WEB BASED CONSTRUCTABILITY REVIEW SYSTEM

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ABSTRACT

One established principle within the building industry is Paulson's level of influence concept (LOI). Paulson's concept is based upon the idea that decisions or actions made earlier in the project delivery process (i.e. in the design phase) have a greater ability to influence the total project costs than decisions and actions made later in the project delivery process (i.e. in the construction phase of a project). One increasingly popular management tool that follows the LOI concept is a formal constructability review. A constructability review is a structured review of a project's plans and specifications before the project is bid. The focus of the review is on the buildability, bidability, and efficiency of construction. When implemented successfully, a constructability review can result in reduced construction phase change orders and reduced total project costs (including operation costs) through value engineering studies of project systems.

Problems with the successful use of this tool has been in the implementation of a process to ensure that corrections that have been identified as part of the review are clearly understood, the corrections are completed, and a back checked performed. Reasons for these difficulties are varied but seem to arise from design process segmentation to engineering specialists, inadequate documentation of corrections and correction progress, and a lack of time to formally review corrections. This paper introduces a new tool to solve these problems and examines performance of the tool across a five separate reviews. The paper will introduce the web based constructability review system; explain the methodology of the constructability review process used; review the tool's programming and database; highlight implementation issues; discuss and analyze the tool's performance; recommend improvements to the tool, and suggest future research and expansion of the concept to other areas.

KEY WORDS

constructability Review, web based tools, construction, project management, cost control

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INTRODUCTION

One established principle within the building industry is that decisions or actions made earlier in the project delivery process have a greater ability to influence the total project costs than decisions and actions made later in the project delivery process (Paulson 1976). One increasingly popular management tool that follows this concept is a formal constructability review. A constructability review is a structured review of a project's plans and specifications before the project is bid. The focus of the review is on the buildability, bidability, and efficiency of construction. When implemented successfully, a constructability review can result in reduced construction phase change orders and reduced total project costs (including operation costs) through pre-bid identification of construction changes and through value engineering studies of project systems. Constructability reviews are well accepted within the design and construction industries (Arditi et al. 2002, Gibson et al. 1996, Jergeas and Van der Put 2001, Kartam and Flood 1997)

Problems with the successful use of this tool has been in the implementation of a process to ensure that corrections that have been identified as part of the review are clearly understood, the corrections are completed, and a back checked performed. This paper introduces a new tool to solve these problems and examines performance of the tool across a five separate reviews. The paper will introduce the web based constructability review system; explain the methodology of the constructability review process used; review the tool's programming and database; highlight implementation issues; discuss and analyze the tool's performance; recommend improvements to the tool, and suggest future research and expansion of the concept to other areas.

CONSTRUCTABILITY REVIEW ONLINE SYSTEM

Constructability Review (CR) Online was developed by plans reviewers and a programming staff. It was written in Cold Fusion and runs on a Windows Server with a SQL Server database backend. The group has performed over 350 online reviews totaling about 250 MB of database storage. The program has 14,531 lines of code. This size of this code is just about 1MB, though the site itself takes roughly 23MB (not including the data stored in the database).

The program is password protected and menu driven. All users (reviewers and users) are given a password to access their project site. After a project kick-off meeting, the reviewers begin to add comments to a project specific review database. After a review comment is posted, a member of the design team reviews the comment and assigns a response code of one of four numbers where

- 1 means "Agree - will provide suggested solution"
- 2 means "Agree - will provide alternate solution"
- 3 means "Disagree - no action to be taken"
- 4 means "Owner's input/clarification required"

