Critical Assessment of the usability of a New Modular Ward

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ABSTRACT

An acute District General Trust commissioned a new modular building to house a surgical ward. The process of commissioning and design of the building was in accordance with standard trust practice and established building regulations for hospital buildings. The purpose of this project was to assess the ward layout in terms of safety and efficiency and offer mitigations for any problems found.

Observation of the ward layout demonstrated significant problems with sight lines in to bays, layout and design of toileting facilities, and layout and positioning of key ward areas including kitchen facilities, office space, drug and fluids stores, and nursing stations.

To further examine the ward layout, Hierarchical Task Analysis and link analysis were performed to review two tasks: one an emergency task (treatment of a deteriorating patient) and a routine common task (serving meals). We also considered the Systems Engineering Initiative in Patient Safety (SEIPS) framework to ensure that our analysis was as thorough as possible.

This work demonstrated significant problems with the ward layout, in terms of sight lines, workspace, communication, and contributed to significant extra time doing both emergency and routine duties. This led to a series of recommendations to mitigate on the ward, as well as a recommendation that appropriate staff involvement is included at appropriate times in planning future new build and refurbishment projects.

KEYWORDS

Environment, deterioration, link analysis, observation, hierarchical task analysis

Introduction

The Trust recently commissioned a new modular building to house a surgical ward, so surgical patients could vacate an established ward to allow more medical beds within the main ward block. Due to the constraints of the hospital estate, the site chosen was distant from the main ward block and built on the site of a car park. The process of commissioning and design of the building was in accordance with standard trust practice and established building regulations for hospital buildings (NHS England, 2014). However, it was not until the building works were well underway and major decisions regarding the layout were made that ward staff were tasked with completing the building commission, and so had no scope for contributing to the layout.

The ward was due to be occupied by surgical patients at the end of July 2022. The team therefore took the opportunity to investigate how the ward layout would impact on the patient and staff experience and to see if the ward footprint would have positive or negative impacts.

This project is pertinent not only for this ward, but also because the trust is in the process of planning major new buildings with a budget of £310m. The team felt it was vital that we learnt from the commissioning of this ward to provide guidance for subsequent new buildings.

Methods

A mixed-methods approach to the analysis of the modular ward was performed. A period of observation was undertaken on the ward to examine the physical layout of the ward to see how this would impact on routine and emergency care. The layout was considered with respect to how it would impact on safety, and also in the performance of common routine tasks. staff members who work there, including ward clerks, nurses, junior doctors, consultants and ward managers were observed and interviewed. In addition two common tasks on the ward were selected for further analysis, one being the management of a deteriorating patient (an emergency scenario), the other being serving meals (a routine scenario) using observation, Hierarchical Task Analysis (HTA) and Link Analysis. Recommendations were then made to improve the usability and safety of the ward, which were shared with the senior leadership team of the trust.

Results

Observations

The ward is a modular building with access via automatic doors with coded access, off a major atrium. The atrium acts as a major hub for the hospital and contains a reception and waiting area for outpatients, endoscopy patients, surgical patients, pre-assessment clinics, a shop and café. All patients moving to and from the ward will go through this atrium.

The ward is based on the spine of a long corridor with 6 4-bedded bays and 8 side rooms (32 beds). There are all the necessary services including offices, stores, a kitchen, clean and dirty utility areas and staff rest areas. This ward has a higher proportion of side rooms and toilets/bathrooms than the ward it replaces but has 4 fewer beds.

Figure 1 is a plan of the ward. There is a corridor 54 metres long and 3 metres wide with 2 sets of fire doors along its length. There are 3 nurses' stations, none of which have line of site views of bays or side rooms. There are no areas within bays for nursing work. There are offices halfway along the corridor, and the doctors' office and kitchen are next to the ward entrance. The fluids, clean store and medicines store are off a spur corridor, through a set of double doors, and are approximately 35 metres from the furthest bed space.

The ward is currently used as a temporary intensive care unit but will house complex inpatient surgical patients with gastrointestinal, vascular or urological problems, and are typically elderly with significant dependency and comorbidities. They will be a mix of elective and emergency patients.

The ward is close to the operating department and day surgery ward, but a significant distance from the emergency surgical admission unit, X ray department, ITU and other surgical wards.

