MARK III CONSTRUCTION

TOPIC

STANDARDIZE DESIGN MANUFACTURE:

CHANGING HEALTHCARE PROJECT DELIVERY THROUGH MULTIDISCIPLINARY COLLABORATION & OFF-SITE MANUFACTURING

PREPARED BY

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INTRODUCTION

Mark III Construction is transforming the way healthcare construction is approached. By working with owners to standardize common rooms, Mark III has proven that manufacturing can decrease cost and compress schedule. Mark III's vertically integrated process streamlines workflow and increases productivity by standardizing building elements and moving production off-site to a controlled manufacturing environment.

KEY FIGURES AT A GLANCE

18K

SQUARE-FOOT TWO-STORY MEDICAL OFFICE BUILDING

10%

COST SAVINGS CONTRIBUTED TO THE CUSTOMER BY MARK III

8

DAYS TO INSTALL ALL INTERIOR WALL PANELS, INCLUDING MEP'S

BACKGROUND & OVERVIEW

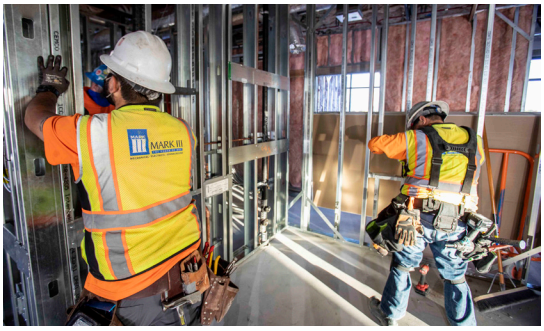
Mark III believes all owners should be able to build more with less. One approach that is not new, but is becoming increasingly popular, is modularization and componentized building. This method has been gaining the most momentum in residential, education, and hospitality markets.

These benefits can also be captured within the healthcare space, beginning with the typical exam room. Exam rooms are one of the most common and repeatable units within healthcare facilities and once these standardized templates or modules are created, they can be reused on future projects, expediting the design and on-site construction phases along with capturing future savings.

Change will not happen overnight; learning by doing, testing new ideas, and incremental progress followed by radical change is what drives progress and innovation. Over the past five years Mark III's team has been dedicated to planning, testing, and implementing manufacturing principles to deliver healthcare facilities better, faster, and cheaper. In 2017, Mark III Construction launched a series of internal research and development (R&D) projects, called Project Mountain (PM). These R&D initiatives are self-funded and built within the company's innovation incubator. The goal of each round of R&D is to find new and improved ways to deliver projects and address the current resource, time, and money pain-points that exist in the construction industry.

In partnership with a forward-thinking major Northern California healthcare provider Mark III completed construction of a two-story medical office building (MOB) utilizing manufacturing, standardization, and componentized building. The goal and objectives for this project were to take findings from our Project Mountain series and implement our findings into a real-life project. From the PM2 efforts, we found that manufactured standardized kits (MSK) and wall panel delivery method added the most value so both were utilized on this project. Encompassing a spirit of innovation and continuous improvement, this case study will dive into the project findings, lessons learned, and results yielded throughout the project.

INTRODUCTION



PROBLEM STATEMENT

There are over 8,000 medical facilities across California alone and one of the most common units within those facilities is the typical exam room. Even though similar facilities have been built countless times before, healthcare owners consistently stated that project teams started at square one with each new project.

HEALTHCARE

Healthcare buildings are inherently complex and resource intensive projects to design, build and operate. Hospitals, medical office buildings, and healthcare facilities host more MEP systems per square foot than any other building type. The opportunity lies in the repeatable nature of the aforementioned healthcare systems.

Year over year, the healthcare industry continues to grow. The market is stable and has the unique ability to withstand economic downturns. Overall, the healthcare industry makes up approximately 10% of all new non-residential and non-infrastructure construction spending year over year (United States Census Bureau Construction Spending).

PROJECT OVERVIEW

"Modular projects likely to deliver the greatest cost savings are those that have the highest proportion of labor-intensive activities and the greatest level of repeatability."

