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DPS Group is a global consulting, engineering, and construction management company serving high-tech industries around the world. DPS has sector experts in key locations in Europe, the US, Asia, and the Middle East, bringing world-class resources and the latest innovative technologies to every project. Our sector expertise spans many markets, including Biotechnology, Pharmaceutical, Medical Technologies, Oil and Gas, Advanced Technology, Food & Beverage, Energy, Science & Education. DPS delivers full-service Engineering with a Client-first mentality and personal touch across a range of disciplines: Project and Programme Management, Procurement, Design, Construction Management, Health & Safety Management, Commissioning, Qualification, and Start-up. DPS employ more than 1,800 people worldwide.

Author

Dara Quirke

Author

Sean Kinnane

Author

David McCarthy

Author

William Power

Overview & Background to the Lean Initiative

DPS Group modestly prides itself as being an early adopter of Lean thinking and practices in both Irish and International construction sectors. The company invests heavily in staff subject matter experts, Lean education and training, and in internal process improvement initiatives. DPS Group has previous case studies on Last Planner® System (LPS), Target Value Design (TVD), and Takt Planning published in the 2018, 2019, and 2020 LCi Annual Books of Cases respectively. DPS Group strives to be innovative in continuously improving its delivery methodologies and is thankful to Felipe Engineer Manriquez for introducing us to the concepts and principles of Scrum and Agile. Our trade partner, Ardmac, hosted an on-site Scrum introduction facilitated by Felipe and immediately some of our staff recognised how Scrum could assist with project coordination and execution. DPS Group now commits to a full-time Scrum/Agility Coach, three Scrum at Scale (S@S) Practitioners, five Product Owners, 48 Scrum Masters, and over 500 trained Scrum development team practitioners.

Lean Initiative Undertaken – Lean Thinking, Tools, Techniques

Agile, with its roots in Lean thinking and practice, emerged from the software engineering world from dissatisfaction with the traditional waterfall, sequential, and time fence approach to scheduling product delivery and releases. As the demand for software increased, speed to market became an overriding priority, lowering the priority of other goals such as quality. In 2001, a group of software development professionals formulated and published the Agile Manifesto to break the traditional software development project mould and free software developers from unreasonable and unproductive constraints. A definition of Agile in the context of capital project delivery is given as: a collection of values, principles, and practices originating from the Agile Manifesto that is used to improve project delivery. An agile project is designed to be nimbler and more dynamic. Whilst a stable backbone defines clear deliverables and work packages at the standard project gates, dynamic capabilities are overlaid to react quickly to changes and allow projects to move more seamlessly through each stage.

The key characteristic of an Agile project is the empowered cross-functional team working across silos to create end-to-end accountability. Work is carried out in shorter and more iterative sprints that enable the teams to quickly test and adjust ideas, minimising risk of miscommunication or overdesign.

Scrum is a subset of Agile and allows people to manage complex and adaptive projects. It is based on the three pillars of transparency, inspection, and adaptation. The Scrum Guide (2020) describes Scrum as:

"Scrum is a lightweight framework that helps people, teams and organizations generate value through adaptive solutions for complex problems. In a nutshell, Scrum requires a Scrum Master to foster an environment where:

1. A Product Owner orders the work for a complex problem into a Product Backlog.
2. The Scrum Team turns a selection of the work into an Increment of value during a Sprint.
3. The Scrum Team and its stakeholders inspect the results and adjust for the next Sprint.
4. Repeat Scrum is simple. Try it as is and determine if its philosophy, theory, and structure help to achieve goals and create value.

The Scrum framework is purposefully incomplete, only defining the parts required to implement Scrum theory. Scrum is built upon by the collective intelligence of the people using it. Rather than provide people with detailed instructions, the rules of Scrum guide their relationships and interactions."

Scrum involves three key roles:

- Product Owner: Define and prioritise the features of the Product Backlog; Decide on release date and content; Responsible for the profitability of the product (ROI).

