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# The Participative Design of an Endoscopy Facility using Lean 3P

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## Abstract

In the UK, bowel cancer is the second largest cancer killer. Diagnosing people earlier can save lives but demand for endoscopies is increasing and this can put pressure on waiting times.

To address this challenge, an endoscopy unit in North East England decided to improve their facilities to increase capacity and create environments that improve the experience of users. This presented a significant opportunity for step change improvement but also a problem in terms of creating designs that meet user requirements whilst addressing structural or space constraints.

The Lean design process known as '3P' (standing for the production preparation process) was utilised as a participative design strategy to engage stakeholders in the design of the new department. This involved a time-out workshop (or 3P event) in which Lean and participative design tools were utilised to create an innovative design based on 'point of delivery' (POD) principles. The team created a design that demonstrated an increase in treatment room capacity by 25% and bed capacity by 70% whilst reducing travel distance for patients by 25.8% and staff by 27.1%. This was achieved with an increase in available space of only 13%.

The Lean 3P method provided a structured approach for corporate and clinical staff to work together with patient representatives as cross-functional teams. This participative approach facilitated communication and learning between stakeholders about care processes and personal preferences. Lean 3P therefore appears to be a promising approach to improving the healthcare facilities design process to meet user requirements.

## Problem

In the UK, bowel cancer is the second largest cancer killer. Of those diagnosed with bowel cancer, the five-year survival rate is a little over 50%. Diagnosing people earlier can save lives but this requires that diagnostic capacity is available.[1]

Demand for endoscopies is increasing.[1,2] Some units are struggling to keep pace and this can put pressure on waiting times.[3] Long waits are a common reason for units failing to maintain accreditation with JAG (the Joint Advisory Group on GI Endoscopy that maintains quality standards for endoscopy practice in the UK).[3,4]

To address these problems and meet future challenges, an Endoscopy unit in North East England decided to improve their facilities through new build or refurbishment. Such capital developments present an opportunity not only to increase capacity but also to improve processes of care delivery through creating environments that improve the experience of users. This presents a significant opportunity for step change improvement but also a problem in terms of creating designs that meet user requirements whilst addressing structural or space constraints.

Lean is an improvement philosophy derived from the practices of Japan's automotive industry.[5] Application of Lean thinking to improve healthcare processes is increasing and well documented in recent reviews.[6-10] There are reports of Lean being used as means of improving facilities design by early adopters in the USA[11-13] but there are no examples in the literature of such approaches being used in the UK NHS where the context is different.

## Background

Government strategy to improve outcomes of cancer care has had an impact on endoscopy departments. Where cancer is suspected, endoscopic investigations must be offered within two weeks of receipt of referral.[14] Furthermore, to improve outcomes in cancer treatment, a national bowel cancer screening programme has been developed. Launched in 2006, the programme initially entitled anyone between the ages of 60 and 69 to faecal occult blood (FOB) tests at intervals of every two years with patients testing positive for FOB invited for endoscopic investigation. In 2012/13 the programme extended its age limits to include those up to the age of 74.[15] In 2012 the screening programme also started to offer 'bowel scope' screening to those aged 55 to 64. Bowel scope screening involves a one off endoscopic investigation which has been shown to be a safe, practical and effective test when undertaken with the target population.[16] The introduction and expansion of national programmes to improve cancer care is predicted to increase demand for endoscopic procedures and there is a need to do things differently to respond to this increase.[3]

Despite cuts,[17,18] NHS capital budgets total circa £4 billion per year.[19] A significant proportion is spent on improvements to premises or development of new premises. Though extensive guidance is available to support estates projects (building notes,

health technical memoranda, and health facilities notes),[20] it does not incorporate information on how to design in Lean concepts and flow. This represents a significant gap. Capital developments are expensive and time consuming. Once complete, introducing design changes can be costly or even impossible. Time invested in participative design processes using Lean concepts and tools may produce better designs and create less wasteful processes.

Though there are case examples, mainly from North America (USA and Canada),[12,21-23] of using Lean techniques in facilities design there is little published empirical research detailing how to use such processes to help stakeholders design in Lean principles. This project set out to address this gap by adopting the Lean design process known as '3P' (production preparation process) to bring together estates and quality improvement staff with clinicians and service users (patients) to facilitate the design of an endoscopy facility refurbishment at a hospital trust in North East England.

The project took place at a small acute foundation trust employing over 3,300 staff with a turnover of £184 million per annum. The trust offers a range of general and acute services and is also a regional hub for cancer screening services including bowel screening. The trust serves its local community of around 200,000 residents in a mixed urban/rural area. The main driver for change was shifting patterns, and expected increases, in demand for endoscopy procedures. These shifts are attributed in part to population demographics (lifestyle choices and aging population) and to government policy on cancer (such as screening programmes and two week referral to diagnostic targets). The aim of the project was to produce a design for the endoscopy unit which:

- would be compliant with JAG guidelines;
- increased capacity in line with predicted future demand;
- facilitated flow and improved communication (with all involved in the service);
- met patient expectations, was patient friendly, and aesthetically pleasing.