MCKINSEY MODULAR CONSTRUCTION REPORT

PROJECT SCOPE

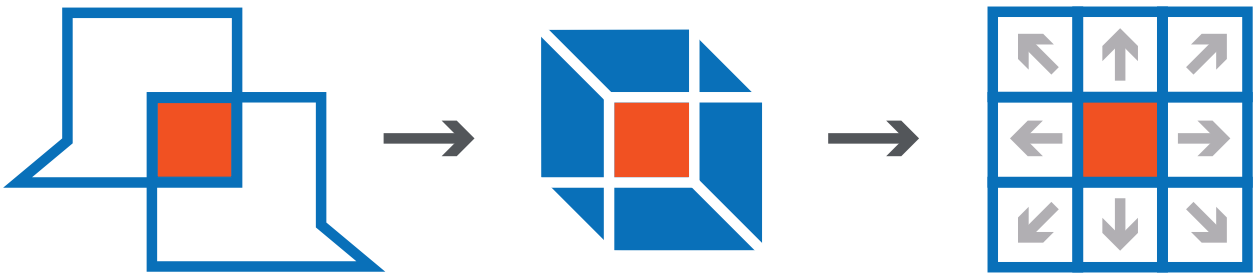
This design-build tenant improvement project is a two-story 18K square-foot medical office building for a major Northern California healthcare provider. The facility houses (25) exam rooms, (7) restrooms, (3) treatment rooms, and (13) offices. Mark III's scope included the design, procurement, manufactured elements, and final installation of the mechanical, electrical, and plumbing systems. Mark III also delivered the non-structural interior wall framing, including all backing and framed openings. Leveraging the opportunity for standardization, all MEP's and light gauge steel framing for this project were manufactured and panelized off-site before being delivered for on-site installation. The tenant improvement team worked in tandem with the core & shell building contractor to deliver this fast-tracked project in 7 months.

VIRTUAL DESIGN AND CONSTRUCTION (VDC) & MANUFACTURING

Manufactured and installed in phases, Mark III's VDC and manufacturing teams worked in tandem to design, manufacture, and panelize a total of (167) wall panels and MEP assemblies. Each panel was modeled, manufacturing documents were created, and material was procured before assembly began in Mark III's MEP manufacturing facility. Finished wall panels with integrated utilities were flat-packed in strategic order by area and shipped to the job site for installation.

EQUIPMENT

Mark III was also responsible for the full MEP scope, including HVAC wet and dry systems, electrical, and plumbing. The HVAC system included (2) roof-top AC units, (1) boiler skid, (26) VAV's, (4) mini-splits, (3) exhaust fans, and full building management system. The plumbing system included (1) 100-gallon water heater, (1) domestic water booster pump, and (79) plumbing fixtures. The electrical scope included the building lighting package, (3) sub panels, (1) high board, and (3) low boards. It also included a fully furnished lighting package upgrade with Title 24 compliant controls, (3) sub panels, (1) high board, and (3) low boards.



STANDARDIZE DESIGN MANUFACTURE

PROJECT OVERVIEW

BASELINE FOR COMPARISONS

Mark III used a recently completed medical office building (built by the same major Northern California healthcare provider) as a baseline for pricing and scheduling comparison purposes.

PROJECT GOALS

- Test delivery methods that will lead to successfully capturing 25% cost & schedule savings by 2025
- Better, Faster, Cheaper
    - Beat schedule
    - Cost savings
    - Higher quality & increased predicitibility
- Establish partnership with owner to standardize and componentize building parts and systems
- Multidisciplinary collaborative approach

TRACKED METRICS

Prior to starting the project the Mark III team established which metrics were going to be tracked during the project, both in the manufacturing facility and on-site. Collectively it was decided to track the following:

Panel Production Time

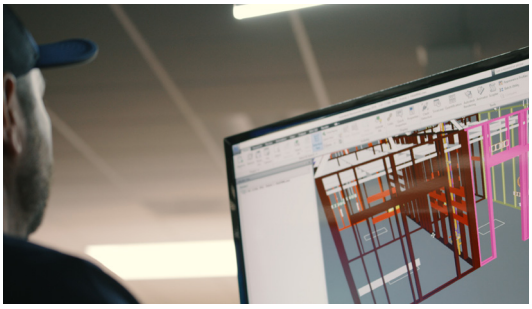
- Panel linear footage
- Panels with or without framed openings
- Plumbing assembly installation into each panel
- Electrical assembly installation into each panel
- Quantity of backing

Panel Installation Time

- Time from each panel being removed from the flat-packed pallet to when the final power actuated fastener is shot in place.

