Orchestrating Success: Connecting Work, Effort & Time

By Dr. Heather Moore & Phil Nimmo

Much like the conductor who must understand the music, guide each musician's contribution, and deliver a performance that resonates with the audience — all without playing a single note — the GC's project manager (PM) orchestrates the timely and budgeted delivery of a building. They must harmonize the sometimes conflicting objectives of various trade contractors where any missteps with work, effort, and time can lead to diminishing results and profits, falling short of a perfect performance.

This article delves into the interplay of a project's critical elements — work, effort, and time — and how their interdependence can make or break a project. By employing traditional time-based scheduling as well as Work Environment Management (WEM®), this article also includes a real-world case study that presents the power of project management, ensuring each component plays in concert with the others.

UNDERSTANDING THE VARIABLES: WORK, EFFORT & TIME

These three variables dictate the successful completion of a project, yet their interconnectedness is often misunderstood. When a deadline looms and the schedule falls behind, the instinctive response may be to increase labor to get it done. Trade contractors often balk at the suggestion of bringing on more people when they are already losing productivity with people, materials, and tools stacked on top of each other in areas where damages to finishes will lead to back charges.

On the other hand, when a trade contractor is delayed due to late materials, time constraints are frequently overlooked under the old adage of "it takes what it takes [to do the work]." This can lead to escalating tensions, disputes in coordination meetings, contentious emails, change orders for the cost and time impacts, liquidated damage payments, and, worst of all, claims and legal fees.

Construction industry professionals should understand the need to manage work, effort, and time as well as the need to balance these with appropriate finesse and coordination.

PLANNING & TRACKING FOR A SMOOTH PROJECT

On the jobsite, everyone has work to do, a schedule to keep, and is facing similar resource constraints and labor availability challenges.

Proper project planning and tracking allows your team to proactively see the project's flow — not just after the work is done, the deadlines are missed, or the conflicts and stacking begin.

By recognizing the ebbs and flows of each variable early on, the necessary labor and skills can be aligned to maintain the schedule, helping to ensure the project's completion is both timely and within budget.

Beyond having the labor with the correct skills to perform the tasks required, it is necessary to plan and organize the work into a logical and effective flow. There are tools that can help with organizing the work, but experts are necessary to properly create and implement a useful project model.

BREAKING DOWN THE WORK

Developing a useful project model and plan begins with breaking down the work. Using a Work Breakdown Structure (WBS) [1] to facilitate the process ensures that your breakdown is complete and without gaps from either unplanned work or work that isn't broken down enough to be useful.

A WBS focuses only on the work that is to be done, without regard to how much effort is required or how much time it will take. The effort should be a function of the work; but, unlike typical unit-based estimating practices, the planned effort is applied with consideration given to the specific job conditions, the means and methods to be used, and the tools available. In most cases, the effort may vary by the experience and skill set of the available labor. All of these factors must be reasonably known for the effort to be estimated in the project model.

Once the work is identified and the effort to complete the work is established, then the timing and sequencing can begin.

Timing & Sequencing

Timing and sequencing are two independent activities that must be managed separately. The scope of work remains constant and only changes if the contract changes. Similarly, the effort also stays the same and will only change if there are substantial changes to the conditions, means, methods, tools, or labor involved in performing the work.

The GC controls the timeline since its primary responsibility and profit relate to finishing on time and within budget. The GC also gives a sequence of time for when certain activities need to happen, as a "backward pass." A trade contractor's WBS is built based on the sequence of work, and therefore is a "forward pass" of the work that will happen onsite from their perspective as an expert in a skilled trade. This forward-looking plan informs the project's overall cadence and resource allocation from the vantage point of those executing the work, according to Dr. Perry Daneshgari.

Synchronizing the Orchestra

The orchestration of a successful project happens through *connecting the work* (made visible and planned through a WBS) to the time (made visible and planned through a project schedule). Both elements must be appropriately considered to produce a useful schedule to communicate conflicts between the field crews and GC. Neglecting one can lead to assumptions and a flawed project model that does not generate profit for all parties, as well as a potentially late and expensive project for the end customer.

For tasks that are effort-driven (i.e., the work is fixed and an increase in labor produces a proportional reduction in the time required to complete the task), only the duration (time) or personnel (headcount) can be determined, but not both.

On jobsites where the owner and GC provide milestone dates and coordinated time frames for each trade contractor to complete their work, the maximum duration is set. With a fixed duration, labor is then calculated for each task. Laying these variables out on a timeline then allows the headcount for overlapping tasks to be summed to produce a labor loading curve. This labor loading curve should be compared to the actual available resources from the trades.