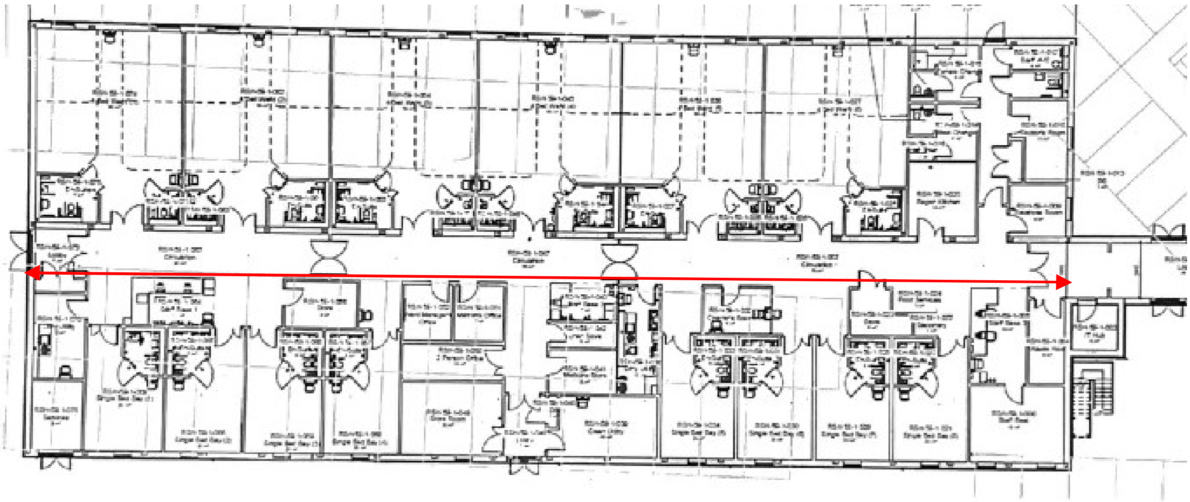


Figure 1. Ward layout. The red arrow demonstrates 55 metre length corridor

The position and layout of the washing and toileting facilities are of concern. As the toilet and shower flank the entrance to the bays or at the entrance to the single rooms, they significantly impede line of site into the bay. During the observations sight lines were assessed by having a staff member lie down on the floor next to a bed space with the doors to the bay and side room open respectively; this demonstrated that the sight lines were such that the staff member could not be seen. (figure 2). This is further exacerbated by the design of the doors which have small narrow windows (figure 3).

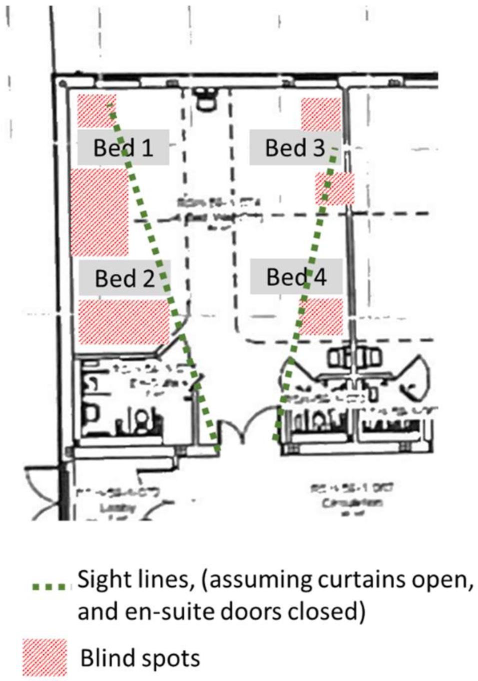
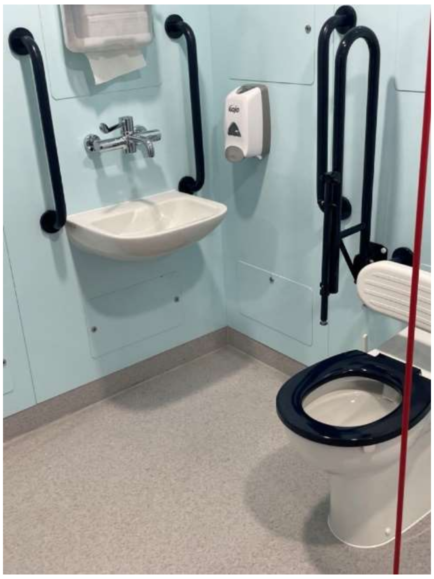


Figure 2: Sight lines and blind spots in bays

Figure 3: Door design for entrance to bays

The shower room layout is poorly designed (figure 4). The transfer bars are positioned such that even for an able-bodied person, reaching for toilet paper would be difficult and mean twisting on the toilet seat significantly, increasing the risk of falls.