PROCESS

VIRTUAL DESIGN & CONSTRUCTION TO OFF-SITE MANUFACTURING



Throughout the design process Mark III's internal virtual design and construction (VDC) department worked closely with both the engineers, architects, and structural engineers to coordinate the flow of the project. The scope was 100% modeled, detailed, and spooled for fabrication.

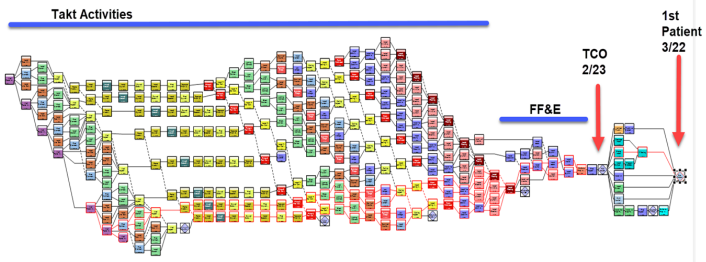
Contrary to a traditional project delivery method, Mark III's VDC team began designing and modeling components for fabrication early in the project, prior to the completion of design drawings. These documents were continuously reviewed to maximize efficiency for our MSK's and integrated wall panel approach.

All material orders were generated via a precise bill of material (BOM) from our building information modeling (BIM) model, eliminating overproduction and inventory waste.

Utilizing 3D scanning technology to identify existing building component (columns, exterior walls, and steel joist) locations the team was able to accurately coordinate all overhead MEP's within the existing structure. Additionally, utilizing our robotic total station (RTS) Mark III was able to capture real time as-built data from the field as well as layout wall panel locations, MEP hangers, and equipment. This eliminated the need to spend unnecessary hours pulling tape measures on-site and the chance for human error.

SCHEDULING & PLANNING

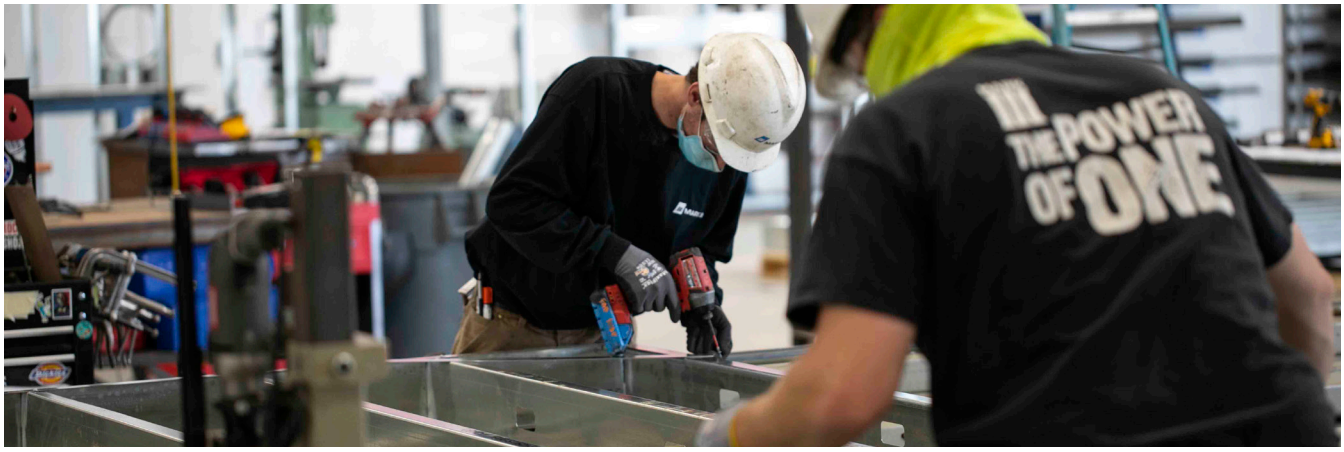
Mark III and the project team coordinated the schedule and delivery of our manufactured elements using vPlanner. The software is described as “a comprehensive solution for production planning and it supports the workflows of the Last Planner® System (LPS) and solves two key issues. First, is the alignment between near-term and long-term project plans and the second is the constant management of the near-term plans to identify and remove constraints that may impact workflow reliability. vPlanner eliminates the redundant effort required to align the work that can be done on a project with the work that should be done for each work planning cycle.” (vPlanner.com)



Mark III participated in pull planning efforts for all phases of the project - design, manufacturing, and the construction activities on-site. Additionally, the project team used Takt time planning as a scheduling tool. Takt time planning is a work structuring method that aims to achieve the lean principle of continuous flow. Successful Takt time planning on a construction site results in trades working on activities at the same rate to release work areas at standardized times.