For example, an eight-hour task can either take one day or four days depending on the number of available resources. By identifying the available units (labor available for the work) and the duration (how long the task takes), work can be determined.

By modeling this scheduled plan, the trade contractor can prepare for the resources accordingly, such as requesting to do work out of sequence, externalizing more work (e.g., prefabrication or vendor managed inventory) to be done in parallel, or finding more labor resources (if necessary).

There are no shortcuts — what may seem obvious or trivial is often neither. Because of interactions between tasks and other events, both before and after, the model must be interconnected and cannot be expressed as just a line on a paper.

The symphony of work, effort, and time is a dynamic process and requires a dynamic model to remain accurate.

Exhibit 1: Lighting Schedule

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Task Name	Work	Duration	Start	Finish	Resource Names
500 – Upper concourse	2,264h	179d	Thu 4/13/17	Tue 12/19/17	
OH – Conduit	320h	40d	Tue 7/25/17	Mon 9/18/17	
In-Wall Rough IN	336h	62d	Thu 6/15/17	Fri 9/8/17	
Lighting	**240h**	**89d**	**Wed 8/2/17**	**Mon 12/4/17**	
Manufacturer Lead Time	0h	40d	Tue 9/26/17	Mon 11/20/17	
Vendor Lead Time	40h	5d	Tue 11/21/17	Mon 11/27/17	Vendor
Lay-in Install	40h	5d	Tue 11/28/17	Mon 12/4/17	Foreperson
Manufacturer Lead Time	0h	40d	Fri 9/1/17	Thu 10/26/17	
Vendor Lead Time	40h	5d	Fri 10/27/17	Thu 11/2/17	Vendor
Exposed Install	40h	5d	Fri 11/3/17	Thu 11/9/17	Foreperson
Manufacturer Lead Time	0h	40d	Wed 8/2/17	Tue 9/26/17	
Vendor Lead Time	40h	5d	Wed 9/27/17	Tue 10/3/17	Vendor
Hard Lid Install	40h	5d	Wed 10/4/17	Tue 10/10/17	Foreperson

Failure to develop a fully integrated model means that this entire planning process must be repeated weekly or even daily.

Most often, what changes throughout the life of the project isn't the work (other than a few well-defined and negotiated change orders) or the effort required to complete the contracted work. Instead, the dates are what frequently change because of interference from other trades, material delays, design changes, and other factors that impact when the work can be done in a specific area.

To compensate for this, the work needs to be resequenced constantly while still maintaining all of the constraints. This most often happens with verbal direction from the overall project superintendent, discussions in weekly coordination

meetings, or through various lean construction programs, which only pay attention to time without consideration of each trade's WBS.

The project model representing the work, effort, and time in sequence is much more complex than these methods. The project model must be built to perform these tasks in a matter of hours for the trade contractor to meet the typical response and notification deadlines of their contracts. The response must be supported by updated labor loading and shifting to accomplish the established milestones given the new constraints and task sequencing.

MANAGING RESOURCES: MONEY, LABOR & MATERIALS

The project model contains the labor resources needed to provide the effort necessary for the work. However, both money and material are required to complete the project, and, therefore, can create schedule constraints.

Money is managed in real time to ensure a healthy and predictable cash flow throughout the life of the project. Material is often outside of the control of the trade contractor and must be identified as a constraint in the project model. Material delays can happen for administrative reasons such as delayed submission or approval of submittals, failure to make a timely release of the purchase orders, or impacted production scheduling.

Logistics delays and errors can also result in schedule impacts that will affect the sequencing of work and the productivity of the installation team. Quite simply, any lack of needed money, labor, or material will impact the productivity, timing, and profitability of a project.

With that in mind, labor loading helps to predict material needs. Long lead items are associated with production and logistics schedules and are often carefully watched.

Exhibit 1 illustrates a lighting schedule with fixture delivery as a predecessor to the assembly and installation of the fixtures. Exhibit 2 shows that the delay in receipt of complete and correct fixtures has interrupted the installation tasks. Exhibit 3 shows the impact on installation productivity resulting from slower than planned progress, replanning of the work, and returning to complete the installation at a later time.