Figures 4 and 5: toilet layout

The position of the toilet that access to the sink is difficult, particularly if the patient is being wheeled to the sink on a chair for a wash. It is very difficult to easily manoeuvre a chair to the toilet so that a comfortable position could be attained for washing (figure 5).

Hierarchical Task Analysis and Link Analysis.

Two tasks were considered that are common on a general surgery ward, one emergency situation and the other a commonly performed routine task: firstly the recognition and management of a deteriorating patient, and secondly the serving of food at mealtimes. These were chosen to demonstrate how the ward design impacted on both emergency and routine tasks, and in turn how that would influence safety and the work that staff have to do and the time taken in performing such tasks.

HTA was performed to understand the steps in the process, broken down to individual steps as would be performed by the staff doing the work. Link analysis was then performed to demonstrate in pictorial terms what the task entails in terms of the physical environment.

For the deterioration scenario the bed space furthest from the ward entrance was selected. It became clear that the position of the various offices, clean stores and medicine stores would mean that staff attending a sick patient would be taken from that patient for significant periods of time while fetching equipment, help and drugs to treat the patient. Using the HTA (Table 1) as a guide a link diagram was constructed to demonstrate the routes that a nurse would have to take to perform the tasks associated with recognition and treatment of a deteriorating patient (Figure 6). In turn, the link analysis shows that the positions of stores, offices and bed spaces are not ideal for rapid response to a sick patient. The approximate walking distance that a nurse would cover in order to complete the tasks was calculated and found it to be approximately 600m. The average walking speed is 1.4m/s so this means that a nurse would spend 428 seconds (7.15 minutes) walking, before any time is spent locating and carrying items.

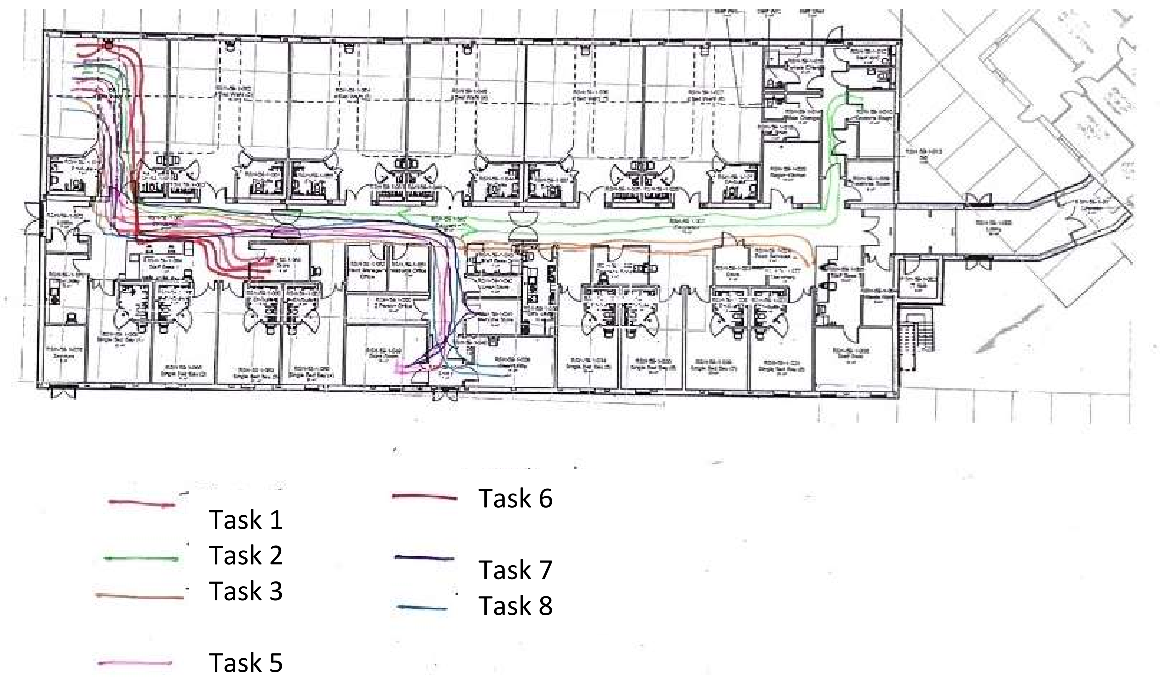


Figure 6: Link analysis of the deteriorating patient.