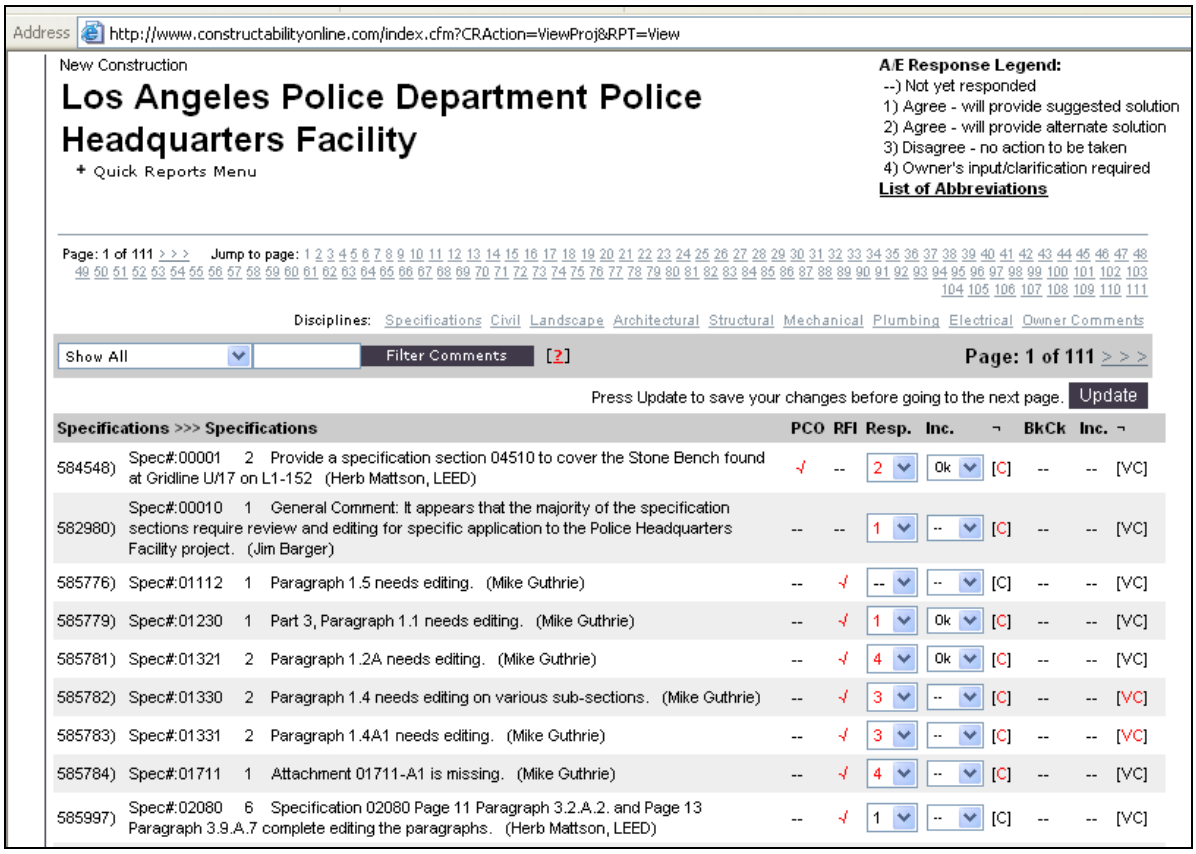

Figure 1: Constructability Online Summary Page

A shot of the first few constructability comments from one of the projects of this study is shown in figure 1. Note within the program there are fields for indicating whether the comment would likely result in an "RFI", request for information, and "PCO", potential change order. In addition to the categorization of responses described above, three fields are added to monitor the inclusion of constructability comments – the "Inc." field is used by the designer to indicate that the correction has been made, the "BkCk" field is used by the review team or project manager to confirm that the corrections have been made (on a revised submittal set). Two fields are used to enhance communication between the reviewer and designers. The "C" and "VC" fields are discussion boxes that can be used to explain comments and to provide additional information beyond what is shown on the construction documents. All project comments can be reviewed online and sorted by design discipline. All comments can also be printed from a selection of nine hard copy reports.

The advantage of the tool as compared to traditional reviews is the concurrency of designer access to reviewer comments. Figure 2 shows the concurrency within the online process.