Exhibit 2: Short Interval Scheduling (SIS®) Capture of Fixture/Material Issues

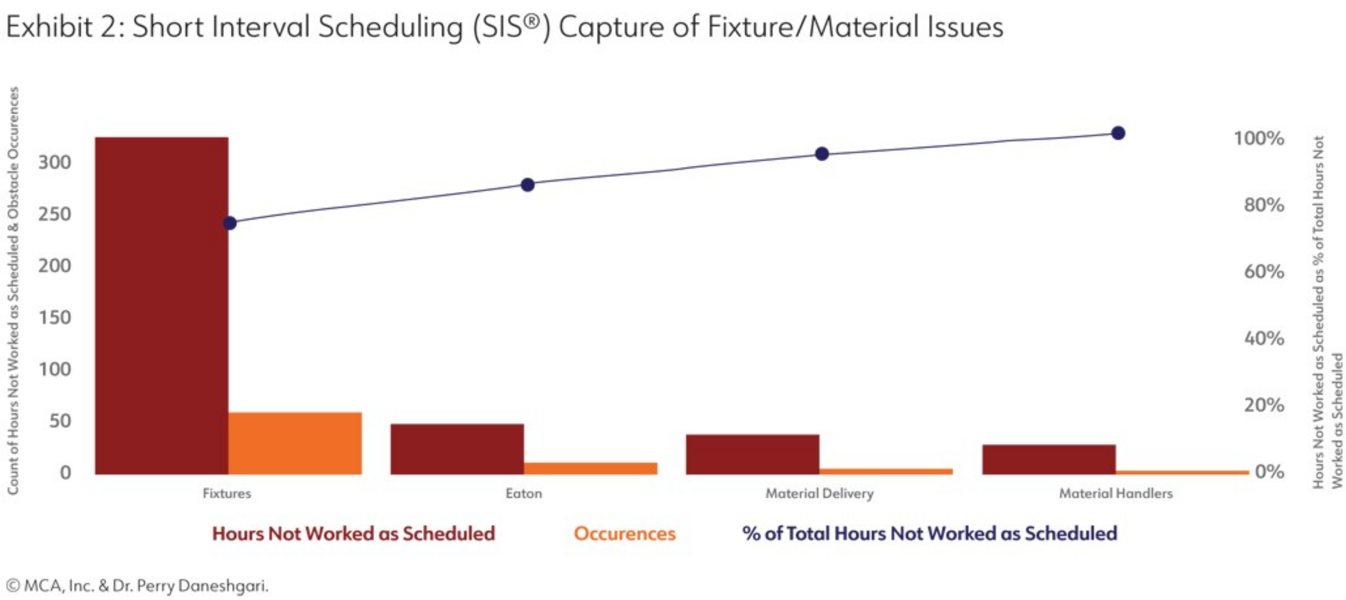
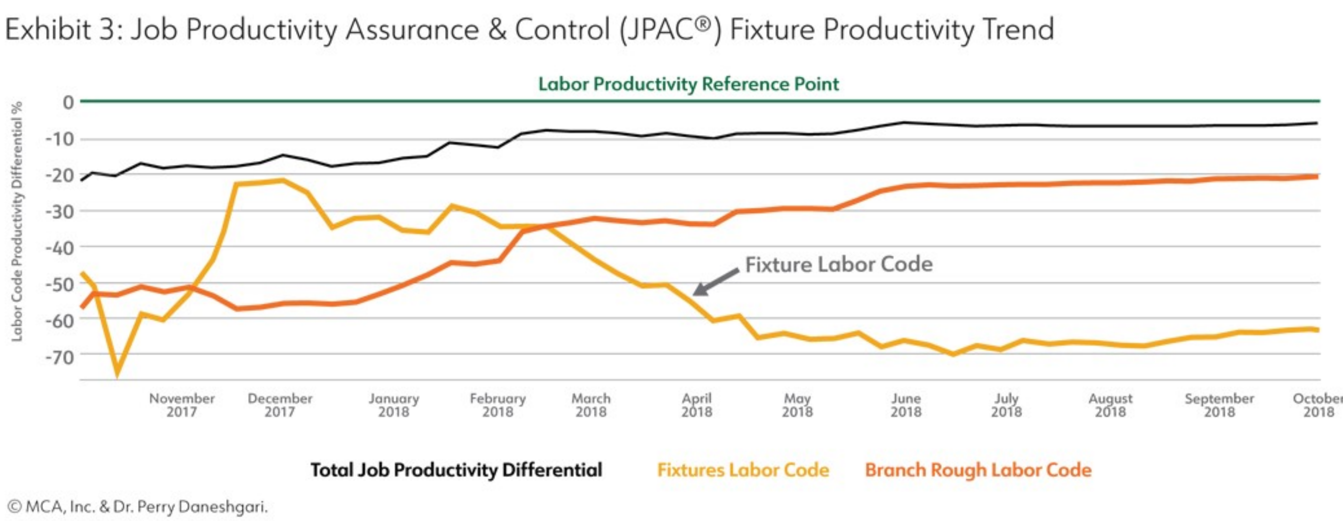


Exhibit 3: Job Productivity Assurance & Control (JPAC®) Fixture Productivity Trend



This productivity reduction translates directly into eroded profitability. Smaller, more commodity-type devices and equipment can be just as disruptive and are often overlooked. By tying the material procurement tasks into the schedule and project model, these become a part of the same program that produces the labor graphs and projections.

