USING THE FORWARD THINKING INDEX™ TO REDUCE DELAYS RELATED TO REQUEST FOR INFORMATION PROCESS

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ABSTRACT

This paper presents a solution to help eliminate waste and mitigate risk through the compilation and monitoring of project indicators that contribute to costly and timely rework. The Forward Thinking Index™ (FTI) concept promotes team communication while leveraging the team's ability to become proactive, rather than reactive. FTI measures project team members' practices with regards to submitting requests for information (RFIs). Late submission of RFIs often leads to project delays and the corresponding potential for cost overruns. Introducing a measure like FTI helps the project leadership mitigate potential issues related to RFI submission and builds team awareness around the importance of timely RFI submission. The FTI tool can be implemented to accumulate and store historical data to identify trends and monitor results for use during current and future projects. Continued and consistent use of FTI creates a culture shift that encourages proactive planning which helps the timely identification of potential issues and benefits all stakeholders. FTI requires minimal management; however the data collected provides numerous project and business benefits. Used in conjunction with Percentage of Promises Completed (PPC), it provides a powerful tool to encourage a proactive project environment.

KEYWORDS

Culture change, request for information, look ahead, collaboration, forward thinking, work flow, continuous improvement/kaizen

INTRODUCTION

The Forward Thinking Index™ (FTI) is a lean construction tool that provides a metric that quantifies a construction project team's ability to think ahead about design and field conditions and take proactive steps to ensure that projects flow smoothly. FTI measures the project team's ability to track requests for information (RFIs) and minimize the amount of delays caused by RFIs that are not processed in a timely manner. RFIs are formal written requests made by general and subcontractors for

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additional information or clarifications regarding design and construction issues related to contract documents. RFIs are an important part of the construction process in terms of improving communication between the design and construction teams (Hanna et al 2012). The formula-based FTI score allows the general contractors, subcontractors and design team members to measure how well they stay in front of the day-to-day work sequence and provides an incentive for continuous improvement.

Awareness of the FTI scoring system promotes employee engagement, keeping the principle of forward thinking on the minds of the general contractor, subcontractors and design team members. The FTI tool represents a significant step forward in continuous improvement exploration, with a specific focus on minimizing negative impacts on schedules and budgets, while encouraging a culture of anticipating problems and solving them before the impact the project.

The FTI increases participants' awareness and accountability, while providing contractors with a simple, effective tool to assess performance. Most important, FTI helps keep all participants aligned and working collaboratively for the owner's benefit.

In delivery models such as Integrated Project Delivery (IPD) and Design-Build (DB), there is incentive among the project participants to resolve RFIs quickly or prevent them altogether. Contractual and organizational tools, such as co-location of the design and construction team members, can facilitate the prevention or fast resolution of RFIs. There is less incentive to resolve RFIs in the Design-Bid-Build (DBB) delivery model because there are fewer contractual or financial incentives for the design and construction teams to work together and the construction contract price and subcontractor selection is typically based on lump sum contracting. General contractors and subcontractors, knowing that their selection for a project will be either highly or solely dependent upon submitting bids with the lowest price, are incentivized to base their bids on interpreting the plans and specifications in such a way that they can arrive at the lowest bid price and ask clarifying questions via RFIs once the project is underway. RFIs that result in additional work are often resolved with change orders that lead to increases in the project cost and/or project delays. By delaying the RFI resolution process, some project team members may create potential delays in the project that may result in increased leverage to settle issues with change orders as a means to keep the project on schedule.

BACKGROUND

The construction industry has become hyper competitive, with pricing so aggressive that work is frequently bid at or below costs. Clients have sensed the shift to a buyer's market and have, in many cases, gone back to a traditional DBB hard-bid approach, impacting the market share, growth, and development of collaborative IPD type projects utilizing lean concepts.

Cost cutting by all parties translates to less time for detailed, site-specific design and review during preconstruction, which directly affects work execution during construction. Additionally, price pressures may lead general contractors to award work to subcontractors with whom they have had little or no previous experience. Unfortunately, working with unproven subcontractors can result in cost escalations, project delays, and concerned owners. General contractors need to be cognizant of the fact that owners remember initial budget estimates and project completion dates.

