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MERCURY
YOUR VISION, OUR DUTY.

Mercury is a European contractor that builds and manages complex engineering projects that reimagine how people work and live in the built environment. Mercury believes that real innovation happens if you are willing to be brave. Its determination and sharp focus enable Mercury to deliver leading-edge construction solutions across a range of key sectors, taking our clients to new territories they never thought possible.

Mercury's purpose is to deliver its clients vision through leading-edge construction solutions, going beyond their duty which turns clients into partners and builds relationships that thrive across the following Sectors: Enterprise Data Centres; Hyperscale Data Centres; Life Sciences & Technology; Building Services; Healthcare; Fire Protection; and TSS.

Author

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Overview & Background to the Lean Initiative

Company Overview

Mercury began its Lean journey in 2014 with a great deal of energy and enthusiasm. Through our Yellow and Green belt programmes, many Lean projects have been undertaken and successfully implemented across all of Mercury's business units in Europe. Like most organisations that are on their Lean journey, Mercury hit a state of homeostasis after a couple of years of success and lost some of its original momentum.

In the last year, Mercury has refocused its efforts, and, by following the Plan, Do, Check, Act (PDCA) continuous improvement cycle has set up a governance structure to manage its Lean implementation plan and roadmap. The Mercury senior management have been actively involved in communicating our Lean philosophy across the organisation. We have re-established our Lean training program, with ten members of staff gaining Green Belt accreditation and one gaining Black Belt accreditation.

The Lean initiative discussed in this case study examines the modular wiring system design and installation on a large-scale project in Ireland. The objective of this project was to reduce the time taken to produce Modular Wiring 2D drawings and reduce waste on-site utilising Lean Principles. The DMAIC methodology was used for this initiative, with several Lean tools utilised, including: Gemba Walks; Brainstorming; Current State Mapping; and Cause and Effect Diagrams. Collaboration and communication also played a significant part in the success of this initiative.

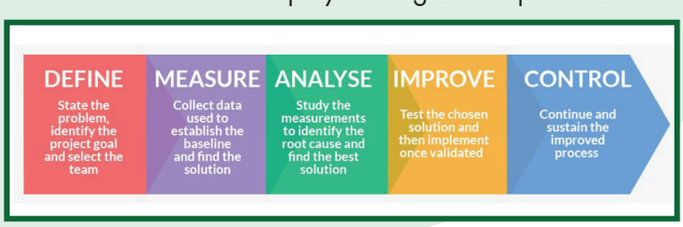

Figure 1. DMAIC Methodology

Lean Initiative Undertaken – Lean Thinking, Tools, Techniques

Multiple cross-functional teams collaborating together is required to produce the end result of a modular wiring system designed, manufactured, and delivered to site. This includes the Site Engineering Team, BIM Modellers, CAD Technicians, Modular Wiring System Specialists, Lighting Control System Specialists, Project Design Consultants, and Electrical Distribution Board Manufacturers.

A kick-off meeting between all the modular wiring stakeholders, that is, the "internal customers", was arranged to complete the following:

- Communicate to the team the nature of the project, the reasons for selecting the project, and what the improvement expectations and goals for the project were.
- Select an initial cross-functional team and appoint a team leader for the improvement project, and communicate this to all stakeholders, as well as identifying all team members' roles and responsibilities for the project.
- Ensure buy-in and approval from the stakeholders for the project.
- Initiate and communicate a timetable for the meetings and activities required to complete the project.
- Generate a project charter to define the objectives of the project.

Using the DMAIC methodology, an action plan/timetable was generated detailing the durations for each phase of the project and with the appointment of cross-functional cells at each phase (Figure 2).