Essentially, work that is tied to material in the schedule can't happen until the material is available, so movement in material dates will create an immediate and visible shift in the labor loading. This is an otherwise invisible impact that must be detected and recognized to mitigate the risk and damage.

COORDINATION AMONG TRADES & MANAGEMENT OF WORKFLOW

Historically, the GC always maintained an authoritative and commanding role in determining anything to do with the duration and sequencing of trade contractor work. In fact, the historical model allowed most trade contractors to perform their work when and where they were directed. This model frequently resulted in increased costs for stakeholders.

In most projects under construction today, trade contractors now selfmanage coordination among the various trades, which is only successful when the GC maintains an active and engaged role in the coordination.

Despite sincere coordination, effort, and intention, time continues and deadlines loom. The damages are only distributed among those that do not complete their work on schedule. Even jobs with effective design coordination are still susceptible to poor installation coordination.

When the GC's stance shifts to a supervisory role overseeing workforce coordination of all trades in the constrained areas of the jobsite, operations progress faster and more seamlessly. The objective basis of the supervisor function is the labor projections from all trades overlayed on a single timeline, making trade stacking visible.

In almost all projects, there are gaps in the labor — periods of time where busy work is identified to maintain the specific individuals on the job — but the work areas and the work itself isn't yet available for the most productive flow. In these cases, the GC may need to accelerate other trades in areas where the gaps can be filled. The GC can ensure that expediting and delaying specific work in particular areas is done to achieve a globally optimized solution.

CONCLUSION

Great symphonies — like great, successful projects — are independent of space and time, based on how they are orchestrated and run. With symphonies, timelessness is achieved through harmony; the music can be played to the enjoyment of an audience anytime, anywhere.

With a coordinated effort to manage work, effort, and time among the owner's requirements, the GC responsible for delivering the overall project, and the trades responsible for delivering their pieces, the same can happen in construction to create a well-rehearsed performance that leaves a lasting impression on the landscape and community.

Endnote

1. Daneshgari, Dr. Perry & Moore, Dr. Heather. "Jobsite to Garage: Changing the Mindset of Prefab & Modular Construction." CFMA Building Profits. March/April 2020. ***www.cfmabponline.net/cfmabp/20200304/MobilePagedArticle.action?articleId=1656724****.*

Case Study: The Symphony at the Convention Center

The Wisconsin Center project in Milwaukee, WI had an electrical (Divisions 26 and 27) scope of about $50 million and was expected to take two years to complete.

WEM, LLC provided scheduling support to Staff Electric and its joint venture partner on both the electrical and low voltage/ technological scope of work, totaling approximately 173,000 labor hours.

Creating the Project Model

Trade WBS

Exhibit 1 shows one section of the electrical work breakdown structure (WBS), which is color-coded to represent the scopes of work for two different electrical contractors. The top level of the structure contained areas that connected directly to the GC's schedule structure, allowing the detailed work breakdown (sequence of work) to be planned within and planned for connections to the overall project sequence of time.

