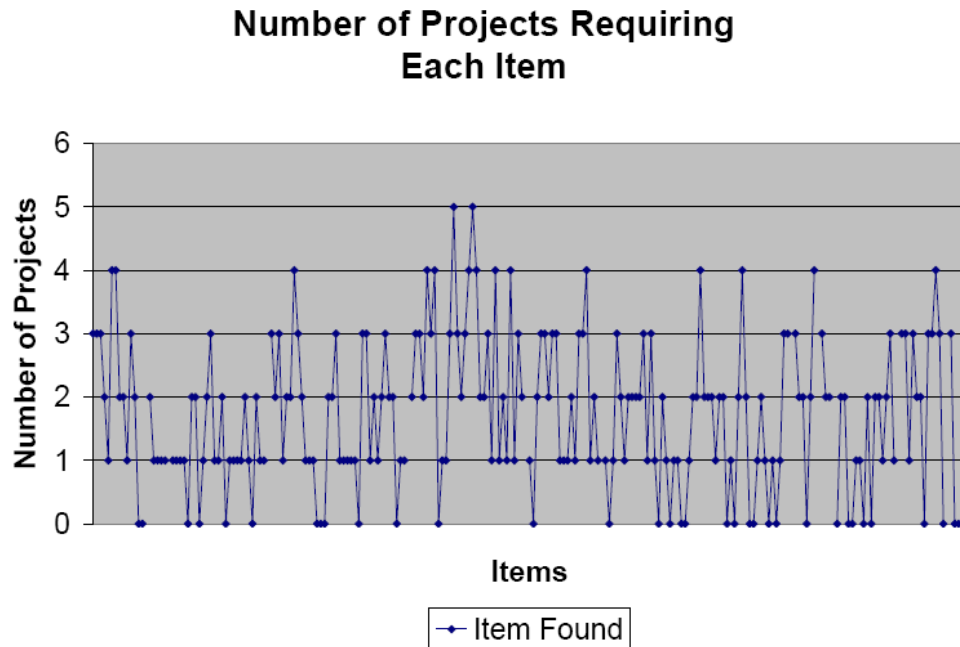
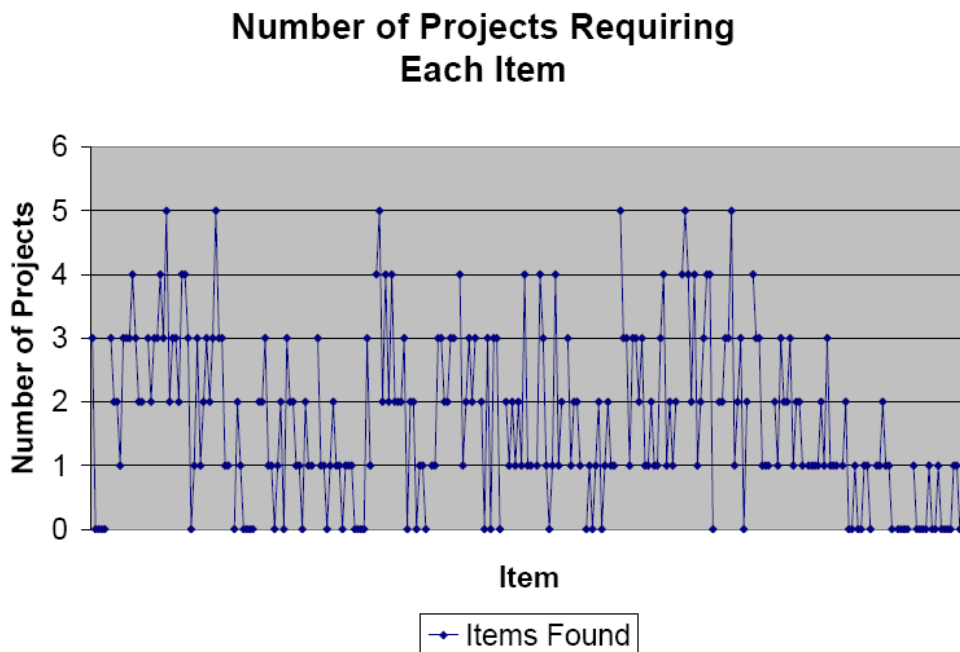


Chart 5. Number of Projects Requiring Action for Each Item (second half)



1.6 Challenges

It seems like it would be fairly easy to convince the owner that it is a good idea to have the plans checked before they go out to bid, especially when there is a guarantee that the amount saved will exceed the fee for the service. Although the fee is usually about \$30,000 for a \$15 million project, because it is typical to find over \$100,000 of corrections this is money well spent. It may also be noted that in the projects studied, which include 260 prime contracts, there was only one claim filed. Because most owners should be interested in having a smooth, successful, construction project, this fact may appeal to them.