Mark III participated in weekly Owner-Architect-Contractor (OAC) and scheduling meetings with the all project stakeholders. Each week the team was required to commit to the tasks on the weekly work plan (WWP) and report out on tasks that were completed over the course of the previous week. This produced a very collaborative culture, full transparency and buy-in by all stakeholders.

FINDINGS



OVERVIEW

“Slow down to speed up” is a common strategy to capture efficiency gains. Mark III's manufacturing team embraced this philosophy throughout production on this project.

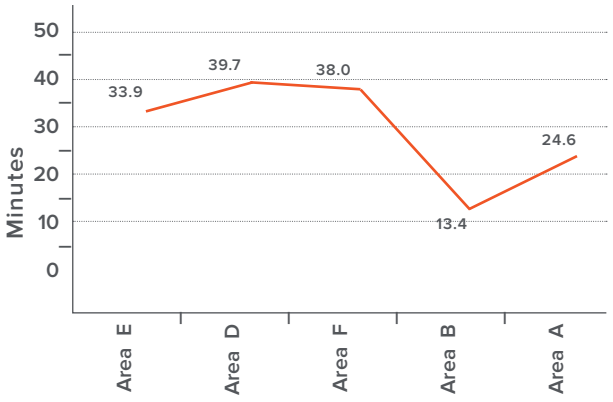
The additional factor of both the core and shell contracting team working in tandem with the tenant improvement team proved to be extremely challenging. This meant the tenant improvement team did not have access to CAD files or as-builts to reference during our virtual construction efforts. Therefore, Mark III was required to wait for elements of the core and shell to be completed before 3D scanning the space. From the 3D scan the VDC team modeled the existing conditions and moved forward with virtual efforts. These tasks took time and the initial on-site date did not adjust to accommodate these added up-front efforts. As a result, maximum efficiency was not achieved.

Manufacturing began before all material was received, checked-in, and confirmed accurate which caused wasted time and effort.

PANEL MANUFACTURING

While the overall manufacturing process was successful and the team met the on-site dates, there is additional room for improvement. One of the areas of waste in the panel manufacturing process was material procurement. To meet the scheduled on-site dates the team was required to release the material by area rather than as a building or even a whole floor. Each release consisted of a precise quantity take-off from the Revit model, studs and track were received, cut to length, and bundled by wall. Due to the modeling delay, bill of materials went out late and the project team was forced to expedite delivery of materials and begin our manufacturing efforts before all materials were 100% received. Ultimately this caused unnecessary disorder and waste to the production process for the first few areas. The team was able to recover slightly for the final two areas and production levels increased.

PANEL MANUFACTURING TIME



*No plumbing assemblies were included in Area C. For this reason it has been omitted from the table.
**Incomplete electrical data was collected for Area C. For this reason it has been omitted from the table.

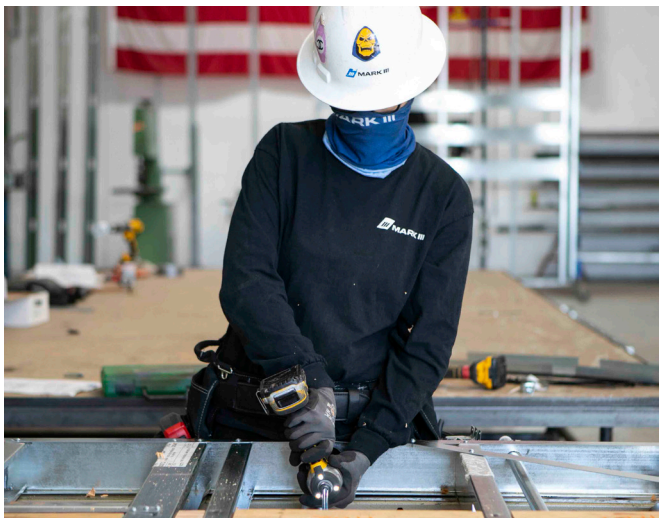
FINDINGS

Standardization and repetition are common themes in across lessons learned from the project. During this project, the team focused on standardizing panels for rooms. The standard panel length for the project was 8', but with some panel lengths ranging from 1' to 13'. For future products, Mark III is looking to make the range of panel size and the average panel size shorter. The team believe this will increase the quantity of standardized panels, increase manufacturing efficiency, and make shipping and handling easier.