Results that don't meet with these original expectations are discouraging and could lead to relationship separations. FTI was developed to help address these concerns.

While delivery models such as IPD and DB can be used by owners to mitigate the risks associated with the cost cutting measures previously mentioned, with the current economic issues facing project owners concerning tight capital markets to finance projects, DBB remains a popular form of project delivery method for less sophisticated Owners, most public agencies, and misinformed Owners that believe that DBB delivers better value. As such, general contractors are increasingly interested in developing tools to increase lean thinking in DBB environments. Therefore, it is important for project participants to manage the RFI process in such a manner that will minimize project delays. FTI can be used to track the management of the RFI process for current projects as well as assist in selection of trade partners for future projects.

DISCUSSION

Project delays and associated costs are enemies of lean construction. Unforeseen issues—such as incomplete or incorrect design documents, material delays, and other unanticipated problems—make up the primary reasons projects fall behind schedule and go over budget. As contractors set about to mitigate the risk that unforeseen factors could negatively affect a project's success, they begin with an understanding that the best way to avoid problems is to see them coming. The only way to gain such foresight is for all team members to examine design drawings and documents for upcoming phases, verify material delivery schedules, ensure adequate resources are available for the tasks ahead, and take other proactive steps to uncover and resolve would-be issues before their potential could be realized.

While adopting a policy of avoiding surprises makes sense as a first step, it is important to find practical ways to implement such a policy. Further, general contractors need to formulate methods that encourage all project participants to adopt a "no-surprises" policy. Finally, general contractors must be able to measure policy adoption and effectiveness.

Part of avoiding surprises and improving work flow is making quality work assignments (Ballard and Howell 1998). The Last Planner^{TM} System (LPS) is a production planning and control system used to reduce variations in construction work flows, develop planning foresight and reduce uncertainty in construction field operations (Ballard 2000; Ballard and Howell 2004). LPS advocates, among other things, identifying and removing work constraints ahead of time as a project team to make work ready and increase the reliability of work plans and taking preventative actions. FTI measures the effectiveness of timely submission and processing of RFIs. By submitting RFIs before their underlying issues become critical, work constraints and their associated delays can be avoided. Common project control measures, such as earned value, are not effective measures of work flow because they assume that each activity is independent and they focus on local speed and cost rather than the reliable release of work downstream (Kim and Ballard 2000, 2002). FTI, on the other hand, seeks to create planning foresight by identifying potential issues early, allowing the project team to develop corrective actions before delays occur and impact multiple project participants.

WORKING HYPOTHESES

The authors set out to test the validity of the following hypotheses:

- Requests for information (RFIs) offer a way to measure the incidence and frequency of issues that lead to project delays and cost overruns.
- Using FTI to review planning efforts will encourage forward thinking and raise the level of accountability for individual stakeholders, which will help eliminate urgent needs that result in delays and higher costs.
- Using FTI will facilitate a smoother work flow for all project stakeholders during all phases of work.
- Once such FTI is adopted, historical data can be used to balance current project staffing levels to ensure team strength and performance.
- FTI data can be used to validate and support issue resolution throughout the project.

PROGRAM DEVELOPMENT

Knowing that the success of forward-thinking approaches rest heavily on project-wide collaboration and communication, the authors held discussions with project team members of commercial building projects to identify factors that impede their productivity, efficiency, and work quality. Through these conversations, the authors gained important insight that enabled development of the FTI.

The conversations verified that RFIs are the standard tool construction professionals use to clarify and solve construction-related issues. Traditionally, general contractors and subcontractors generate RFIs when they come across issues that stop forward progress.

As in many areas of life, timing is everything when it comes to RFIs. An RFI sent when the issue is at hand almost certainly results in a delay and can often lead to cost increases, while an RFI submitted well in advance has a greater likelihood of being resolved before an issue becomes critical, lessening the chances for slowdowns or cost increases.

Through empirical data from completed projects, the authors determined that RFIs submitted at least 10 days in advance of a construction activity typically provide the time necessary to resolve issues. Using the empirical data generated from historic projects, the authors developed a formula to measure success in forward thinking.