Connecting Work, Effort & Time

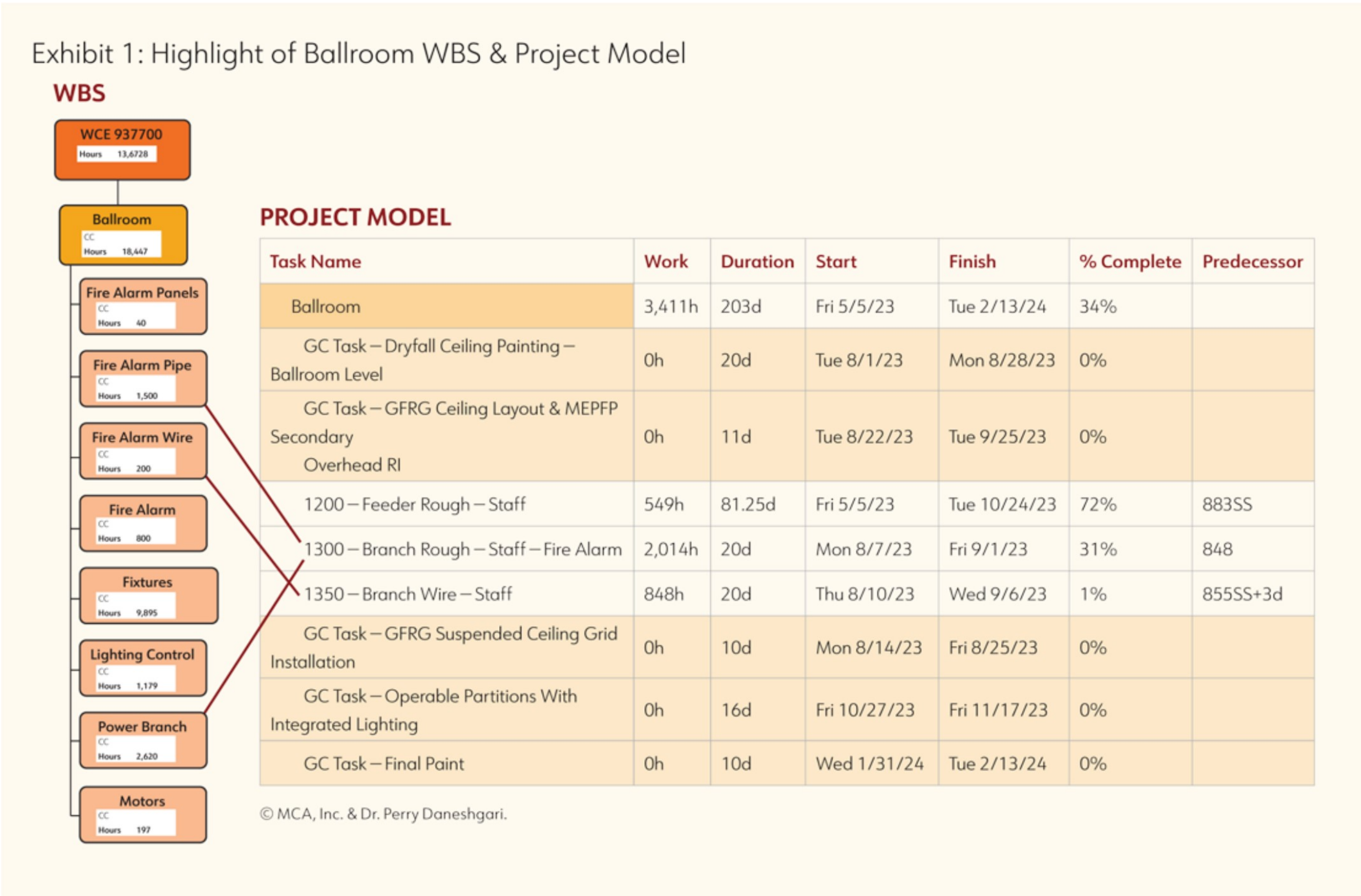
Exhibit 1 also shows one section of the schedule where the two electrical contractors tasks are broken down to match their WBS yet are interconnected to the overall flow. This is what builds the project model and interconnects work, effort, and time. If a task slips, starts late, or finishes early, then the interconnection of related work allowed the impacts to be visible immediately.

Using a Three-Week Lookahead for Planning Work & Effort

A three-week lookahead of planned work can help two electrical contractors plan their work in individual areas on a weekly basis. It's important to note that sometimes this planned work could be scheduled and other times not.

For example, if an area showed branch rough planned to be completed in week two but the electrical contractors knew that wasn't feasible due to waiting on some wall framing to be completed, such reasons were displayed in a schedule impacts capture.