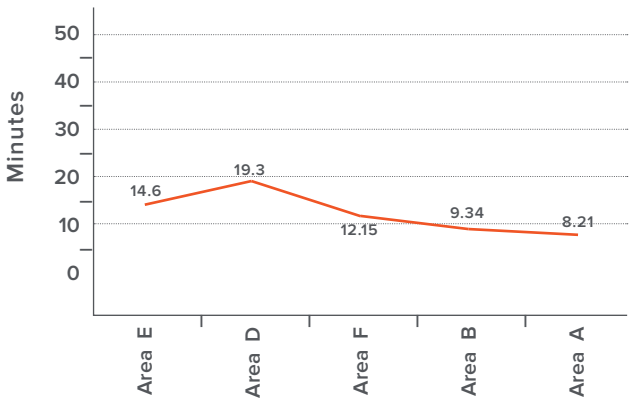
PLUMBING & ELECTRICAL IN-WALL MANUFACTURING

The plumbing and electrical in-wall assemblies were manufactured in their designated areas of Mark III's manufacturing facility. These assemblies were then transported across the facility to the wall panel assembly zone. Because some plumbing assemblies spanned multiple stud bays of a panel, several assemblies required rework when they were ready to be installed within the wall panels. The team was anticipating an increase in efficiency from area to area, but this proved to be insurmountable due to plumbing rework.

Contrary to plumbing, the electrical installation efficiency did improve as anticipated. The manufacturing team began with an average of 14.6 minutes per panel for the first area and finished at 8.21 minutes per panel for the final area, as illustrated in table below.

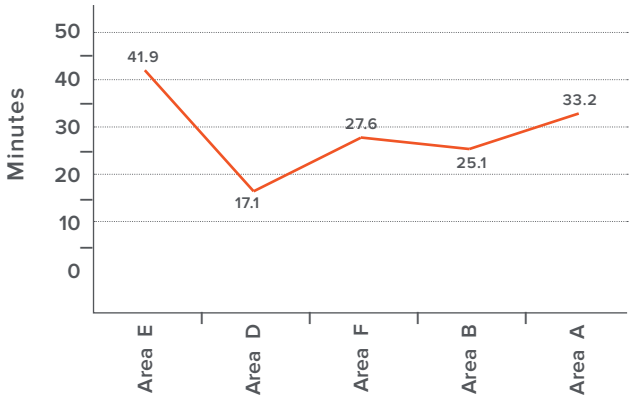


ELECTRICAL INSTALLATION TIME



*Incomplete electrical data was collected for Area C. For this reason it has been omitted from the table.

PLUMBING INSTALLATION TIME



*No plumbing assemblies were included in Area C. For this reason it has been omitted from the table.