It is sometimes more difficult to convince the designer that it is a good idea. They may feel intimidated or resentful when told that their design is going to be reviewed by another architect. This is a natural reaction by most people when they feel somebody is going to be looking over their shoulder.

The best way to avoid this feeling of animosity is to educate the architect as to the goal of the review. It is not to pick apart their design; it is to act as a peer reviewer. Just as a writer does not send their book directly to the printer, but to an editor first, an architect is much better served by having a fresh set of eyes look at the plans. They may also be reminded that in a time where owners are increasingly filing claims against designers for errors and omissions, and it is becoming easier for a contractor to file claims directly against an architect, it may also be a smart financial move to get another opinion before sending their drawings out for bids.

When given the report after a plan check has been conducted, architects will participate to varying degrees based on their understanding of the process, temperament,

and ability. Some are naturally more cooperative than others and are more likely to make the changes recommended (See Charts 6 and 8). Others seem to be openly hostile to the process, but will still find some obvious errors that they will grudgingly fix. This seemed to be the case on Project 4. As shown in Charts 7 and 8, only 14.48% of the items found on this project were fixed leaving 248 items still unclear or incorrect. Some of these items seem to be major issues such as missing elevations, ADA requirements not met, and no lighting fixtures included on reflected ceiling plan. However, the architect still fixed 42 items would likely have been cited as reasons for a change order. In cases where the items are not fixed, the owner will have documentation that the architect refused to exercise due care in creating the construction documents and knew that the errors could cause problems. This may be beneficial if the items cause a major change order later in the project.