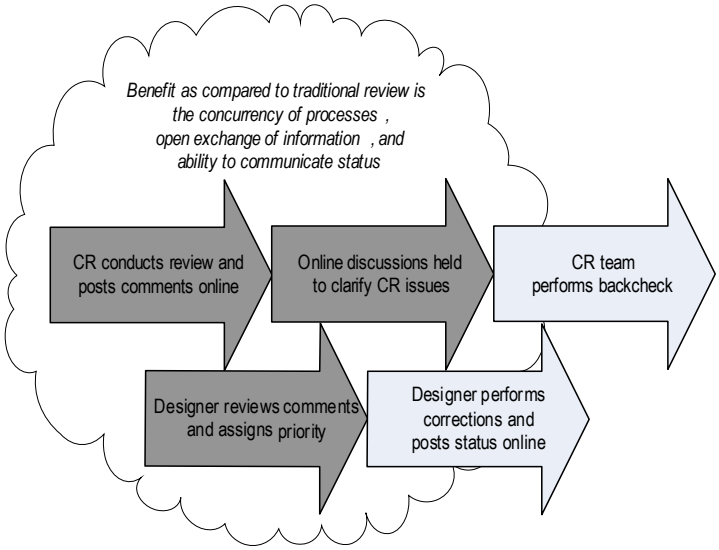

Figure 2: Concurrency within the Constructability Online Process

CASE STUDY PROJECTS

Five projects are compared within this study of the online tools. The five projects are off varying sizes and types and are meant to represent typical pubic sector projects. Table 1 summarizes the projects. Table 2 summarizes the comment breakdowns.

Table 1: Constructability Review Project Summary

Project Name	Construction Cost ($M)	Total Number of CR Comments	CR Comments per Cons. Cost ($M)
State Highway Rest Area	5.4	371	68.7
Sewer-Vacuum Station	22	152	6.9
K-12 Learning Center	48	1196	24.9
University Classroom Building	52	1178	22.7
Police Department Headquarters Facility	303	1707	5.6

Table 2: Constructability Review Comment Breakdown

CR Review Discipline	Designer Response	Project Name				
		State Highway Rest Area	Sewer-Vacuum Station	K-12 Learning Center	University Classroom Building	Police Department Headquarters Facility
Specifications	1	17	13	45	46	87
	2	4	2	15	13	31
	3	13	7	8	36	14
	4	6	2	4	7	12
	Total	40	24	72	102	144
Civil	1	52	30	6	60	57
	2	34	11	74	18	18
	3	19	8	3	7	1
	4	6	0	0	6	0
	Total	111	49	83	91	76
Architectural	1	66	15	352	454	483
	2	16	3	55	54	130
	3	26	6	1	23	49
	4	1	0	6	0	0
	Total	109	24	414	531	662
Structural	1	25	10	127	81	77
	2	18	6	5	0	40
	3	16	2	13	9	14
	4	0	1	1	0	0
	Total	59	19	146	90	131
Mechanical	1	4	5	104	83	325
	2	3	1	31	18	1
	3	1	11	30	18	15
	4	1	0	0	5	0
	Total	9	17	165	124	341
Electrical	1	15	1	180	100	301
	2	6	10	56	37	31
	3	22	8	75	97	5
	4	0	0	5	6	16
	Total	43	19	316	240	353

These two figures show that except for one project, smaller projects (based on construction cost) have fewer constructability comments. The discipline with the most comments is the Architectural discipline and the Civil, Electrical, and Mechanical disciplines have the second most comments (depending on the project). The figure also shows that regardless of the design discipline, most comments are agreed to and will use the provided suggested solution. The mechanical and electrical disciplines are more likely to have comments that are disagreed with or that require owners input/clarification.

Two figures are used to summarize the review comments for the five projects. Figure 1 shows the breakdown of designer's responses to the constructability comments (for all projects). Figure 2 shows the breakdown of the comments by discipline (for all projects).