- Scrum Master: Facilitates the Scrum process and Team self-organisation; Removes obstacles and shields the team from interference; Responsible for improving performance of the team.
- Team: Cross-functional (including testing); self-organising and self-managing group of individuals has autonomy regarding how to achieve its commitments; typically comprises 3-9 team members.

Scrum entails four core meetings:

- Sprint Planning: Product Owner presents READY backlog to Scrum Master and Team; Deliverable is Sprint Backlog.
- Daily Scrum: Team self-organises to improve performance; Deliverable is new daily plan for implementation and impediment removal.
- Sprint Review: Team presents backlog that is DONE to Product Owner and Stakeholders. Deliverable is velocity (what Product Owner confirms is DONE), feedback (used to update Product Backlog), and potentially shippable Product Increment.
- Retrospective: Scrum Master and team identify the top process improvement; Deliverable is the kaizen project to put at top of Sprint Backlog for next Sprint.

The Scrum process, as illustrated in Figure 1, is initiated by the Team, Scrum Master, and Product Owner holding a Sprint planning meeting (1) which clarifies the batch of work to be undertaken. This work batch is refined into executable deliverables and assigned an effort measurement. These tasks are arranged in order of highest priority into a sprint backlog. The sprint is the event of executing these selected tasks and can be between 1-4 weeks in duration.

Generally, we find that two-week sprints work best for all parties. The sprint is reviewed at a daily Scrum stand-up (2) where impediments and exceptions are highlighted. During the sprint, change can be accommodated with constant refinement of the backlog. Also during the sprint, any deliverables to be handed-off are reviewed by the Team (3) to ensure the definition of done has been met and the next-customer's conditions of satisfaction are fulfilled. On completion of the sprint, a retrospective (4) is conducted to capture any learnings for continuous improvement of the process. Whilst change and iterations can be accommodated during the sprint, it is important that focus is maintained on the duration and the goal (5). The process circles back to (1) to initiate the next sprint and batch of deliverables. Figure 2 shows one of the early sticky-note Scrum boards where the objective is to work through the sprint by moving the highest priority sticky-notes across the board from To Do (Backlog) To Doing and to Done.

Figure 1. The Scrum Process

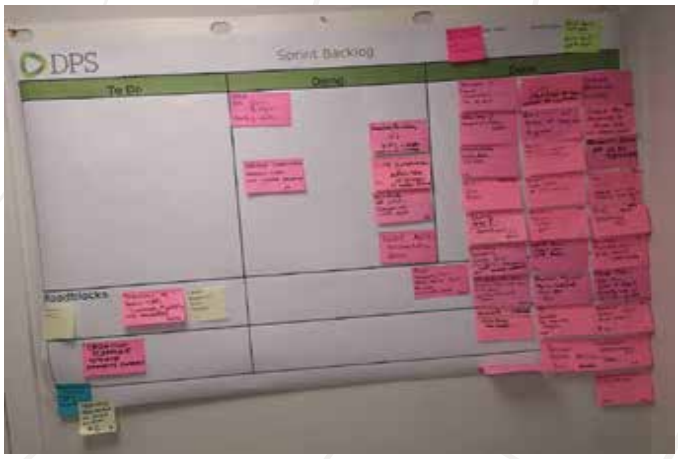

Figure 2. 'Sticky-note' Scrum Board

The nature of DPS Group daily work involves thousands of interactions and hand-offs between designers, constructors, vendors, contractors, and clients. Any process that can enhance the visibility and transparency of these interactions will positively contribute to project outcomes. DPS Group is recognised globally as being an early adopter of Agile and Scrum principles, and implement the Scrum framework for Concept, Basis of Design, Engineering, Construction, Commissioning, Procurement, Continuous Improvement, Tender Bid Analysis, Departmental Management, and Operations Management coordination. Scrum is now embedded as a core element of our execution process. Consistent application is assured with the development of a procedural Guideline and Implementation Health Check. The following case examples illustrate the versatility of the Scrum approach towards resolving issues as diverse as achieving Mechanical Completion (MC) on a HVAC system, constraints management in LPS, and pre-screening potential change within the TVD process.