Table1: Excerpt of Hierarchical Task Analysis for the management of the deteriorating patient (nursing tasks)

1. Assess patient's vital signs 1.1. Fetch vital signs assessment kit 1.1.1. Find dynamap 1.1.2. Find thermometer 1.1.3. Ensure dynamap and thermometer are charged 1.1.4. Ensure Right size BP cuff is available 1.2. Do observations 1.2.1. Take temperature. 1.2.2. Apply BP cuff. 1.2.3. Activate dynamap. 1.2.4. Connect oxygen saturation monitor. 1.3. Record observations 1.3.1. Open application on handheld device 1.3.2. Record temperature, BP, pulse and oxygen saturations. 1.4. Calculate NEWS Score 1.4.1. Add additional information for NEWS score 1.4.2. Read instructions for NEWS score. 2. Escalate to Dr 2.1. Find Dr 2.1.1. Go to office 2.1.2. Page doctor if needed. 2.2. SBAR patient 2.3. Go to patient bedside with Dr 3. Doctor assesses patient. 3.1. Assist with examination 3.1.1. Move patient as needed for examination. 3.1.2. Find help for examination. 4. Plan for resuscitation 4.1. Dr to Prescribe oxygen 4.1.1. Find drug chart 4.1.2. Doctor to complete prescription for oxygen 4.2. Dr to prescribe fluids 4.2.1. Turn fluid pump on 4.2.2. Set rate 4.2.3. Start pump	5. Give oxygen 5.1. Locate mask 5.1.1. Go to clean stores 5.1.2. Find appropriate mask 5.1.3. Return to bedside with mask. 5.2. Attach to oxygen outlet 5.3. Apply mask to patient 5.4. Turn oxygen on 6. Administer Drugs 6.1.1. 6.1.2. Check prescription 6.1.3. Go to medicines store 6.1.4. Find prescribed medicines. 6.1.5. Find colleague to check drugs. 6.1.6. Locate giving set 6.2. Check prescription 6.2.1. Check drug chart 6.3. Give medicines 6.3.1. Open packet for medicine 6.3.2. Open packet for giving set 6.3.3. Attach giving set to medicine 6.3.4. Attach to fluid pump 6.3.5. Turn fluid pump on 6.3.6. Set rate 7. Take bloods. 7.1.1. Withdraw blood from venflon. 7.1.2. Cap off venflon 7.1.3. Add blood to blood tubes 7.1.4. Check patient wrist band 7.1.5. Label blood tubes 7.1.6. Put tubes in bag 8. Print blood form 8.1. Dr to go to nursing station 8.2. Log on to computer 8.3. Open requesting programme 8.4. Log in to requesting programme 8.5. Find patient details 8.6. Fill in online form 8.7. Print form 8.7.1. Turn on printer 8.7.2. Check printer for correct paper 8.7.3. Print document 8.8. Put form in bag with blood tubes 8.8.1. Locate bag 8.8.2. Put bottles in bag

For food serving, the link analysis shows that there is a significant amount of time taken in walking the food to and from patients (figure 7). The kitchen receives cooked and chilled food which is rewarmed in the ward kitchen before service. The kitchen is at the entrance to the ward, so staff must walk along the main corridor to serve food to patients. The link analysis shows that there will be significant activity in the corridor, particularly in the area nearest the kitchen and the first bays and rooms. As this task is undertaken by more than one staff member at mealtimes, this area will become congested and will impede other ward activities.

If a single staff member serves each bay and 2 side rooms then the staff member in the furthest bay will walk approximately 700m in completing the task of serving food, and another 700m clearing trays. The walking time alone is 500 seconds. Assuming it takes 1 minute to collect each meal (the staff queue to collect meals at the serving station), the time taken to serve 6 patients is 860 seconds (14.3 minutes) or one meal every 2.4 minutes. With similar clearing up time, each staff member will spend 28.6 minutes each mealtime walking and collecting trays. As meals are served 3 times a day this means each staff member will spend 85.8 minutes on meal duties.