## Baseline measurement

A scoping, planning, and information gathering phase was used to understand the situation in detail in the current endoscopy facility and to measure the 'as is' state before attempting to design a future state. Throughout this phase, a number of Lean tools were used and regular meetings were held in the department to keep key stakeholders involved in the process.

Historical data from the Trust's information system were used to create Pareto charts identifying the most common procedures. Data were then shared with the endoscopy team to gain their insights into the process steps for each procedure type. Procedures sharing similar process steps were grouped to reduce the number of unique routings. The process routings for the most common procedure types were: oesophago-gastro duodenoscopy (OGD) - a type of upper gastro investigation accounting for 43% of activity and; colonoscopy – a bowel investigation accounting for a further 36% of activity. These two procedure groups were then observed in detail in the endoscopy department and various flows were mapped.

The first and most important flow is the patient and their pathway through the department. This was first depicted as a value-stream map - essentially a form of process map that also carries additional information such as process cycle times and high level information flows.[13,24,25] To enable patient flow, there are other healthcare flows that must also be considered. These include the flows of: patients' families and carers; healthcare staff that provide treatment and care; materials (such as medications, consumable supplies, and equipment); and timely information to ensure flows work together in harmony.[13,26]

Healthcare flows for the most common procedures were depicted visually on scale drawings of the current endoscopy layout. In addition to the patient movement through the department, staff flows for the various components of the process were also mapped alongside the main equipment and supply flows (e.g. clean/dirty scopes, procedure room consumables, etc). Mapping the flows in this way allowed patient and staff travel distances per procedure to be calculated.

## Design

Using an action research approach, data were collected whilst delivering the design intervention to develop a case study.[27] Action research tends to be defined by its characteristics which include: a participatory group approach; collaboration between the researcher and researched to bring about positive change; simultaneous contribution to practical problems as well as scientific knowledge.[28,29] It is an approach that "actively involves participants and which has an explicit focus on promoting and facilitating change".[30] Though it has drawn criticism for its emergent nature, action research is considered appropriate for the development of new services and evaluation of untested interventions.[28] As the main focus of the project was to bring about positive change through testing an innovative intervention, action research was considered an appropriate fit.

The design intervention structure has been developed using Lean expertise gained from North East England's long association with Virginia Mason Medical Centre (VMMC). A Lean healthcare early adopter, VMMC has earned a reputation as a world leader in pursuing the perfect patient experience through continuous improvement.[26,31-33] VMMC use a combination of incremental change and step change approaches to drive continuous improvement.[34] Step change workshops, known as 'production preparation process' (or 3P) workshops, comprise a set of methods and tools used when traditional incremental improvement strategies are insufficient or when new space, products, or services are needed.[13,34] It is believed that VMMC are the first health organisation to use Lean 3P in healthcare facilities design and they have reported saving millions of dollars in capital expenditure by doing so.[13,34]

The Lean 3P method comprises a three step approach. The first step is scoping and planning and involves data collection and analysis using a variety of Lean tools. Typically, this begins with a study of current and predicted demand to understand volume and variety of activity. The area under study is then observed and care

pathways documented using spaghetti mapping tools to describe different flows (such as patients, families, staff, equipment, supplies, etc.) and show relationships between them. Processes with similar flows are grouped to reduce the number of unique routings and value-stream maps developed of the current state process. Data are shared with staff to diagnose opportunities for improvement in the future state design. The second step involves a time-out workshop in which clinicians, patients, and corporate staff create a future state design. This is not dissimilar to the “structured conference” described by Muller in which a range of participative design tools might be used.[35] Participative design tools common to 3P include visioning, idea generation, innovation, a variety of prototyping techniques, ‘design by doing’, mock-ups, organisational games, and iterative testing of concepts.[35-37] The 3P workshop however, also uses a number of Lean tools such as process and flow mapping, fishbone diagrams, workplace layout and organisation, and visual communication.[38] The third step of the 3P process is working towards the implementation of the new design. This project adopted the Lean 3P approach as a participative design intervention, the outcome of which was a concept design for a new endoscopy facility.

## Strategy

The intervention strategy utilised Lean 3P as a participative design process to engage stakeholders acting as cross-functional teams to design the new department. Teams used the opportunity to create more innovative, patient focused service models than the traditional model currently in use. An alternative to the traditional model of endoscopy had been thoroughly trialled following an earlier Lean improvement event – based on Point of Delivery (POD) treatment principles to maximise privacy and dignity for patients. To comply with JAG guidelines the continuation of the new system required significant change to the physical layout of facilities. The 3P approach gave staff the opportunity to design a new physical layout that could deliver a POD based system in a purpose built, JAG compliant facility. This involved a week long time-out workshop in which Lean and participative design tools were utilised through a number of design iterations. Each iteration represented a PDSA cycle in which participants created and tested design ideas for their new endoscopy department.

Cycle 1 involved multiple design concepts being produced using 2D block diagrams within an A4 sized template showing the boundary of the available space.

