# Astins

## Astins Plasterboard Waste - Sustainable Improvement

**By**

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## 1. Executive Summary

Over the last 5 years Astins (astins.com, 2016) has been on a continuous improvement journey to reduce plasterboard waste. In this time, Astins have reduced this waste by 40%.

Early on in the process of waste reduction, Astins was more focused on site base processes, in particular, the reuse of off-cuts. However as we concentrated on waste generation, it was found that issues from the supply chain, and from the external client, have a significant impact on the production of plasterboard waste.

Further significant reductions in plasterboard waste will come from a greater collaboration with Astins supply chain.

## 2. Introduction

One of Astins core values is continuous improvement, and it is by living this value that plasterboard waste has been reduced in a structured way, enabling the benefits to become embedded.

This paper introduces the journey into the investigation of plasterboard waste within Astins. It concentrates on the practical application of the theories raised during the investigation.

The Lean Construction Institute "eight waste" (leanconstruction.org, 2016) model will be used to discuss the cause of plasterboard waste and the practical steps Astins have taken to reduce this.

Interestingly, this study has also prompted safety improvements that will be discussed briefly.

This paper has considered only three of Astins more recent projects; many other projects have contributed their knowledge and lessons learned during this process.

## 3. Literature Review and Waste Management Development

The landfilling of gypsum and other high sulphate bearing wastes has been prohibited in England and Wales since July 2005. Since April 2009, waste containing gypsum can no longer be mixed with biodegradable waste at a standard landfill site. Gypsum is the main raw material for plasterboard, so this prohibition applies to all plasterboard waste. (Gov.UK, 2016)

To understand where plasterboard waste comes from, a root cause analysis (Fishbone) has been used (see fig 1). We will discuss these root causes and corresponding actions based on the "eight waste" model.

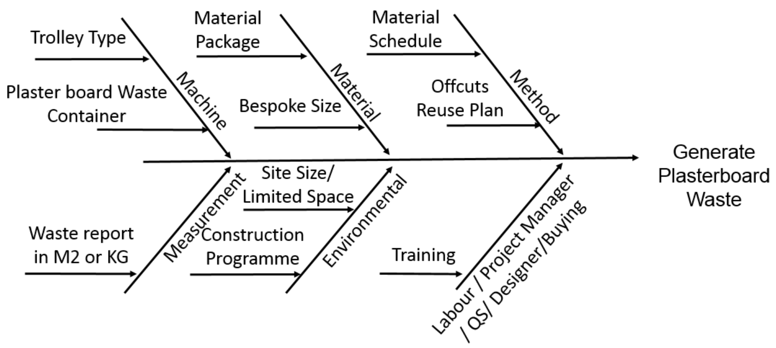


Fig 1

The Lean Construction Institute have adopted the "eight waste" (originally based on Toyota's model 'The Seven Wastes' (gcu.ac.uk, 2016)):

- Transport –moving people, products and information ;
- Inventory – storing parts, pieces, documentation ahead of requirements;
- Motion – bending, turning, reaching, lifting;
- Waiting – for parts, information, instructions, equipment;

- Over Production – making more than is immediately required;
- Over Processing – tighter tolerances or higher grade materials than are necessary;
- Defects – rework, scrap, incorrect documentation;
- Skills – Underutilizing capabilities, delegating tasks with inadequate training. (isixsigma.com, 2016).

This model is useful in helping to organise the teams thinking about what constitutes 'waste' from a Lean perspective, and therefore helpful in developing processes to eliminate the impact of the waste.

Astins commenced a significant project on the reuse of "off cuts" on Pembury Hospital project in 2010. In summary, selected dry lining operatives were tasked with constructing a given area and were presented with new sheets of plasterboard for each installation. The same team then constructed an identical area where they carefully planned the reuse of plasterboard 'off-cuts'; this resulted in a 50% reduction in waste. Although this improvement could be described as significant, this would be akin to working in laboratory conditions and therefore not necessarily achievable in the real world. But this experiment did demonstrate an opportunity to significantly reduce plasterboard waste.

More recently in our New Southern General Hospital (NSGH), Glasgow (2011-2014) and – Karolinska Hospital (KH) – Stockholm (2012-2016) project Astins has a continuous improvement programme in place to review plasterboard waste at different stages of the process. The "eight waste" model will be used here to discuss the actions and findings from the improvement programmes.

**Transport**

Plasterboard arrived by lorry to site and the plasterboard was off loaded using fork lifts. It was found that those board packs coming with simple wooden struts that support the pack and it would get damaged (bottom 2-3 pieces of the plasterboard pack) by the fork lift, while another type of pack with a strong parallel wooden pallet and wrapped by polythene will not have this problem.

The material is then transported to the required location; access is achieved to the higher levels either by hoist or crane for final transportation to the place of work by pump up/electric truck.