The Forward Thinking Index™ is arrived at by calculating the total number of RFIs (*x*) minus the number of RFIs that create schedule delays (y). That difference (z) divided by the total number of RFIs (x) results in the FTI:

$$x - y = z \text{ AND } z \div x = FTI$$

Example:

200 total RFIs – minus 50 RFIs that result in delays = 150; AND
150 divided by the total number of RFIs = 0.750 FTI

Similar to baseball players' batting averages, the FTI shows the percentage of "hits" that helped the team avert delays. And as with batting averages, higher FTI scores are more desirable.

COLLECTION AND USE OF FTI DATA

Project engineers typically collect the data necessary to determine the FTI for each trade. To determine FTI, the project engineers would have to classify the RFIs as either 1) an RFI that has been submitted in a timely manner and won't lead to a project delay or 2) an RFI that can lead to a potential delay, either because it was submitted too late to be effectively dealt with or because it's an RFI that has gone unresolved. Once RFIs are classified, FTI can be easily calculated. The project superintendent can use FTI for each trade and focus corrective action on those with abnormally low FTIs. In this manner, FTI provides an early warning system for potential or actual project delays.

It should be noted that FTI is used as a tool to avoid potential delays and not as a means to punish trade partners. While trade partners that manage the RFI process poorly, or worse, use poor RFI management as a means to generate potential change orders, are a common source of project delays in DBB projects, other sources of RFI-related delays include iterative design issues, incomplete responses, and poor RFI management by the general contractor, among many others. FTI is a metric to prompt appropriate management action to keep projects on schedule.

DELAYS TRANSLATE TO COSTS

Time is money on a construction project, which means that project delays caused by incomplete information almost always result in direct and indirect costs, including:

- Added general conditions due to the time extensions.
- Scope creep caused by design changes, which typically lead to costs developed at higher change order pricing versus lower original bid rate.
- Out-of-sequence costs that will likely be passed on to the owners or general contractor.
- Premium-time cost due to overtime required to maintain the project schedule.
- Subcontractors or vendors that follow the delayed activity will often have manpower, materials, and equipment standing by to complete work that comes after the RFI that caused the delay, which creates waste.

AWARENESS AND BUY IN

A case study project was used to demonstrate the capabilities of FTI. However, before it was used on a real project, it was demonstrated to the case study project team using theoretical projects. As the case study project team assembled for the test project, the concept of FTI was presented to all team members: the Owner, designers, and subcontractor community. They were made aware of the purpose of the FTI tool and its intent to reduce waste. This was important in terms of creating awareness of the problems associated with the late submission of RFIs and to get team buy in for the use of FTI to measure the effective management of RFIs and to increase work flow while mitigating potential delays. The focus was on the field team, those working directly on the project who are, in essence, the last planners.

Key discussion points included:

- Delays due to poor planning (lack of forward thinking) have significant impact to the project.

- Owners are frustrated by the volume of design changes that can be generated by RFI's and the cost of those changes due to late RFIs.
- FTI objectively evaluates the ability of all team members to look ahead.
- FTI is a tool that will create efficiency and encourage forward thinking that will benefit all parties.

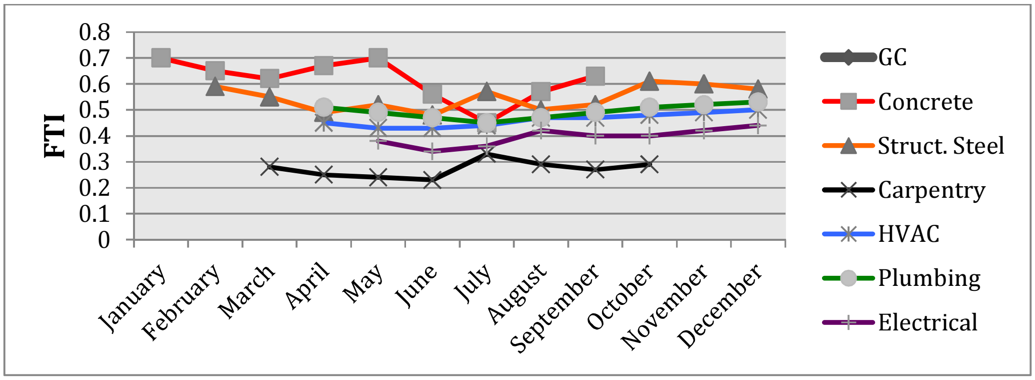
For training purposes, data sets and trend charts of subcontractors were assembled without names to ensure neutrality for all of the construction team members, as seen below in Figures 1 and 2.