Exhibit 1: Highlight of Ballroom WBS & Project Model



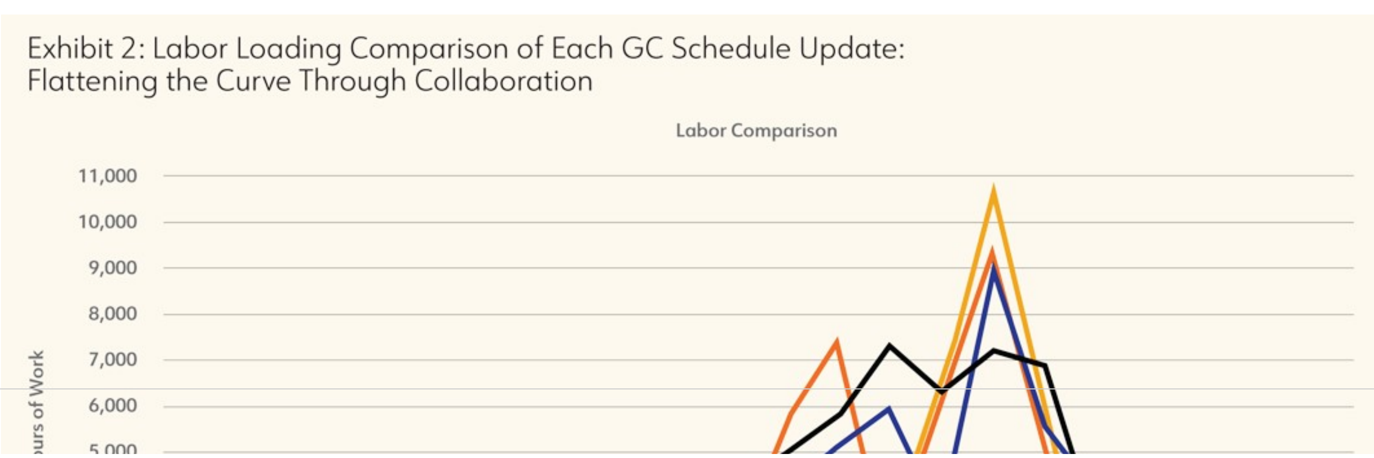
Task Name	Work	Duration	Start	Finish	% Complete	Predecessor
Ballroom	3,411h	203d	Fri 5/5/23	Tue 2/13/24	34%	
GC Task – Dryfall Ceiling Painting – Ballroom Level	0h	20d	Tue 8/1/23	Mon 8/28/23	0%	
GC Task – GFRG Ceiling Layout & MEPFP Secondary Overhead RI	0h	11d	Tue 8/22/23	Tue 9/25/23	0%	
1200 – Feeder Rough – Staff	549h	81.25d	Fri 5/5/23	Tue 10/24/23	72%	883SS
1300 – Branch Rough – Staff – Fire Alarm	2,014h	20d	Mon 8/7/23	Fri 9/1/23	31%	848
1350 – Branch Wire – Staff	848h	20d	Thu 8/10/23	Wed 9/6/23	1%	855SS+3d
GC Task – GFRG Suspended Ceiling Grid Installation	0h	10d	Mon 8/14/23	Fri 8/25/23	0%	
GC Task – Operable Partitions With Integrated Lighting	0h	16d	Fri 10/27/23	Fri 11/17/23	0%	
GC Task – Final Paint	0h	10d	Wed 1/31/24	Tue 2/13/24	0%	

Proactive Modeling of Work, Effort & Time

Flattening the Workforce Curve

Having more workforce onsite than available or needed can be a productivity drain for the trade contractors due to trade stacking, compression, and overtime and can lead to risks such as exposure to safety hazards. By modeling the workforce loading based on the work, effort, and time interconnections, the electrical contractors could evaluate their required workforce and identify that a peak of 8,000-11,000 hours in October would not be ideal or potentially infeasible.

Exhibit 2: Labor Loading Comparison of Each GC Schedule Update: Flattening the Curve Through Collaboration



