COMPANY OVERVIEW

Jones Engineering Group
Engineering Contractors

COMPANY WEBSITE
www.joneseng.com

Jones Engineering Group (JEG) is in operation for nearly 130 years. Its core services include Mechanical, HVAC, Process Piping, Electrical, Instrumentation & Controls, and Fire Protection across all sectors. Additional services include Maintenance, Bio-Energy, Technical Support Services, Geo-Surveying, Specialist Lift Division, Fabrication Facilities, and Comp-Ex training (competency in the selection, installation, inspection and maintenance of Ex apparatus in potentially explosive atmospheres). Working in 14 countries across Europe and the Middle East, JEG employ over 2,400 people and have an annual turnover of more than €400M. JEG is strategically committed to the implementation of Lean Construction thinking and practices across the company and its supply chain.

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OVERVIEW OF THE LEAN INITIATIVE

This project was undertaken at a Semi-Conductor Fab in County Kildare, Ireland. The scale of the project included 420km of pipe; 246km of cable; 119km of Unistrut support material (between both Mechanical and Electrical scopes); and the budget was €150M between both Mechanical and Electrical scopes.

BACKGROUND TO THE LEAN INITIATIVE

When the first section of this tool install project was nearing completion it was behind schedule, over budget, morale was low, and overall productivity at the site was way below where it needed to be for the project to break even.

The worksite environment had to improve anyway, but particularly because the next phase of the project scope was twice as big and had a very aggressive schedule. Moreover, the factory conversion was to take place within a facility that was designed for technology that was then 22 years old. Change was required on several fronts, and certainly new thinking was required.

LEAN INITIATIVE UNDERTAKEN – LEAN THINKING, TOOLS, TECHNIQUES

Early in Phase A of the project, the Earned Value (EV) results were pointing to issues in productivity and potential schedule slip (see Figure 1). Whilst management recognised this issue, they had to focus on what could be done to quickly and effectively improve the situation.

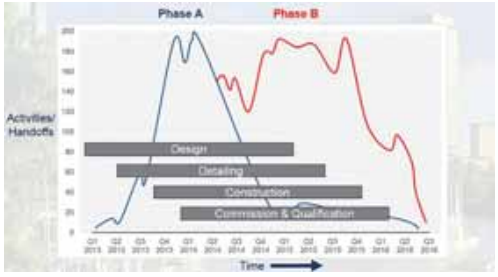

Figure 1. High Level Programme (Phased)

A JEG survey was carried out with the supervision and line management to address the issues they faced on the project and in particular to focus on factors impinging productivity. Several Lean tools and techniques were used to address the issues raised in this survey, including: Standardised Work, 5S, Right First Time (RFT), Visual Management, Just In Time (JIT), 7 Wastes, Audits, Kanban, Value Stream Mapping (VSM), and the Last Planner® System (LPS).

Workplace Organisation Implementation (5S or CAN-DO)

5S principles involve improvement to processes, generally through good house-keeping and sensible workplace organisation, and these principles include:

1. Cleanliness:
- Housekeeping.
- Remove unnecessary materials.
- Only a day's worth of inventory is required.
- Keep tidy records and document learnings and system changes.

2. Arranging:
- Store items correctly in assigned places.
- Arrange material close to hand and eliminate double-handling.
- Tools in set arrangements and marked out.
- Visual Management.

3. Neatness:
- Put all items in their place.
- Visually check all item presentation.
- Hourly housekeeping.
- Visual display all plans and schedules.
- Designate owners for section neatness.

4. Discipline:

- Stop rather than continuing regardless.
- Prioritise, do late in process, and finish early.
- Set up regular processes.
- Carry out audits.

5. Ongoing Improvement:
- Keep the same routine and flow.
- Identify root causes of issues and adapt.
- Make targets a challenge.
- Continually identify and eliminate waste.
- Question traditional methods.

Schedule Variability
One of the measures used to track improvement of the overall project was schedule variability. Reducing the variability enabled the flow of the work and allowed the teams to work on defined scopes, thus reducing changes in work activity and the subsequent associated wastes.

Some of the methods applied and shared via collaborative platforms in the "BIG Room" environment included an integrated frozen schedule, the all-in-one project management information system (PMIS) platform, and LPS (see Figure 2). These collaborative methods enabled over 30% reduction in schedule variability, thus promoting much smoother hand-overs between disciplines and less changes at the workface.