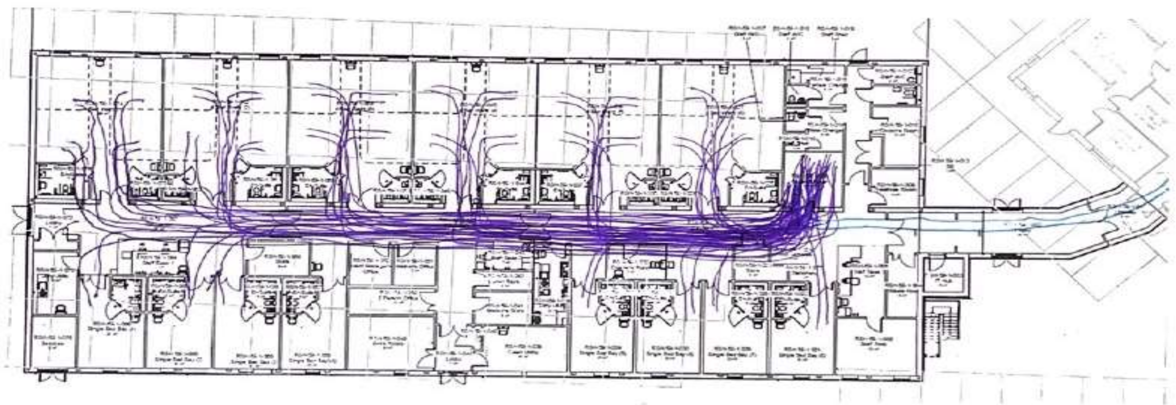


Figure 7: Link Analysis of mealtime serving.

Proposed improvements

- Merge the 3 offices in the middle of the ward in to one large MDT space with windows to the corridor to ensure good visibility. This space would be used for doctors, nurses and allied professionals and would be the ideal place for handover.
- a second kitchen bay towards the end of the ward. Mealtimes would then be served from both ends of the ward which would reduce walking time and be more efficient.
- The drug cupboard should be moved on to the central corridor to reduce the amount of time taken to access medication.
- use of mirrors or CCTV in the bays and side rooms to ensure good visibility. This would have to be balanced against the need for privacy and dignity, and also recognise that staff would have to watch the monitors, which would have an impact on staffing levels.

Discussion

The modular ward was designed by architects according to current regulations for hospital buildings (NHS England, 2014), although these are 8 years old and do not account for changes in working practices. They also don’t take in to account future changes as hospitals move to more IT dependent ways of working.

It is clear from the observations, HTA and link analysis that the design of the ward, and in particular the length of the main corridor and the position of services means that staff will be spending more time walking than on the previous ward. This will have a detrimental effect on their working lives and job satisfaction and lead to greater fatigue.

Two of the major challenges facing hospitals with an ageing and more dependent patient population are falls and the recognition and treatment of deteriorating patients. From observations it seems that the ward design will make falls more likely (for example in the bathrooms) and less likely to detect due to poor sightlines. From the perspective of deterioration, as staff will be spending more time on other tasks due to the ward layout meaning more walking, together with poor sight lines, it is likely to make the detection and timely treatment of deterioration more challenging.

Human-centred design is a method of engaging with and involving users of a system or environment in order to ensure that the results promote good working practices, ensure that there is user satisfaction, and in this setting that the environment promotes a safe and effective place to deliver healthcare. This approach has been shown to be effective in designing hospital environments (Hammouni & Poldma, 2021) and equipment (Wiggerman, Rempel, Zerhusen, Pelo, & Mann, 2019). As this trust is undergoing further building works, we need to engage with this process to ensure that further buildings are designed with ergonomic principles in mind.

For this study we used several relatively simple to use tools to help analyse how work would be done on the ward. These tools were chosen as they are commonly used, descriptive and easy to understand. We also considered the work being done using Systems Engineering Initiative in Patient Safety (SEIPS) tool to guide our analysis in terms of the domains described including people, tools and technology, internal environment, tasks and external environment. By using this tool we were able to ensure that our HTA and link analysis reflected work as done as accurately as possible.