Figure 2. Improvement Initiative Action Plan & Timetable

Lean Initiative Life Cycle

At the first project meeting, the phases of the project were identified as follows:

- Define the problems in the process in more detail and develop a strategy to accomplish the goals set out in the charter. All agree on project goals and how the project would be considered a success.
- Investigate the root causes of the wastes identified through analysis of the current modular wiring process state, and map the modular wiring process as it stands today through completion of a current state value stream map.
- Select the tools and practices most appropriate for eliminating the wastes.
- Implement the tools and practices selected and measure any improvements.
- Evaluate the project results and review any key learnings. Document and standardise the new and improved modular wiring processes.

A gemba was scheduled of both the drawing production itself and the plan for how the on-site modular wiring was intended to be installed. Once the gemba was completed, the team scheduled a brainstorming session and a cause and effect exercise which identified several different wastes, including:

- Very little storage space was available on-site to store any of the modular wiring intended for site.
- Large bottlenecks were quickly identified within the drawing production process at various review stages and several process steps could be seen as being non-value-added.
- Given the vast size of the construction project, a plan would need to be implemented to avoid the install team having to travel long distances to retrieve the modular wiring for their install in each construction zone.

The team was then tasked with gathering the data of what is currently taking place in the modular wiring drawing production process, and identifying the wastes in more detail through Cause and Effect Diagrams. This information was then used to produce a current state map which clearly identified the wastes and delays in the drawing production process, as well as to quantify the actual time it was taking to complete each step. The first construction zone where the general services and lighting modular wiring drawings were produced was picked as the current state process which would be used to gather the data. Each stage of the current state process was documented with the person responsible for each step identified and the time taken to complete the step confirmed through a process step tracker.

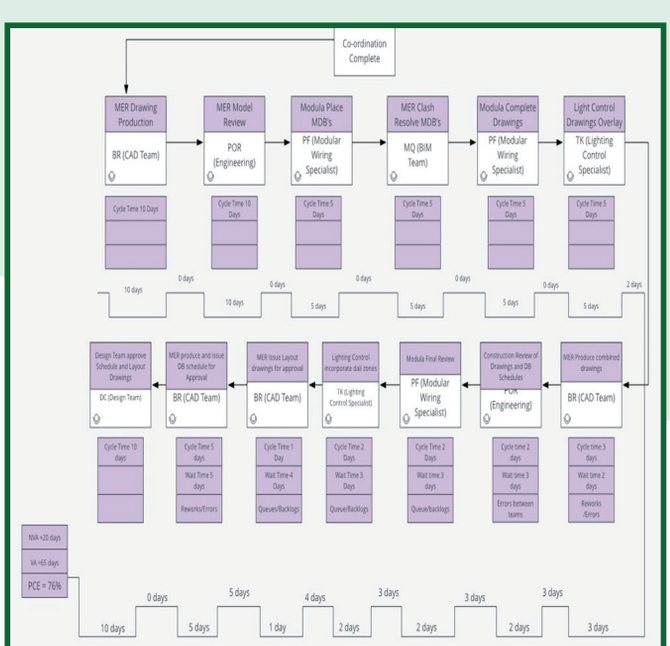

Figure 3. Current State Map

Through the above Lean tools and practices, a number of wastes were evident in the current state map, along with re-occurring errors, queues, backlogs, and unnecessary process steps (see Figure 4).