An important part of the data set is the visualization—trend lines and the benefits the data set provides to the project. The data represent a cross section of subcontractors, project engineers, or trades (concrete, electrical, HVAC, etc.).

Fundamentally there will be a tri-modal distribution. The majority of the subjects will be average. A few subjects will have much better FTI scores, such as Concrete and Structural Steel in this example. And a few will be much worse, as illustrated by Carpentry and Electrical.

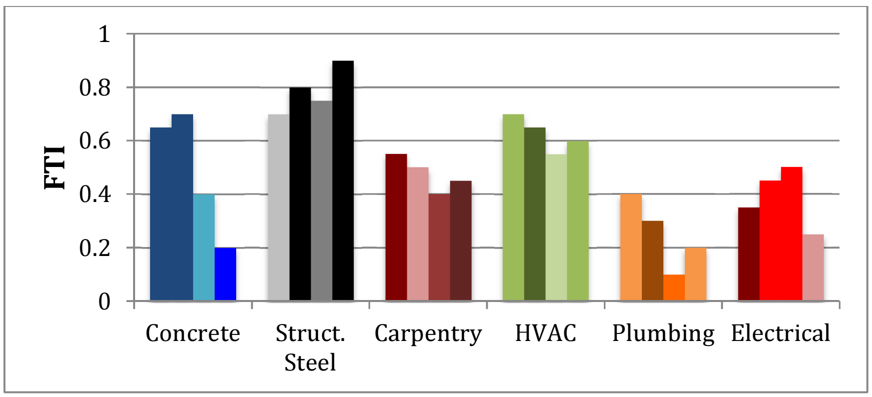
- If this data set represented the RFI data collected by a project's project engineers, the general contractor would have an opportunity to use Concrete and Structural Steel as mentors to help Carpentry and Electrical improve their forward thinking.
- If the data set represents dissimilar trades (e.g. site work, electrical, HVAC), the general contractor might choose to balance its own resources, (balloon squeeze) based purely on the needs of the schedule.
- If the data set represents similar trades, for example competitive carpentry firms, a general contractor would gain powerful data for developing a list of preferred subcontractors for design-build or IPD projects. For hard bid work, the general contractor would know before the project started which players might cause schedule delays, enabling it to balance its resources in advance. As such, FTI could be used as an alternative means for prequalifying and selecting the most appropriate subcontractors for a project in a similar manner as using qualitative methods (Hatush and Skitmore 1997; Moore 1985), financial data (Severson et al 1993), or safety metrics such as the Experience Modification Ratio (Samelson and Levitt 1982).

Figure 1: FTI– Trend Lines for One Calendar Year



In Figure 1 above, general contractor and subcontractor FTI figures are compared against each other for a single project. Best practices regarding the creation, delivery, and processing of RFIs can be gleaned from subcontractors such as Concrete and Structural Steel (and the general contractor's project engineers that work with them to process RFIs). Those best practices that lead to higher FTI values, and corresponding fewer project delays, can be shared with other subcontractors on the same project. Subcontractors with low FTIs, such as Carpentry and Electrical, stand to learn the most from other subcontractors, assuming their processes for submitting RFIs is deficient. It should be noted that low FTI values are not solely an indicator or poor subcontractor performance. Low FTI value may also be due to issues with unforeseen site conditions, excessive owner-requested changes, or issues being created by other subcontractors, among other issues. It is important for the general contractor to work with each subcontractor to figure out what is at the root cause of poor FTI percentages and to remedy them in order to facilitate better work flow and mitigate potential delays. Most importantly, the general contractor's superintendent can look at a graph like Figure 1 and quickly determine in which trades issues are likely to originate and course correct before the potential issues materialize, allowing for forward thinking project management.