FINDINGS

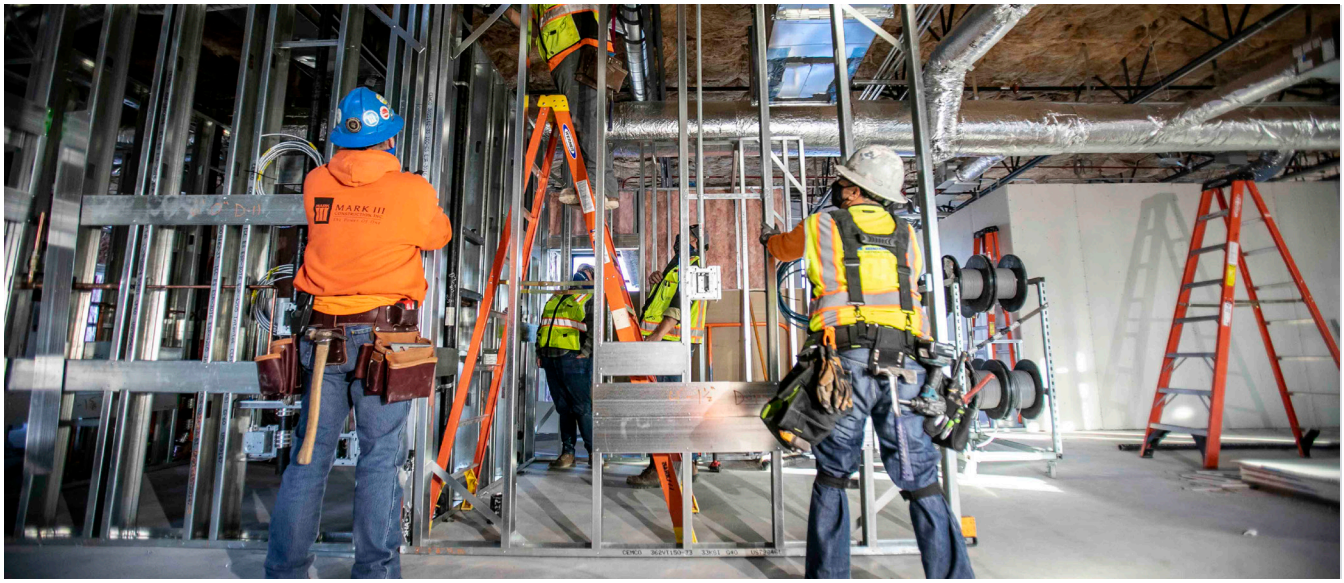
ON-SITE INSTALLATION

On-site installation was tracked in a similar fashion to manufacturing production. Utilizing a stopwatch the time was tracked from the panel being removed from the flat-pack to when the final power actuated fastener was shot into place. As expected, linear footage and complexity of the panel greatly influenced the installation rates.

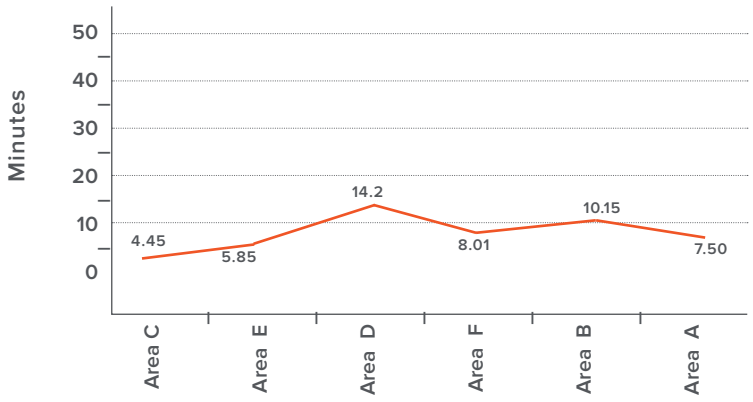
Install schedule for the interior wall panels were developed with the same length durations from the referenced baseline project. The baseline project included a total of 30 days for internal wall framing and in-wall utilities to be installed by the independent contracting firms (mechanical, electrical, plumbing, low voltage and framing). The 30 day schedule was divided by 6 areas of the project, giving the team 5 days per area.

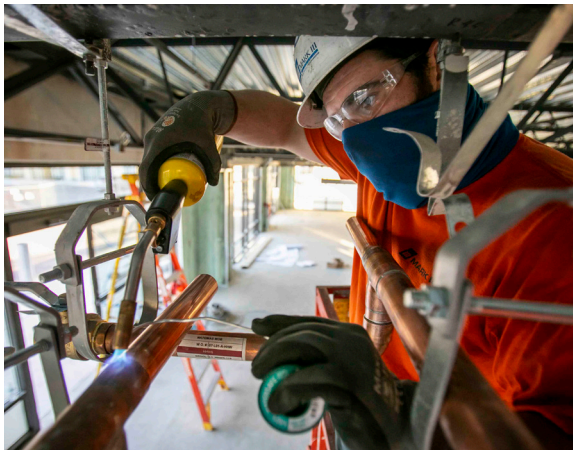
No area took more than 1.5 days to complete and the entire installation of all 6 areas took a total of 8 days. Unfortunately, the team was not able to shorten the schedule because the manufacturing team could not keep up with the on-site production.

All lessons learned in manufacturing of wall panels, in-wall assemblies, and on-site installation were captured in great detail and the team intends to implement countermeasures on our future projects.