Location of Waste	Potential Action to Address
MER model review held post-model completion with 10-day cycle time.	Step could be incorporated prior to model completion, thus removing step completely from value stream.
Drawing produced at first step, but DB schedules produced through CAD at a later step added a further 10-day cycle time to the process.	During brainstorming with cross-functional team, it was identified that the DB schedules could be produced as an export from the BIM model, eliminating the need for the 10-day cycle process step and allowing the DB schedule to be produced at the same time as the initial drawings.
Several errors and reworks were causing delays, including, wait times, queues, and back logs in the value stream (10-day wait time). Only 1 review stage by engineering team identified close to the end of the process.	2 additional engineering review stages to be added to value stream – 1 prior to issuing drawings to Modula and 1 on receipt of modular drawings from specialist – to ensure any errors are captured incrementally and dealt with promptly as no back and forth between various stakeholders required.
The lighting control specialist was involved in 2 separate process steps which caused unwarranted queues.	Incorporate the lighting control overlay and the addition of the dali zones to the lighting drawings as one process step.
Lighting and General Services Drawings issued at the same time, but, through monitoring of the current state value stream map, it was identified that the general services drawings could be issued for approval earlier than the lighting drawings as less process steps were involved.	Work split between 2 CAD team members – 1 working on Lighting and 1 working on small power at the same time. On completion of general services layouts and post-modular wiring review, the general services drawings were issued for approval whilst the lighting drawings would continue through the final process steps.
Queues and backlogs evident at issuing of layout drawings for approval step (3-days) due to verbal communication that drawings were ready to issue.	Electronic notification system implemented with visibility from all team members to ensure accountability in issuing drawings in agreed time frame.
It was identified that, due to additional review stages being added to the value stream, the final review by the modular wiring specialist was not required.	Final review by modular wiring specialist removed from value stream and thus removing 5-day lead time at process step.

Figure 4.
Waste Analysis

A future state value stream map (Figure 5) was then created by the team to gain visibility on the improvements from the current state map generated, to further develop the improvements steps identified, and to review what the new lead time and value-added activities would be if the improvements were implemented. Construction area Level 3 Zone 2 was identified for the improvement project with a drawing production start date end of October.

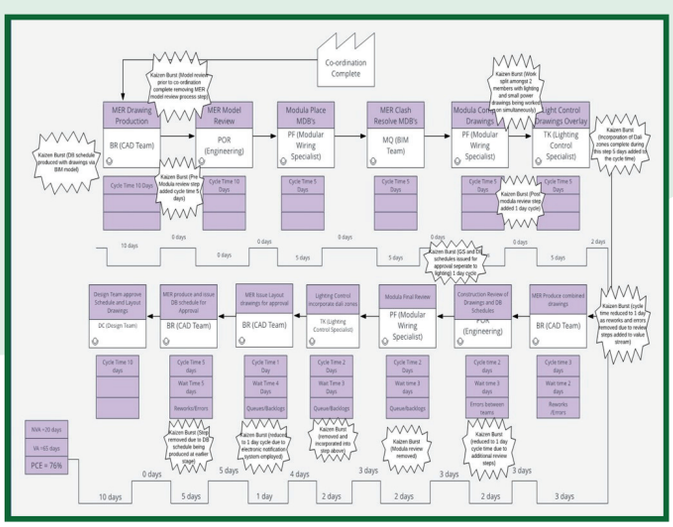

Figure 5.
Future State Value Stream Map

On completion of the future state value stream map, a new process step tracker was generated which detailed the new process steps involved, with the redundant process steps from the current state value stream map removed, and the new process step durations indicated from implementation of the improvements. Overall, this identified that the new proposed lead time of modular wiring drawing production was reduced from 85-days to 65-days.

A meeting was then scheduled with the BIM team, CAD team, modular wiring specialist, lighting control specialist, project general contractor, and the project planners to discuss lead times for manufacturing of the modular wiring for a given construction zone. This indicated 35-days and this was added as a process step to the new process tracker produced. Access dates for modular wiring install were identified for each construction zone by the general contractor, and these were also added as a process step to the process tracker to ensure commencement of manufacturing of the modular wiring for a given construction zone would only be initiated within a timeframe that would allow minimal storage prior to delivery and thus allowing JIT deliveries. Model completion dates were added to the process tracker by the BIM team for each construction zone to ensure the CAD team, modular wiring specialist, and lighting control specialist were ready to commence drawings once the model was complete. The process tracker was issued to all stakeholders to ensure dates were kept as agreed and all stakeholders had visibility of where the modular wiring process was currently at for a given construction zone, thus initiating Pull into the modular wiring process.