Figure 2: FTI – Comparing Teams Across Similar Projects (Hospitals)



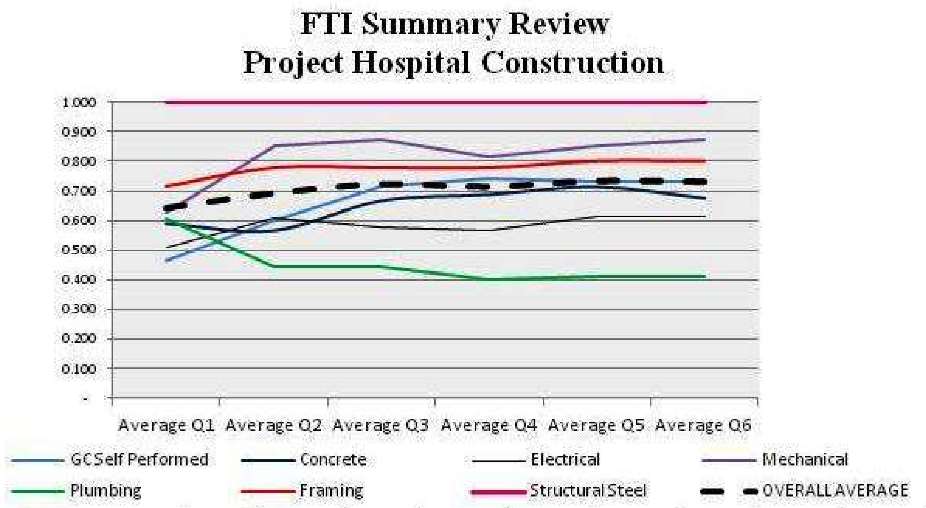
In Figure 2 above, subcontractor FTI performance over multiple similar projects, such as commercial office buildings, can be assessed. In this example, Figure 2 shows FTI values for differing subcontractors on four different projects (each project represented by one of the bars for each trade). The data provides two key pieces of information. First, it shows that trades like Structural Steel and Heating, Ventilation and Air Conditioning (HVAC) consistently score higher in terms of FTI, meaning that they consistently submit RFIs early so that wasteful delays can be mitigated. Conversely, trades such as Plumbing and Electrical tend to score low. Secondly, the figure shows which subcontractors score the highest FTI. If the general contractor is assembling a team for a DB or IPD project and wants to select the subcontractors that are the most responsive with respect to RFIs, and hence proactive in terms of avoiding delays and cost overruns, then it could select the subcontractors from each trade that have the highest FTIs, for example the Structural Steel subcontractor represented by black bars.

FTI ACTUAL PROJECT TRENDS

Once the project team understood the goals of measuring FTI, the proper buy-in was gained from all project participants and it was decided to collect FTI data for a real commercial building project. The data in Table 1 below is actual project data and illustrates FTI trends over the duration of the project and shows marked improvement for the majority of the subcontractors.

Ideally, by submitting RFIs early enough so that they can be processed in a timely manner, the general contractor and subcontractors should be able to mitigate schedule delays and cost overruns. By measuring look-ahead performance and openly communicating the FTI's existence and meaning, all project participants should experience greater work flow through each project phase and decreased uncertainty. In essence, projects should contain fewer surprises.

Table 1: FTI Summary – Case Study Project



Author Company	Potential Delay	Unfore-seen Condtion	Timely RFI	Average Q1	Average Q2	Average Q3	Average Q4	Average Q5	Average Q6
GC Self Performed	6	5	30	0.467	0.600	0.714	0.744	0.732	0.732
Concrete	12		25	0.588	0.565	0.667	0.688	0.714	0.676
Electrical	17	19	57	0.510	0.610	0.580	0.566	0.613	0.613
Mechanical	3	3	42	0.626	0.852	0.871	0.818	0.854	0.875
Plumbing	17	13	21	0.606	0.444	0.444	0.400	0.412	0.412
Framing		2	8	0.714	0.778	0.778	0.778	0.800	0.800
Structural Steel			15	1.000	1.000	1.000	1.000	1.000	1.000
OVERALL AVERAGE	**55**	**42**	**198**	**0.644**	**0.693**	**0.722**	**0.713**	**0.732**	**0.730**