Chart 6. Number of Items Fixed on Each Project

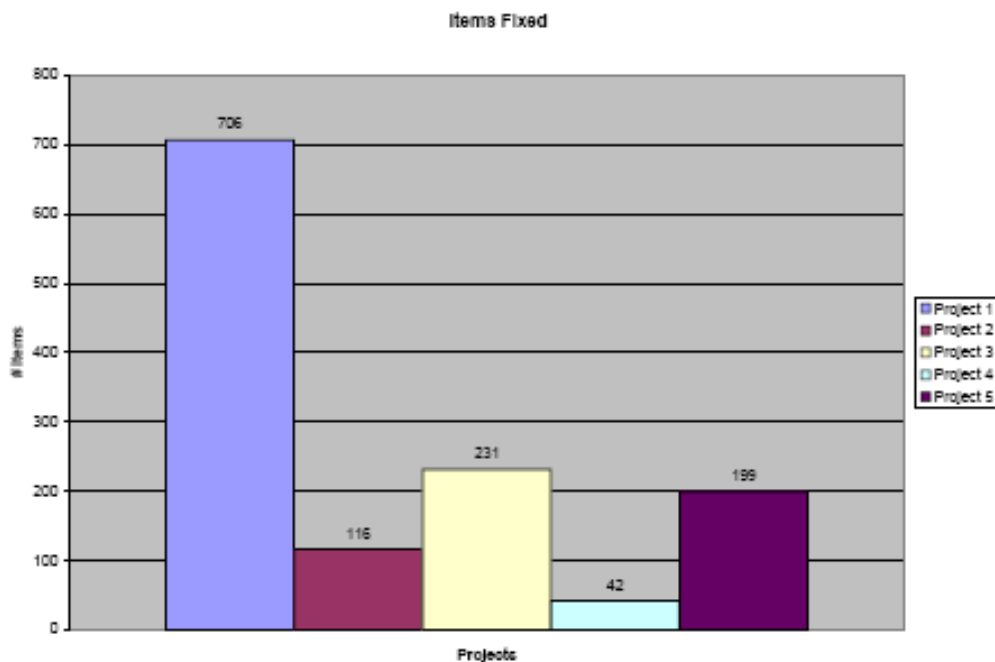


Chart 7. Number of Items Not Fixed on Each Project

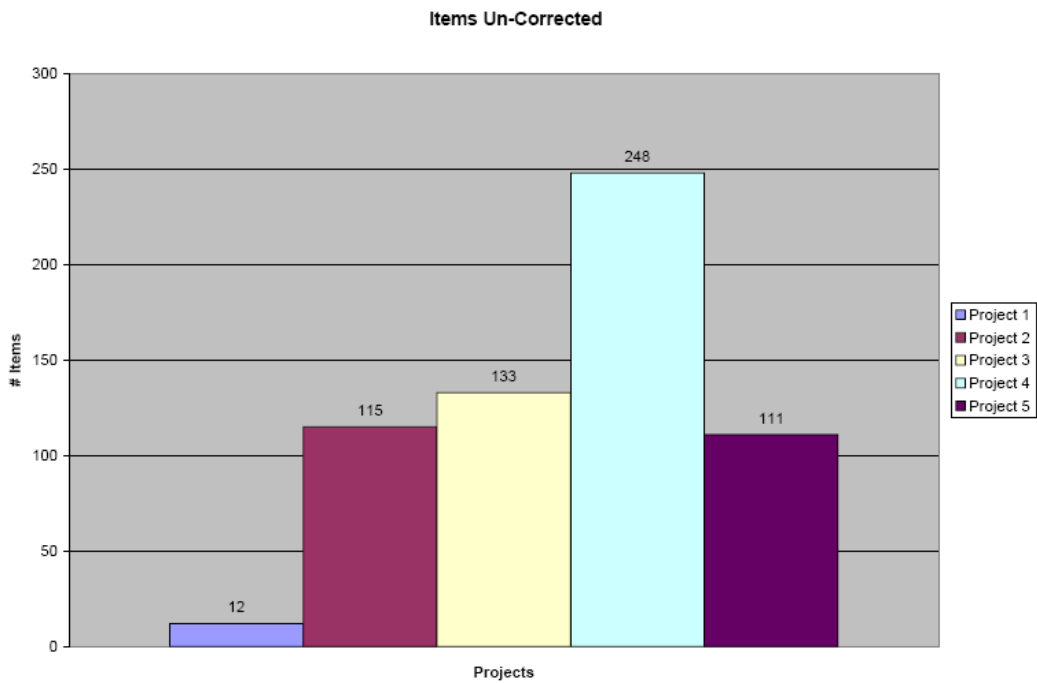
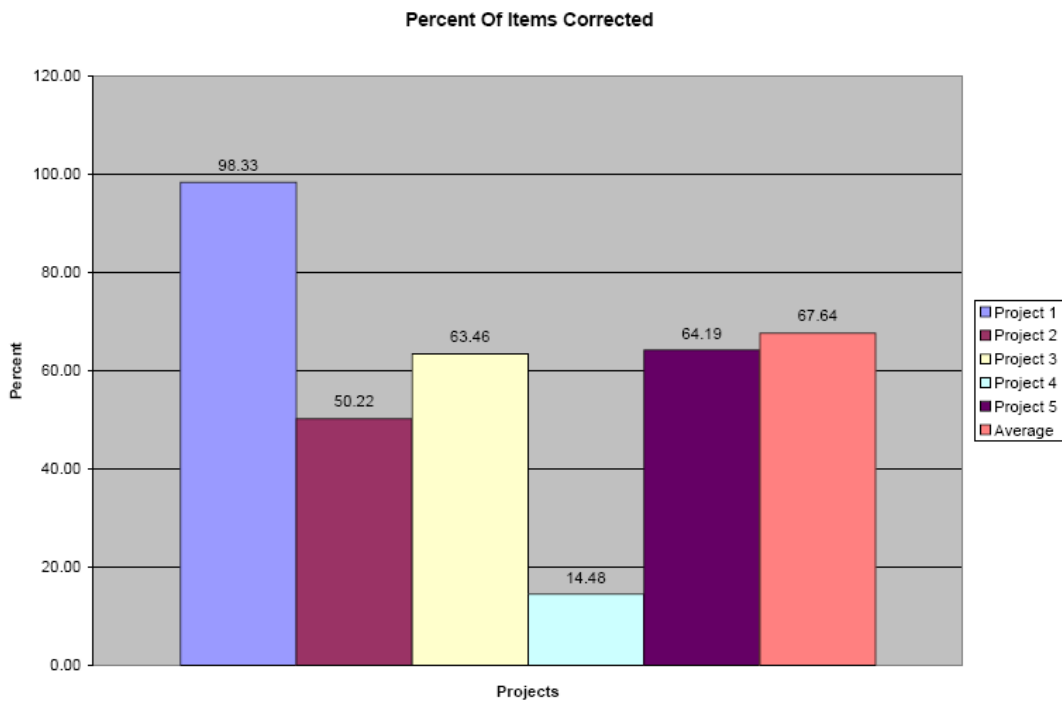


Chart 8. Percent of Items Fixed



1.7 Recommendation

After reviewing the data, the benefits of reduced change order quantity and cost, fewer RFI's, and smoother running projects are clear. There is also an obvious need for educating designers about the process in order to ensure their cooperation. The common errors should also be discussed within the design and construction communities so they can be caught either by the architect before releasing the drawings or by the CM during the bidding process.