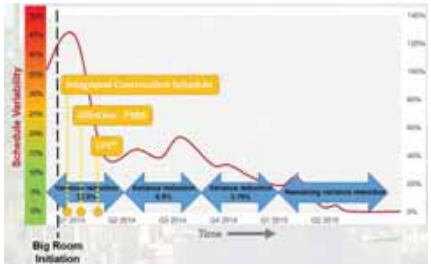

Figure 2. Schedule Variation Reduction

Waste Reduction & Increased Value
Following an initial workshop plus analysis of the categorised results from the online poll, several processes were agreed for process evaluation using "Improvement Activity Reports" (IARs). The teams agreed the scope through the workshop and then set about evaluating the processes identified having been trained how to evaluate using time analysis through video or stopwatch evaluation (see Figure 3). By timing the activities and categorising them through direct observation, the reduction of waste and improvement of value-added (VA) time was realised. The opportunities in construction activities for reducing waste and increasing VA enable buy-in from the construction teams and provide flexibility in their work planning and increased certainty in LPS when planning hand-overs between trades.

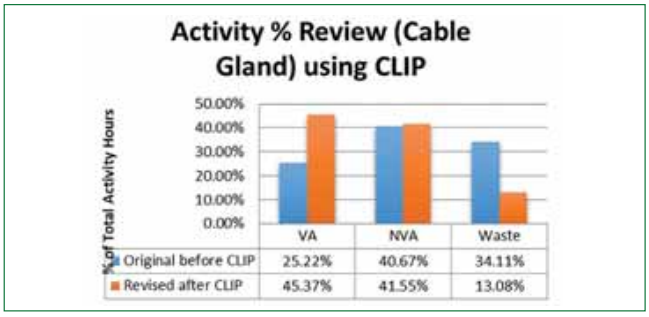

Figure 3. Waste Reduction & Increased Value

Evaluation sheets were used to demonstrate the process steps and the time each step takes, and then each step was categorised as either VA or non-value-adding (NVA). Following this categorisation, all the activities were weighted as a percentage of the overall process and evaluated for improvement. The activities were then prioritised for ease of implementation and possible percentage effect on the overall process. If a countermeasure could be identified from the list of activities, then a target was set for possible improvement. After that, the process was carried out with the countermeasures in place and re-evaluated through the time analysis. The actual improvement was then documented, and the percentage improvement communicated. The findings of all the process evaluation sheets were rolled-up into IARs that enabled clear communication of lessons learned and facilitated possible financial benefit reports also.

Promoting Innovation
Innovative ideas rather than just process improvements give the best results. The research showed that through using an innovative change from the traditional process, the highest yields in terms of cost and quality were realised. Specifically, using BIM for containment manufacture was a step-change rather than just an incremental improvement. One does need to do both, and innovation needs to be encouraged, plus receiving feedback (such as latest equipment seminars) was a welcome response in the research showing a desire to look at new ideas and innovative equipment.

In this regard, equipment suppliers are only too delighted to showcase their wares; however, any Lean improvement requiring purchase of new equipment needs to be offset in the cost comparison sheet. Also, it is advised that one does not assume that the worker on the floor knows what the latest technology available is, and contractors need to educate the workforce in this regard to improve overall. Combining multiple innovations yields the greatest results.

Direct Observation
The direct observation carried out throughout the project allowed for statistics to be generated directly from the sheets used by the workers on the site. The excel format used also allowed for graphical representation of the results, such as those illustrated in Figure 4, with the percentage of time analysis per sector achievable. Direct observation allows for a deeper understanding by work crews of VA work, NVA work, and Waste.

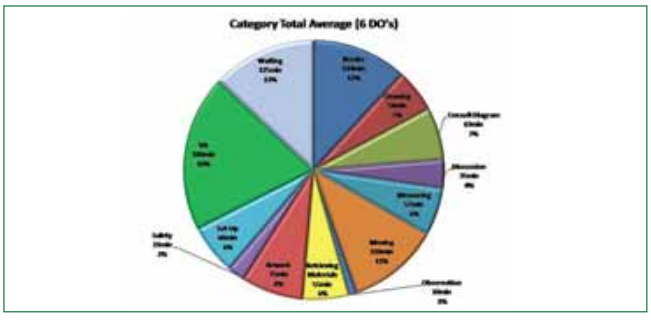

Figure 4. Direct Observation of Work (all categories)

Prioritising activities can be key to getting immediate results, and, as can be seen in Figures 4 and 5, the process evaluation sheet allows for identification of the VA, NVA, and Waste elements, thus enabling prioritisation. The waste identified in the process clearly showed where most of the waste time was being spent, and, by applying a countermeasure directly to the issues identified, the improvement was dramatic and amounted to over 25% overall.