Lean Initiative Improvements & Impact

Case #1 – MC on HVAC system

Systems Completion is the process of taking a project from engineering into construction, and transitioning to full mechanical completion ready for commissioning and operations. Completing the final one per cent of scope has traditionally been a major pain-point for Construction and Project Management teams. Niggling close-out issues pertaining to Building Management Systems, Loop Checks, System Safety Checks, and Design Compliance Alignment can easily add several weeks onto construction/commissioning hand-over dates. A DPS Group construction team successfully applied Scrum to achieve MC on a HVAC AHU system, and this development has resulted in Scrum becoming a standard way of working to assist MC transitions from construction to commissioning teams. Figure 3, taken in early-2019, shows the Scrum board and the Team transitioning

the detailed actions of each task from left (backlog) to right across the board. Each task is hyper-cared to hand-off and completion with twice-daily huddles at 10:30 and 15:00 daily to ensure all obstacles are removed to allow the Agile Craft Teams operate at speed in closing out tasks. In parallel, the next trade in-line had greater visibility of when they could, to the nearest hour, commence the critical tasks to bring the system nearer completion.

Figure 3. Early-2019 Scrum Board to achieve MC on HVAC AHU

The team members in the huddle in Figure 3 are DPS Construction Manager (Scrum Master), Client Representative, Electrical Contractor Supervisor, DPS Electrical Supervisor, DPS Commissioning Manager, DPS Mechanical Supervisor, and DPS HVAC Designer. To assist final hand-over of mechanical and electrical systems, Scrum achieves the micro-planning and task-step detail that would not be available from the traditional LPS as used on the project. Focused one-week or two-week sprints keep the eye on the prize.

Case #2 – LPS Constraints

Much has been written advocating the benefits of LPS towards improving project outcomes. LPS is a series of interconnected functions and optimum results will only accrue from effective execution of each function. The constraints identification and resolution process are a key enabler of smooth and even workflow – a constraint is anything that will prevent a task from starting or finishing as scheduled, except prerequisite work identified on the phase schedule. The DPS Group LPS and project execution experience has highlighted the constraints management process as the single greatest contributor to effective LPS implementation.

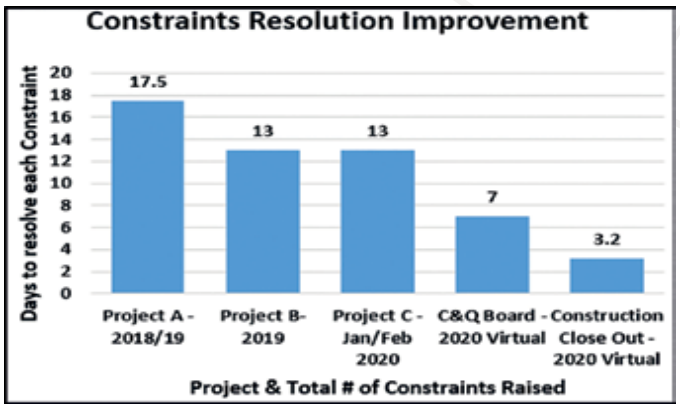

Figure 4. Construction Resolution Improvement

Traditionally, identified constraints would have been logged on an excel sheet and would be emailed to the person identified as best placed to resolve it. This process was slow and tedious as someone had to constantly chase individuals to address their assigned constraints, and there was much back and forth seeking clarity around both the ask and the response. In 2018/19 the average resolution time per constraint was 17.5 days. By applying Scrum and Kanban to the constraints process, this duration was reduced by mid-2020 to 3.2 days per constraint. Virtual platforms like Trello and Microsoft Planner greatly assisted this process, and Figure 4 illustrates the improvements generated.