Cycle 2 used a larger scale drawing of the available space boundary which was used by staff to develop their three most promising designs. Further detail was added using to-scale cut outs of room sizes. Patient, staff, and equipment flows were tested using yarn with different colours used to denote each of the key flows.

Cycle 3 used 3D scale modelling to add further detail and develop each team’s most promising design.

Cycle 4 involved full scale mock-up of key features of the department. In addition to a full scale endoscopy suite, three variations of the admit/recovery PODs were created (one by each team). These mock-ups were used to simulate procedures and test room sizing as well as placement of key equipment and supplies.

Cycle 5 used what was learned from the previous cycle to inform a further iteration of design. In particular, the teams agreed on their preferred POD design and used the dimensions of this to refine their 3D scale model designs of the whole department.

Rapid cycle feedback was shared between teams at the end of each stage to highlight strengths and limitations of designs. Early cycle designs were evaluated by dot voting to narrow the most promising options. Later cycle designs were evaluated using nominal group scoring against previously agreed criteria which were weighted towards those that staff deemed most important.

## Results

Rapid cycle quantitative and qualitative assessments were made of designs at each cycle of iteration. Qualitative assessments were made via discussion between delegates. Quantitative assessments of patient and staff walking distances were made for the most common procedures using scale rulers to measure the flow routings in proposed designs.

For the final design, systematic layout planning (SLP) was used to verify patient and staff travel distances.[39] This compared the before and after pathways using CAD drawings for the existing and proposed layouts on a like for like basis. Patient travel distance was shown to have reduced by 25.8% per procedure and staff by 27.1% per procedure.[40,41]

Comparison of CAD drawings also allowed a like for like assessment of functional content and floor space in the before and after designs. This demonstrated that the new design increased treatment capacity by 25% with only a 13% increase in floor space.[40,41]

See supplementary file: ds6985.pdf - “Supplementary File”

## Lessons and limitations

The scoping and planning stage of the 3P approach proved important in a number of ways. Most importantly, it built awareness and momentum towards the design workshop. This was important to align stakeholders’ expectations and establish a clear aim. Holding the planning meetings in the department helped with this as it allowed the project to involve frontline staff more easily in the diagnostic process and relationships developed quickly. The planning was also important from a logistics point of view. The design workshop utilised prototyping techniques such as full scale mock-ups to test ideas rapidly and generate feedback. It was therefore necessary to source an appropriate venue (with sufficient space) and materials (that are easily workable without special construction skills). This stage of Lean 3P should not be underestimated.

The design workshop stage combined stakeholders into a number

of cross functional groups. This provided an opportunity for stakeholders to learn about each other's daily reality and appreciate their point of view. By focusing the groups on specific tasks relevant to the design problem they formed quickly in to functioning teams to explore the design problem and form solutions. Stakeholders used iterative 3D modelling to create and test prototype designs. Building models to scale allowed testing of the main flows with at least some degree of accuracy. Using full scale mock-ups of key design features, such as procedure rooms, helped staff to visualise space and assure themselves through simulation testing that room sizes were fit for purpose.

The case highlighted a number of constraints faced by the team. First of all, the most obvious constraint faced by the team was that of a new sterile processing facility – a functional constraint that could not be moved in the new facility design. Second, the overall space available to the department for expansion was limited and represented only a relatively small (13%) increase in footprint. Also, the available space was an unusual shape (see supplementary material) and this acted to constrain some potential design ideas. Third, following the workshop stage, the location of load bearing steels and walls represented a constraint to the architect in translating prototype designs into a workable plan. This proved achievable - though multiple options were produced to trade off between cost and adherence to the preferred design.

This paper presents preliminary results from postgraduate research reporting a single case of how Lean 3P has contributed to the design of an endoscopy unit. Single case reports have been criticised for lacking generalisability.[42] However, since completing this intervention, the Lean 3P approach has been applied to two further cases – one another endoscopy unit at a different trust and the other a maternity unit at the same trust as in this case. Taken together, the cases demonstrate the practical applicability of the Lean 3P approach to a greater range of contexts. However, there is scope for further work and more papers are planned.

## Conclusion

The Lean 3P method provided a structured approach for corporate and clinical staff to work together with patient representatives as cross-functional teams, participating in the design of a healthcare facility. The participative nature of the approach facilitated learning between these different stakeholders. Patients learned about the design process, staff learned about patient preferences, managers learned about the operational details of care delivery, and architects/estates staff learned about user requirements for the new department. All participants learned about Lean concepts and applied them in creating and testing prototype designs to facilitate the interaction of patient and staff flows in a care pathway. The project achieved its aims of creating a JAG compliant design that increased capacity and improved flows whilst taking account of patient preferences. Lean 3P therefore appears to be a promising approach to improving the healthcare facilities design process to meet user requirements.

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## Declaration of interests

Nothing to declare.

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## Ethical approval

The study was approved by the research ethics committee of the author's academic institution. The research proposal was also reviewed by the Chair of a NHS research ethics committee who confirmed in writing that NHS research ethics was not required for the study as it was considered to be service improvement.