Table 1 shows how the calculated FTI for each trade for each yearly quarter for the project duration, as well as how the FTI trended over the course of the project. The most recent FTI, which was the FTI reported in the column labeled Average Q6, is calculated by dividing the number of Timely RFIs by the total number of RFIs (the sum of RFIs that could lead to potential delays, RFIs regarding Unforeseen Conditions, and Timely RFIs). For example, the general contractor's FTI for self-performed work (the top row in the table) was calculated as $30 \div (6 + 5 + 30) = 0.732$.

As can be seen from the above data, it was revealed that the Structural Steel subcontractor submitted all RFIs in a timely manner, resulting in a FTI of 1.000. It was discovered during the project that because structural steel is a long-lead item, the subcontractor on this particular project understood that it must submit RFIs in a timely manner in order to not delay the project. Knowing that, should FTI values for structural steel on this project or subsequent projects become low, the general contractor would know that the risk for delays could be increasing.

Compared to Structural Steel, the Plumbing subcontractor's FTI started low and declined over time. Seeing this trend, the superintendent for the General Contractor scheduled a meeting with the Plumbing subcontractor to discuss work flow. It was determined that plumbing subcontractor productivity tends to decline as they are required to coordinate operations in walls. The Plumbing subcontractor planned to add resources to prevent any potential delays in the project.

Perhaps most importantly, the adoption of FTI for the case study project created heightened awareness among subcontractors regarding of the importance of timely submittal submission and created accountability for subcontractors. In fact, competition arose between subcontractors to improve FTI values, and since FTI cannot be artificially increased by prematurely submitting RFIs, this competition was healthy and worked to improve the overall work flow for the entire project. Weekly review meetings of current FTI results conducted with subcontractors allowed the team to identify recurring issues with late RFIs and address behavioral problems before they cause project delays. As an added bonus, improvements to the overall timeliness of identifying issues allowed the design team to balance its work load by reducing the number of urgent RFIs.

All told, the introduction of FTI to the project created awareness of the timely submission of RFIs with respect to avoiding delays, reduced the late submission of critical RFIs, and provided a metric that the general contractor's superintendent could use to quickly mitigate potential delays in the project.

RESULTS

FTI is a new tool and is being implemented in additional projects. However, the data from the test project reveals the following benefits regarding the use of FTI:

- FTI quickly and objectively identified areas where advanced planning was appropriate and where additional collaboration was required.
- FTI increased each team member's accountability.
- FTI reduced the amount of late or urgent RFIs, enabling a balanced work load for the designer.
- FTI proved that data can be used to balance resources throughout the various phases of the project.
- Continued and consistent use of the FTI created a culture shift that encouraged effective communication, timely execution, and proactive planning.

There are some limitations associated with the use of FTI. First, more data needs to be collected in order to understand what values of FTI are normal for certain trades. Currently, the FTI of 0.412 for the Plumbing subcontractor seems low when compared to an FTI of 1.000 for the Structural Steel subcontractor. However, more data is needed to confirm if a value of 0.412 is normal for plumbing trades and if 1.000 is normal for structural steel. However, with more data, FTI will become more valuable for subcontractors, both in terms of assessing project performance and screening and selecting subcontractors for subsequent projects. Also, with more data, FTI data can be used to confirm or deny the validity of late claims. This cannot be demonstrated with the case study presented in this paper, but will likely be a benefit of FTI as more data is collected. FTI data will continue to be collected and subsequent research will be performed to expand the use of FTI in an effort to promote forward thinking and lean construction in DBB environments.

CONCLUSION

The Forward Thinking Index™ is a simple formula that delivers a powerful metric. FTI has minimal cost or impacts to resources. FTI is an early warning system, an accountability tool and a planning tool that promotes forward thinking. FTI can facilitate the creation of a cultural shift that facilitates lean construction tools and techniques. FTI has been successfully implemented on a test project and can be used across the construction industry to improve work flow and mitigate wasteful delays.

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