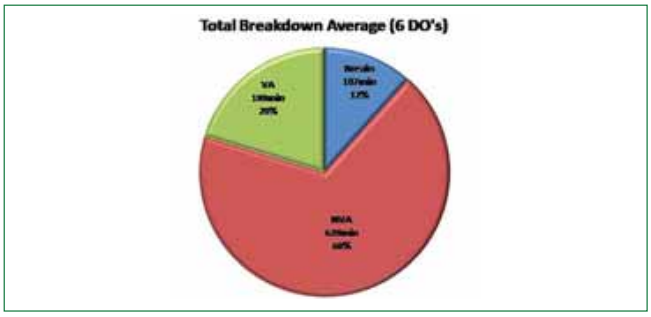

Figure 5. Direct Observation of Work (summary)

Direct Results of Process Improvements
The streamlined processes and collaborative delivery method enabled the project to meet 100% of the scheduled construction commitments for the final peak of the project. This level of service delivery was unheard of in the first year of the project when the Lean approach was not in place.

Utilising BIM from Imagery to Installation
The intent from the beginning was to use BIM technology for every aspect of this project. This entailed every element of installation being computer-generated into a 3D image and then isometric drawings being produced from those 3D images. All this information was loaded and available on JEG's own in-built project database system called "Isoserve", including schedules and milestones. Any new revisions to design were automatically updated on Isoserve so that the latest designs were always available. When the schedule prompted it, a package was generated and distributed to the project teams.

In JEG's off-site workshops, pre-fabrication teams manufacture spools (pre-fabricated sections of a piping system, including for example pipe and fittings), and a complete work pack can be pre-fabricated off-site. As each spool was completed it was placed on a pipe rack with a copy of the isometric drawing, including its unique bar code, ready to go to site. When the site crews were ready, the full set of spools were loaded onto a truck and brought to site. The site crews then began the process of installing each spool in sequence, and, as they did so, they highlighted the drawing packs showing installation progress. A member of the planning department then scanned the barcodes on the highlighted drawings and this information was transferred onto Isoserve indicating how much of each work-pack was complete.

Project Execution Database
JEG has well-established and proven systems, procedures, processes, and tools that are applied consistently for project management functions. All JEG's projects are managed through Isoserve which ensures successful delivery and consistency of delivery of each project. For example, JEG's "Tool Status Dashboard" details various live information on a tool such as the status of workshop fabrication, brackets installed, and pipework installed per tool.

The system can be accessed from any location, either directly from the server or via an internet connection, allowing all members of the project team to have up-to-the-minute access to the latest progress information. Every spool on each isometric has a QR (quick response) code (like a bar code, but it can hold more information) which is scanned using a hand-held scanner when entering updates to increase efficiency and avoid typing errors and multiple entries.

Use of Geo-Surveying Equipment
Digitisation of design through BIM deliverables means that greater accuracy and precision is required throughout all stages of construction. There is a requirement for greater understanding of site conditions to maximise efficiency in all areas of the install process. Technology that is new to construction in the form of 3D Laser Scanning allows JEG to accurately understand site conditions so that all design and build projects can be precisely referenced to their actual environment. This capability can also be employed quickly, and easily captures any changes between "Issued For Construction" (IFC) design and the "As-Built" design, thus saving time completing the required mark-ups following construction. High precision set-out ensures that all JEG construction activities spatially adhere to design, hence minimising errors and clashes during on site construction. JEG's geo-surveying team has perfected a process whereby they set out datums marking a grid across the entire project area. It is then easy for the install teams to accurately measure from a local datum and set up laser lines to pinpoint their starting point.

Cable Spooling Machine – Just In Time (JIT) Delivery
Following a survey carried out by site supervision, cable management was identified as an area for improvement and removal of waste. Specific areas to be targeted were:
- Manual handling of large cable drums (Safety, Time).
- Drums moved multiple times (Motion, Transport, Inventory).
- Waiting & Schedule.

By introducing the use of a cable spooling machine, JEG was able to improve in each of the following areas:
- Reduced risk to Client project delivery.
- Reliable cable spooling system.
- Safer cable pulling.
- Reduced inventory.
- Reduced waiting, motion, and manual transport time (that is, JIT delivery).

Working with the Supply Chain to Improve Efficiency – Kanban
At the start of the project, JEG Electrical met with its electrical trunking manufacturer to discuss and agree where improvements could be made to streamline the manufacturing and supply process. One of the items that the manufacturer was concerned with was that they would not be able to store sufficient material to meet the required dates for the project. Setting up a kanban system was suggested by JEG as a means of assisting with this, and the plan was as follows:
- Firstly, the amount of material in each typical work package was agreed.
- Then, the dates were used from the agreed construction schedule to set up initial material orders.
- Following this, a visual flag was used to warn when each material type reached an agreed minimum level.
- Seeing this flag triggered manufacturing staff to order new stock.
- This resulted in JIT delivery of materials, and elimination of excess inventory.