Finally, agreed by all parties and added to the PO was that, rather than the modular wiring being delivered to a central storage location, the modular wiring for a given construction zone would be delivered to the construction zone itself, thus ensuring the modular wiring was stored in close proximity to the installer and motion waste reduced.

The tools and practices used for each phase of the project are listed below:

- Phase 1 (Define) – Brainstorming was used during the initial meetings to build involvement, commitment, and enthusiasm for the project, and to both help to define the project more clearly and allow the team to think more critically in terms of solving the issues surrounding the modular wiring process. Direct Observation and Gemba Walks were used to better define the problem by studying the area and gathering the information which would be useful during the measure phase of the project.
- Phase 2 (Measure) – A Current State Map was generated to analyse what value-adding and what was non-value-adding within the modular wiring process, and it also helped us to make informed decisions around which improvements to focus on. Cause and Effect Diagrams were used to investigate what were the non-value-added activities in the process and what wastes could be identified.

• Phase 3 (Analyse) – After analysing the data gathered, a Future State Value Stream Map was generated to identify the improvements that could be made from the (then) current state value state map and to tackle any wastes within the value stream. JIT deliveries were identified as a tool that could be used to reduce the amount of transport wastes both onsite and in the office.
• Phase 4 (Improve) – A Value Stream Action Plan was used to clarify what steps and resources were required to reach the end goal, and what needed to be done and when.
• Phase 5 (Control) – Communicate results and document new modular wiring process. We then documented and standardised to ensure the improvements made are maintained and the new value stream is visible to all stakeholders allowing each person within the stream to know their responsibility, what they now need to do, when they need to do it, and when they need to have it completed by.

Lean Initiative Improvements & Impact

The project charter was a key factor to the successful completion of this project. With the charter, we were able to communicate the necessity and value of the project to the sponsor, stakeholders, and project team. In a sense, the team was able to sell the project to the people that mattered with this high-level document. When the project hit roadblocks and people asked "Why are we doing this?" we were able to refer to the charter to show people what we wanted to achieve on the project in the first place. The project charter was the "contract" for what, why, who, where, when, and how the project was delivered. With the project charter we were able to effectively manage the project's triple constraints of scope, time, and cost. When one changed, the other two had to be changed as well.

The investigative tools such as the cause and effect diagrams and the value stream mapping have been an invaluable tool to us in identifying wastes and non-value-added activities, not only within the modular wiring process but in all other systems for which we are responsible for in our scope of work on this particular project. Not only have the investigative tools been an excellent source of information to us, but the Lean focus on waste ("Muda") is something we intend to continue to try and identify in the future along with creating flow in our processes.

A value stream action plan was generated to ensure that all team members were aware of what was needed to be done and when. Improvements were measured via the action plan and through the future state process tracker. This worked well as all team members had clear visibility of their responsibilities over the life cycle of the project.

All durations as per the action plan were met apart from one step of the General Services drawings process. Unforeseen additional electrical services were added by the client as a variation and which added 10 days to the process to allow for incorporation of the additional circuits to the modular wiring general services drawings. This was unfortunate as the change was only initiated by the client when we were at final review stage of the general services drawings and ready to issue to the client design team for approval.

Lighting Modular Wiring drawing production was achieved as predicted in 65 working days, thus reducing lead time by 20 working days and achieving what the improvement project set out to do.

JIT deliveries have been implemented for the construction zone used in the Lean project. The application of JIT in construction differs greatly from the manufacturing industry because of the complexity and schedule uncertainty of large construction projects. If you have a well-structured schedule that everybody works to, it can be of great benefit to a project, and as it has been on this particular project.

Now that a clear value stream has been identified and implemented, the short-term future plan is to continue utilising the Lean principles used in this improvement project for all of our other modular wiring construction zones on this project. Our intention is to continue to look for improvements and wastes at every opportunity within all processes going forward. This new process will now be communicated across the company to utilise this Lean Win.

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