Observation is an essential part of HF analysis. It allows the practitioner to gain information on physical environment and how it interacts with the user, task sequencing, frequency and time spent, errors made, use of technology and tools, communication, and organisational environment (for example operating procedures, protocols etc) (Drury, 1990). There are a variety of methods for observation including site visits, walk-throughs and interviews with those performing the task. Observation has been demonstrated as a valuable tool in healthcare settings (Carthey, 2003). Direct observation helps to remove the gap between work as imagined and work as done.

Hierarchical Task Analysis (HTA) is one of the most commonly used HF tools for the analysis of tasks and describes activity in terms of a hierarchy of goals, sub-goals, operations and plans (Stanton N. A., 2013). It was developed for industries such as chemical processing and power generation (Annett, 2004) but its flexibility and ease of use has made it a popular technique in healthcare settings, including in tasks such as handovers (Raduma Tomas MA, 2012) and medicines administration (Lane R, 2006). Its use comes in the initial stages of a HF analysis and has been used in a wide range of applications including interface design, training, allocation of function, work organisation, workload assessment and many more. The HTA has an overall goal for the task (for example serving meals to patients), and is then broken down in to individual steps and sub-steps with the last one being an operation. This information is informed by observational work, interviews to understand the work as done, walk-throughs and analysis of plans. Mills argues that HTA is best alongside other techniques (Mills, 2007); in this study the HTA informs the next step of the HF analysis, which is link analysis. One of the advantages of HTA is that it requires little training, gives a good understanding of a task, and is easy to understand. However, it is descriptive in nature, doesn't allow for cognitive steps in a process, and can be time consuming for complex tasks. (Stanton N. A., 2013).

Link analysis is a tool for demonstrating relationships within a system or task. It can be used to demonstrate the nature, frequency and importance of links in a task. It is a simple tool that is useful for design of interfaces and systems and in particular the optimisation of work layout. Link analysis requires observation, HTA or both in order to understand the task before the links can be demonstrated (Stanton & Young, 1999). It is easy to use, quick, and demonstrates results in a pictorial manner which is easy to understand. It therefore greatly aids workplace design change. However, it only demonstrates physical relationships and not cognitive processes, and its output is not quantifiable (Stanton N. A., 2013). It has been demonstrated as a useful tool in understanding and improving layout in healthcare settings, for example in ambulance design (Ferreira & Hignett, 2005).

There has been a significant emphasis recently on systems thinking in healthcare, and this is outlined in the NHS National Patient Safety Strategy, which advocates the Systems Engineering Initiative in Patient Safety (SEIPS) tool. First proposed by Carayan in 2006 (Carayon, et al., 2006) and then further developed in 2013 (SEIPS 2.0) (Holden, et al., 2013) and 2020 (Carayon, et al., 2020),clearly demonstrates the importance of systems thinking. Indeed, Carayon states that "Most errors and inefficiencies in patient care arise not from the solitary actions of individuals but from conflicting, incomplete, or suboptimal systems of which they are a part and with which they interact". SEIPS clearly puts the person in the centre and demonstrates the importance of interlinking between tasks, internal environment, tools and technology, people, and the external environment (such as wider healthcare, government policy etc). SEIPS shows that there is a significant interdependence between the domains, and that any domain can significantly impact another one, as well as the process (of caring for the patient in this instance). It also demonstrates the impact that tasks, technology, environment and organisation can have on outcomes. Importantly it states that the outcomes should be measured in terms of both patient outcomes, and outcomes relevant to the organisation and individuals working within it. SEIPS describes how the interactions can affect quality of working life and how the outcomes feed-back in to the system and inform it.

In this study we can see how interaction of technology and the physical environment impact on routine and emergency work on this ward. It highlights the interdependence of the domains in SEIPS as well as emphasising the importance of systems thinking when designing environments. Further, it demonstrates that the use of straightforward tools such as observation, HTA and link analysis, when used at an appropriate point in the design process, could eliminate problems in the design which then lead to inefficiency or unsafe environments. It also highlights the need for involvement by service users and staff early in the design process to ensure that the finished space is fit for purpose, is safe, and promotes good working practice and good job satisfaction through good design. This is particularly pertinent given the ongoing building programme at the trust.

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