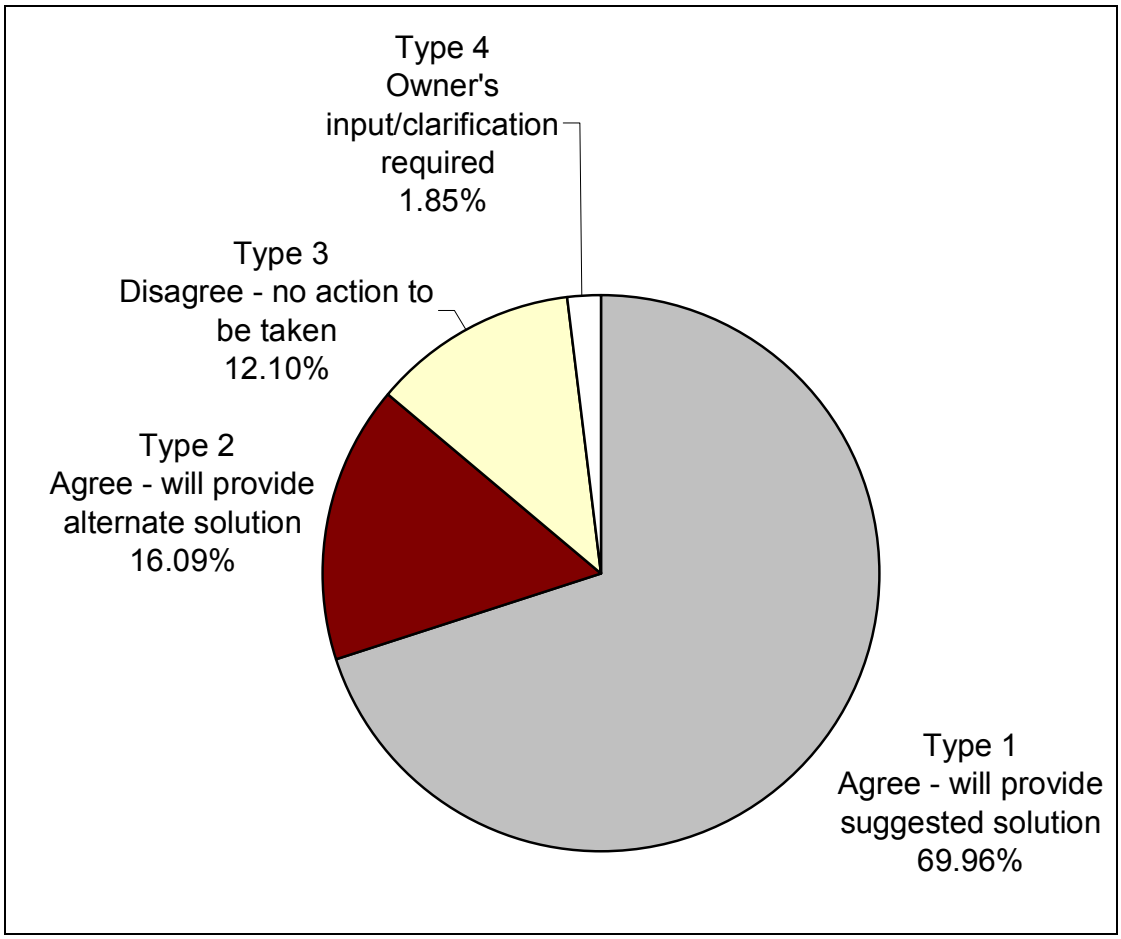

Figure 1: Summary of Designer Responses to Constructability Review Comments

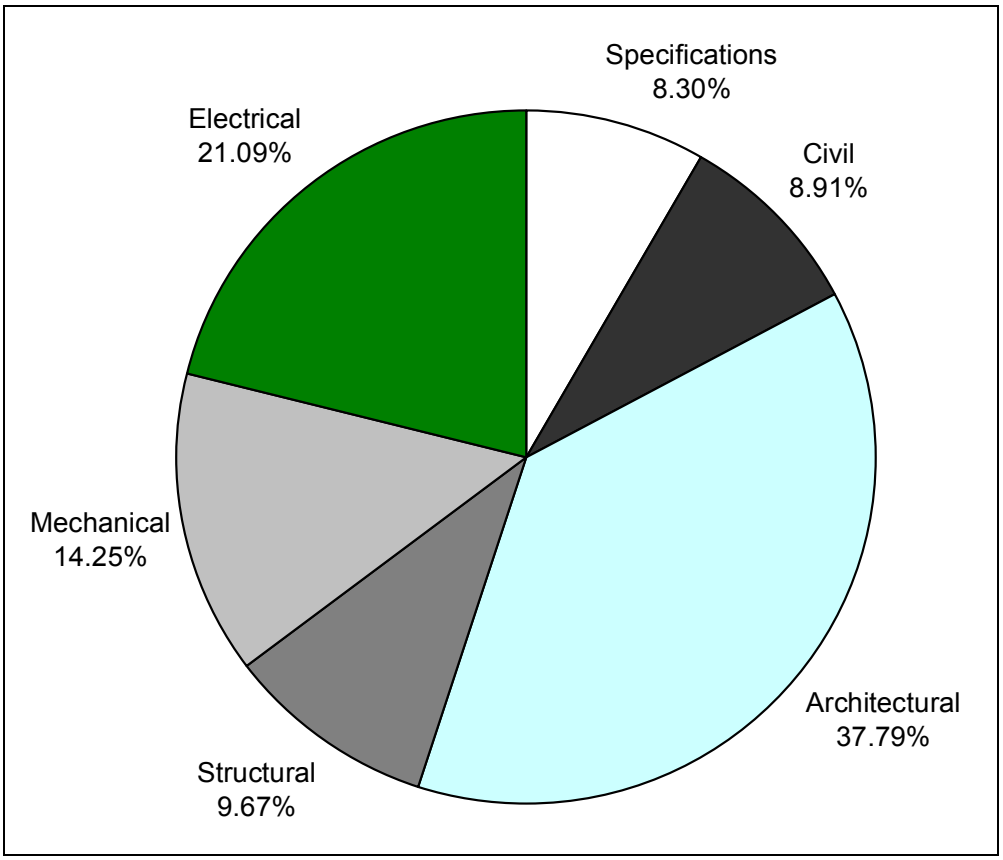

Figure 2: Summary of Constructability Review Comments by Discipline

Recall, one underlying idea behind the review is to identify changes before the construction begins. For the largest project of the five in this study, a construction manager studied the constructability comments and identified which comments would likely result in a change order if they were left uncorrected. Table 3 shows the results of this analysis. The analysis shows that on a percentage basis, the Civil discipline comments are most likely to result in change orders and on a numbers basis, the Architectural discipline is the most likely to result in change orders. The potential change order totals for the table appear high, but 350 changes on a $300M project with a set of poorly coordinated construction documents is not at all unlikely. It is likely that many of the change orders would result in significant cost and schedule impacts to the construction process.

Table 3. Constructability Comments Resulting in Change Orders

CR Review Discipline	Number of CR comments	CR Comments Identified as Future Change Orders	Percentage of CR Comments Identified as Future Change Orders
Specifications	144	70	48.61%
Civil	76	57	75.00%
Architectural	662	120	18.13%
Structural	131	13	9.92%
Mechanical	341	48	14.08%
Electrical	353	41	11.61%
TOTAL	1,707	349	20.45%

CONCLUSIONS

This paper has introduced a new online constructability review tool and tested the new tool across five separate reviews. The tests showed that the two chief benefits of the tool are concurrency of the creation of comments and the designer review of the comments and online communication ability within the program. Most comments were from the Architectural discipline and were accepted by the designer without question.

Suggestions for future research would center on the backcheck process. As the tool is currently designed, the backcheck is done on a hard copy set of documents after the initial review is complete. Future research should identify and implement tools to allow real-time monitoring of corrections from the designers office. Additional research that would be valuable to the industry would be a means to capture of the actual dollars saved by a constructability review and a means to identify areas within the design that did result in changes but were not identified as part of the review.

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