ON-SITE INSTALLATION TIME





LESSONS LEARNED

CULTURE

In the spirit of continuous improvement, the team implemented an issues and opportunities log to capture all areas of waste and improvement. Early on, this log was called the issues log, but it was determined this was creating a negative culture. Changing the name to issues and opportunities positively impacted the teams' perception of this tool. Over the course of the project, 84 issues were captured by the virtual, manufacturing, and install teams. Where applicable, countermeasures to the entries were implemented immediately. All other countermeasures will be implemented on future projects to eliminate repeat mistakes.

Alignment and collaboration between the owner, general contractor, and superintendent is pivotal to success. Increased efficiency and long-term multi-project spanning productivity gains cannot be achieved unless there is synergy between all parties.

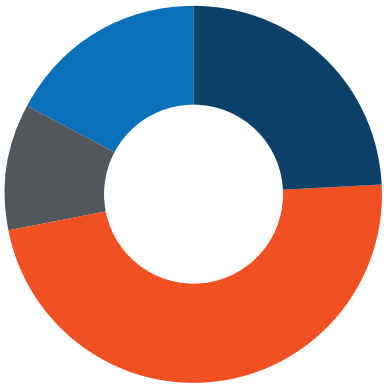
ISSUES & OPPORTUNITIES LOG

The project team utilized an issues and opportunities log as a lean tool to track, encourage, and drive continuous improvements. Together all parties on the project identified and tracked issues and areas of waste to eliminate repeat mistakes and ensure countermeasures can be identified and implemented on the next project.

Entries were categorized by trade (mechanical, electrical, plumbing, framing) and by department (VDC, manufacturing, operations) and given a severity rating code of green, yellow, or red.

- Green – opportunities for improvement or issue that was resolved right away
- Yellow – issue caused pause, but a resolution was established within hours or by next day
- Red – issue caused multiple days to resolve or rework

Mark III is continuously looking for opportunities for optimization. Absence or lack of issues does not mean there is no room for improvement. Encouraging this crowd-sourced issues log encourages behaviors that stimulate continuous improvement and innovation.



Captured during entire duration of the project across all Mark III teams.

COST SAVINGS

At project completion, Mark III contributed 10% of our total contract value back to the project team. This achievement was a result of our vertically integrated approach to the project. Through our multidisciplinary approach the project team was able to streamline work flow, minimize waste, and give back to the owner in both time and money.

THE FUTURE OF CONSTRUCTION

By utilizing modular building and prefabrication, Mark III was able to install all interior wall panels for an 18K square-foot two-story medical office building in just 8 days.

PROJECT SUMMARY

The project team was able to beat the framing and in-wall utility schedule duration by 73%, installing all interior wall panels (including electrical, low voltage, plumbing in-wall, backing, and door frames) for the 18K SF facility in just 8 days. Utilizing a teamwide crowd-sourced issues and opportunities log, the project teams captured 84 issues. Countermeasures and solutions were put into place and additional schedule savings are projected for future projects.

THE FUTURE

In order to further optimize and enhance Mark III's process the company is focusing on key hires and continuing to build and strategically augment our team. The company is adding individuals to the team that have spent years focusing on industrialized construction and the power of standardization and componentization of building systems and elements for construction.

To follow Mark III's progress, visit their website at mark-three.com, reach out to schedule a tour of their MEP manufacturing facility mark-three.com/tour or watch the three-minute video on their website for a behind the scenes look into this project mark-three.com/construction/project-mountain

Find Mark III Construction, Inc. on social media to join the conversation and find out what the company is doing next:

SOURCES

SOURCES

1. Census.gov, *United States Census Bureau Construction Spending*, viewed April 4, 2021, < https://www.census.gov/construction/c30/historical_data.html>
2. McKinsey & Company 2019, *Modular construction: From projects to products by Nick Bertram, Steffen Fuchs,Jan Mischke, Robert Palter, Gernot Struve, and Jonathan Woetzel*, viewed April 22, 2020, <https://www mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/modular-construction-from-projects-toproducts>
3. vPlanner.app, *What Is vPlanner?*, viewed March 29, 2021, < https://www.vplanner.app/vsps#:~:text=vPlanner%20is%20a%20comprehensive%20solution,Planner%C2%AE%20System%20(LPS).&text=vPlanner%20eliminates%20the%20redundant%20effort,for%20each%20work%20planning%20cycle>