The improvement presented in Figure 4 resulted from a dedicated implementation specifically focused on the constraints process. The steps were as follows:

i. Each Team member (DPS site supervision, design team support, Client representatives, Contractor supervisors) received training on the Scrum process and on setting up the Trello or Microsoft Planner platforms on their laptops, I-phones and/or I-pads.
ii Senior management commitment was received from each stakeholder's leadership relating to collaborative engagement with the proposed constraints process.
iii. Any identified constraint is logged on the backlog of the Trello Scrum board with a description of the issues and the ask. Photographs, drawings or sketches can be added to visualise the issue. The key person required to resolve the constraint must be identified. Others required to be informed or to support the process should be copied.
iv. At least once daily (sometimes twice), the Scrum board is reviewed by the Team to ensure the constraints resolution process is flowing and to prioritise focus on the highest value items.
v. When the process is working smoothly, constraints are often resolved before the huddle has taken place.
vi. The process requires an owner (Scrum Master) to confirm constraints noted as closed are indeed closed to the satisfaction of all parties, and to ensure any change introduced is recorded for financial, safety, and quality accountability.

An example of using a Trello Scrum board to transition construction to field close-out is presented in Figure 5.

Management of constraints through the Scrum framework has proven to positively supplement the LPS process on our construction projects.

Case #3 – Scrum in Design Scheduling

The design process often lacks effective planning and control to minimise the effects of complexity and uncertainty, to ensure that the information available to complete design tasks is sufficient, and to reduce inconsistencies within deliverables. While design work does not have the hard logic of construction work, it is still accomplished in a network of commitments made among specialists. That network can be designed and managed so that the work that should be done, can be done, and will be done. While some adaptations have been made, the Five LPS Planning Conversations remain the same except the Look-ahead Planning Conversation shifts to Design Cycle Planning. Also, instead of the traditional weekly work plan or commitments log, DPS Group utilise a Sprint Backlog to generate a two-week batch of design work. All design disciplines engage with

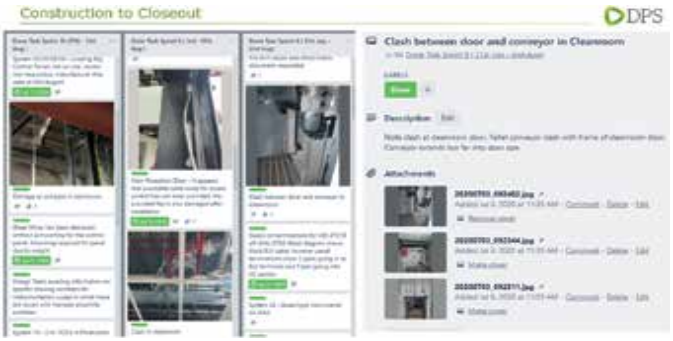

Figure 5. Construction to Close-out Trello Board

the six-week look-ahead interactive planning cycle conducted weekly. Handoffs and interactions are agreed and a two-week batch of work per discipline is agreed. Each discipline proceeds to run their own Scrum board to complete their own sprint. Figure 6 illustrates a two-week sprint for electrical design on a project.

The Trello board, as shown in Figure 6, starts off with a high-level six-week Product Backlog on the left-hand column. The Backlog tasks are broken into finer detailed deliverables in the To Do column by the team members who will execute the work. The tasks then move across the board from To Do to Doing to Done during the sprint

Figure 6. Two-week Design Sprint

duration. The recurring weekly six-week look-ahead session ensures the Backlog is always being topped up with new deliverables. A key aspect of the board is the Blockers/Risks column as this is where the team, through their Scrum Master, can reach to the Product Owner for assistance in rapidly removing constraints or impediments.

DPS Group has experienced tangible improvements in its delivery processes by adopting the concepts and principles of Scrum and Agile. While the impact of remote working has pushed virtual collaboration and accelerated innovative ways of communicating, the Scrum framework has enabled traditional methodologies to move faster and greatly reduced waiting and response time on projects.

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