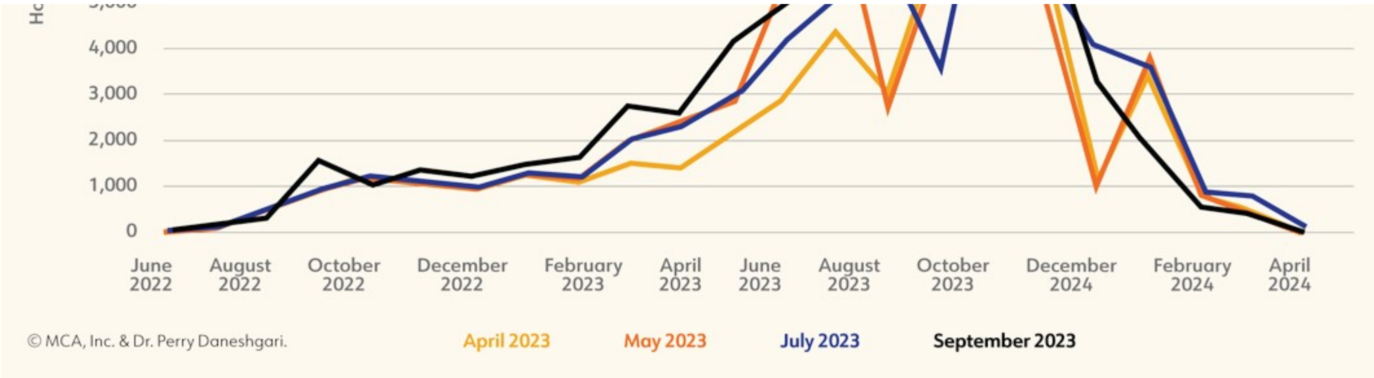
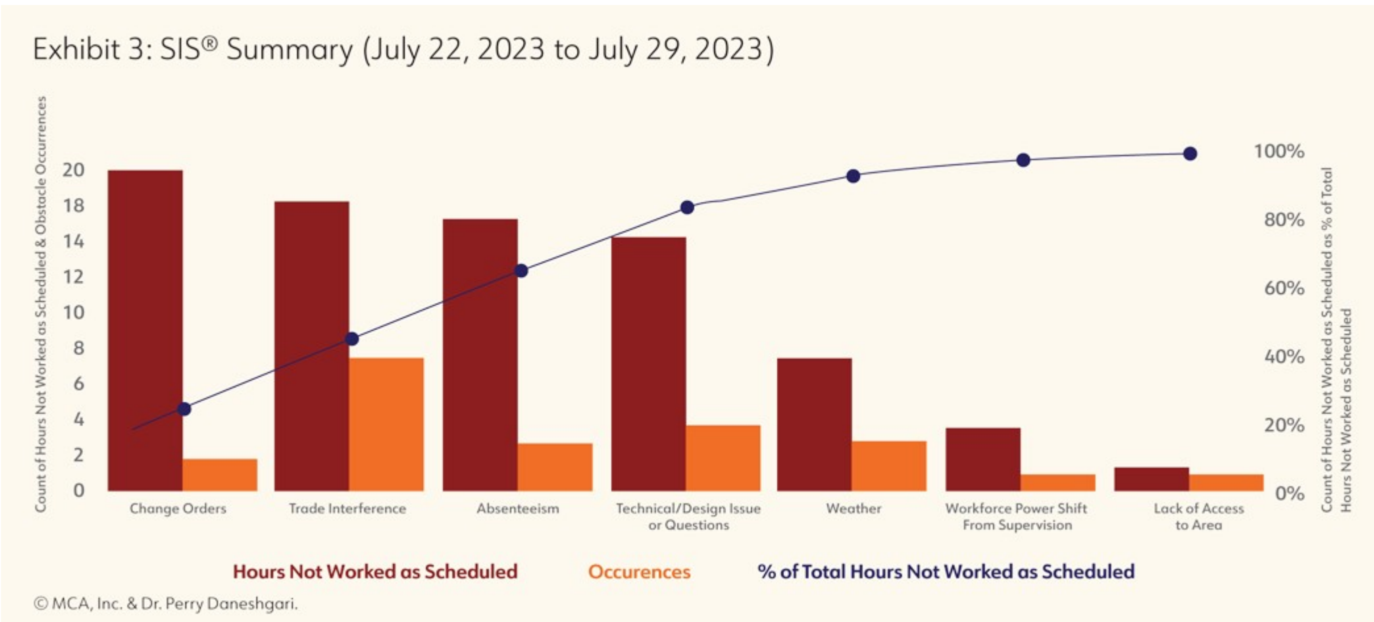


Exhibit 3: SIS® Summary (July 22, 2023 to July 29, 2023)



In a review between the electrical contractor and the GC, gaps of opportunity were identified by WEM, LLC as areas where the electrical contractor's resources could be available early (either onsite or through prefabrication) to pull ahead a sequence of work decoupled from the sequence of time. Exhibit 2 shows the results in the project model, flattening peak workforce to 7,000 hours.

Reduce Risk in the Home Stretch

By managing the work, effort, and time proactively, the contractors could model what needed to be done by when to open a very large and high-profile convention center on time, not to mention protect precious building finishes and assure all systems could be commissioned completely and timely.

Data-Based Feedback From Trade Contractors

Tracking Schedule Impacts

The electrical contractor collected data on obstacles to daily scheduled work, monitoring obstacles to work due to schedule-related time impacts.