The manufacturer in this case was so impressed with the results of the kanban system that it has since introduced this method across its entire operation.

Last Planner® System (LPS)
Use of LPS by all contractors across the project was a notable success. The fact that field supervision attended the planning sessions themselves and made their own commitments ensured that they did their best to achieve these goals.

Orbital Welding Collet Kits and Local Vices – 5S
To address issues related to orbital welders sharing collets between themselves for different sizes of tube, and walking to

different areas to find a vice to cut open their weld coupons, JEG took the following actions:

- Issued an organiser box to each welder with a common set of equipment.
- Set up mobile vices that could be moved locally and be easily attached to structural columns.

Productivity gains were significant as there was now no need for the crew to leave the work area to find any of the required tooling.

LEAN INITIATIVE IMPROVEMENTS & IMPACT

This project was a significant success via the adoption of Lean thinking and the use of Lean Construction techniques as the foundation for the improvements that took place. The goal of Lean is to add value to the customer. In this case, value meant delivering a world-class production facility within budget and on time, thus enabling the Client to begin production on time. At the end of the initial phase of this project JEG was not delivering value to the Client. As noted earlier, productivity on site was a long way from acceptable, and significant change was required in order to deliver a productive environment. With the goal of delivering value once again to the Client, JEG re-grouped and re-organised for the new phase of the project. Critical to that re-organising was the implementation of Lean thinking, including the tools described above and key strategic investments in infrastructure and training.

The results were significant, and Labour Earned Value and productivity substantially improved on site after the implementation of Lean Construction thinking and practices. The drivers for this change were the tools listed earlier and the change in worksite environment brought about by Lean thinking. Before people could engage with Lean, they needed to know what Lean was. The Client deserves a lot of credit here as it has been the main driver and pioneer of Lean Construction within Ireland. JEG Management quickly recognised the importance of training and development, and the company thus embarked on an ambitious training programme to give all staff members an understanding of Lean. The results of this training led to many initiatives being implemented that focused on adding value and removing waste. The training helped to identify the many types of waste that occur daily; and once a person begins to see the waste there is no way to "un-see" it. This in turn led to an overall change in attitude as to how JEG does business – waste was no longer acceptable.

Part of the waste identification process meant engaging more with the work force. It was recognised that the people doing the daily tasks in the field were the experts in what they do, and they needed to be consulted to identify all waste. This enabled some traditional barriers to be broken down as people began to see it as a way to convey their frustrations to management regarding the issues they faced daily, as well as it being a way to remove some of the constraints they were facing and improve the quality of their working day. People want to do meaningful work and Lean thinking has a big part to play in making that happen. There were several formal processes set up to collect this information from the workforce, including the JEG "Waste Walk" programme and "A Better Way" employee suggestion programme.

Other benefits from Lean included a marked rise in the desire to constantly improve, plus the sharing of information regarding best practices and modern construction methods. Such was the appetite for this knowledge that JEG set up an internal magazine called "Lean Times" to share new information throughout the whole JEG Group, as well as with other interested parties within the construction sector.

In summary, the project set out on a path to challenge the status quo and deliver change and innovation based on the foundations of Lean thinking and Lean Construction methods to establish a platform for delivery of a successful project and provide value for the Client. The project strategy and initiatives introduced by JEG are viewed as a model of success in team working and delivering best value. This project has produced a significant step-change in the way JEG construction projects now operate and in setting new standards for all existing and future projects. JEG's objective is to instil Lean principles, practices, mindset, and behaviours across management, operations, and into delivery to ultimately bring greater value to clients. Embedding this Lean culture will be achieved by working collaboratively with like-minded people in a team environment and with a shared vision of continuous improvement. This cornerstone of JEG's business will drive new solutions and greater effectiveness, bringing expectations of better and more demonstrable results in all projects right across the Jones Engineering Group.

Some key initiative outcomes include:

- 8,683,279 man-hours worked on the project with a recordable incident rate of 0.16 (the sector norm is 3.4).
- Punch-list items ("defects") on each completed pipeline reduced from 11 to 0.15 following Lean improvements.
- Performance Against Schedule increased from as low as 30% to 100% continually.
- Over 20% improvement in Earned Value (productivity).
- Improved collaboration and co-ordination.
- Budget targets exceeded for second phase of the project.