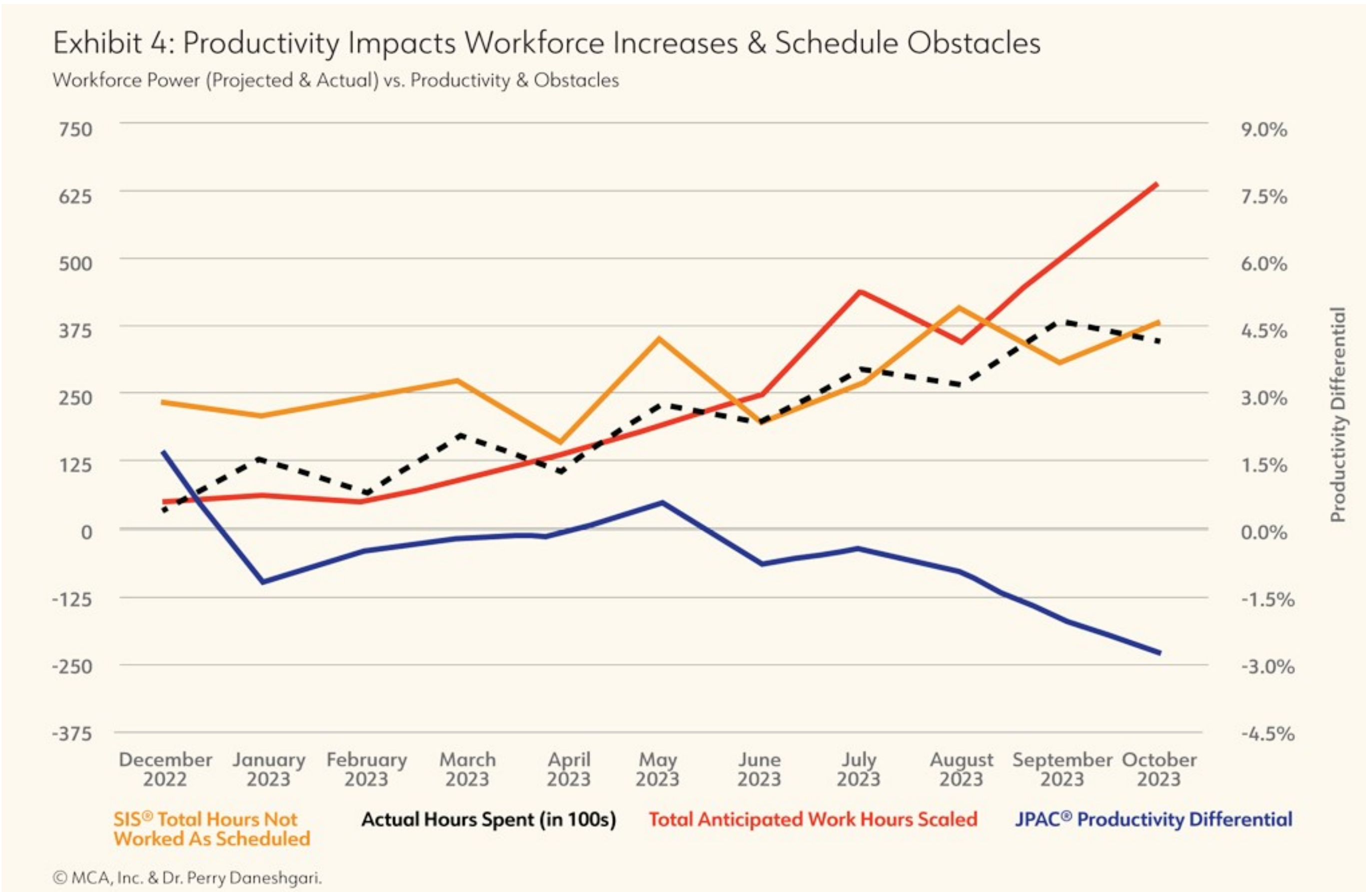
Exhibit 3 shows a Pareto chart of obstacles in a week's time frame, when the workforce was starting to ramp up onsite and other trades were using traditional approaches to just get the work done without adhering to the sequence of time and work being coordinated between the electrical contractor and GC.

Measuring Productivity

To monitor and confirm that the schedule model maintained stable productivity, the electrical contractor measured the productivity differential. Despite some ups and downs, the electrical contractor project team maintained productivity within ±5% of their expectation, which is unheard of on a job this size.

The overlay of workforce loading, productivity, and schedule impacts (see Exhibit 4) clearly shows that workforce increases lead to more obstacles and reductions in productivity. This data-driven project management proves that the harmony of work, effort, and time needs to be managed and monitored.

Exhibit 4: Productivity Impacts Workforce Increases & Schedule Obstacles



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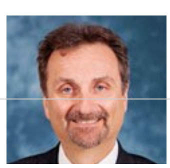

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