On both projects, the business elected to use both the Stark Arvid electric truck and a manual version. (See fig 2)

Fig 2

The use of the trucks proved popular with the labourers who have the responsibility of transporting material around the site. These trucks are used with a trestle system (which will be discussed below in "Waiting ") which stacks boards off the ground. The electric trucks were more popular than the manual ones, as they are more labour saving and easier to operate. For residential projects, where the working space is limited, extra attention will need to be paid when using trucks to transfer boards, as the corner of the board may easily break when the truck turns around in a limited space or corridor. Smaller size of boards may alleviate this situation especially in residential project.

Findings: High quality packaging would potentially protect the boards from being damaged by heavy machinery; advanced transfer tools can reduce the damage of the board during transfer.

**Inventory (Green room)**

The "Green Room" approach is a technique that is well known in the industry. Effectively an area/room is set aside to enable off-cuts to be stored to reuse at a later stage. Labourers collect off-cuts and transport them to the Green Room. However, the reality of the Green Room is that it results in the generation of other waste in the effort to reduce plasterboard waste e.g. transportation of the off-cuts to and from (waste walking); it also generates a hidden inventory of materials that invariably do not get used to anywhere near their potential. In addition, it may give the site team a false sense of achievement in the belief that they are reducing the volume of plasterboard waste.

At NSGH, a review of the plasterboard waste highlighted concerns around the Green Room not being able to realise its potential. In essence, the Green Room was 'out of sight, out of mind'. An operative had no incentive to take the time to walk to the Green Room, particularly when there was virgin material to hand.

We concluded that if the operative wouldn't come to the mountain, bring the mountain to the operative. This lead to the creation of the "Mobile Green Room"; in essence, a metal wheeled trolley with the capacity to transport plasterboard off-cuts around the site.

The "Mobile Green Room" concept had some limited success, however the temptation to take new materials rather than off-cuts was high; in addition, identifying who 'owned' the Mobile Green Room proved problematic, resulting in the Mobile Green Room not moving across the floor plate with the workflow.

The lessons taken from NSGH highlighted the need to create 'ownership' of the Mobile Green Room. The Project Leader at KH decided to 'design and build' Astins Karolinska Mobile Green Room (see fig 3). To create ownership, the Mobile Green Room was assigned to operatives working only on fire stopping so that they would collect and segregate the material they required for their work from the plasterboard and insulation off-cuts.

The site team observed that if a Mobile Green Room was near to hand, the operatives tended to take an off-cut to reuse. The Project Leader, having some insight to 'Nudge Theory' (Thomas C. Leonard, 2008) arranged for some of the Mobile Green Rooms to be co-located with the plasterboard that was stored on trestles and still wrapped; if an operative required a smaller size piece of plasterboard they would take it from the mobile green room as opposed to unwrapping the polythene and taking a full sized new board, which was previously more likely to happen.

Fig 3

Finding: Creating the ownership and improving the flexibility of Green Rooms increases the effectiveness for the off-cuts to be used, hence reducing the plasterboard waste.

**Motion**

Off-cuts are well known as "waste", created by cutting off the boards to the required slab height to fit on the wall. Therefore the board size is a key variable. The NSGH design required bespoke board sizes, the slab height was 4.2m. The standard sizes which are manufactured by the main supplier for plasterboard (Tapered Edge) are:

| Dimension | Weight |
| --- | --- |
| 3000 x 1200 X 12.5 mm | 32 kg |
| 2400 x 1200 X 12.5 mm | 23.9kg |

Table 1

The 2400mm board then can be cut into half (1200mm) and assembling with the 3000mm board which allows for the 4.2m height to be achieved, which still enables the design requirement that the joints between boards for the inner and outer layers are off set from each other.

Application of legislation differs between Sweden and the UK; for the KH project the dimension of the boards were smaller: (900mm wide compared to 1200mm wide)

| Dimension | Weight |
|---|---|
| 1500 x 900 X 12.5 mm | 10.9kg |
| 1700 x 900 X 12.5 mm | 12.4kg |
| 2800 x 900 X12.5 mm | 20.4kg |

Table 2

Comparing Table 1 and Table 2, the boards used at KH are significantly smaller and lighter than at NSGH.

NSGH had an average of 60 boards per a pallet and KH only had an average of 48 boards per pallet.

Evidence from both sites suggested that there was a lower breakage rate of boards of the narrower type during movement: it was often found that the bottom two boards broke on the 1200mm wide pack but this was not to be the case for the narrower boards. This may be due to a greater rigidity or to overall weight being less for the smaller board sizes.

We mentioned at the beginning that health & safety benefits were also found from this study on waste: experienced UK operatives deployed in Sweden were interviewed about the differing board sizes. They initially expressed concern that they would not reach the required productivity levels; however they were pleasantly surprised as they found that as the boards are lighter, they were less fatigued as the day went on, and could continue to install the boards at a steady pace all day.

In December 2015, Astins completed an investigation with healthy and safety specialist on a "comparison study of the physical demands placed upon dry liners when handling 1200mm wide plasterboard versus 900mm plasterboard". The results show that "when 900mm boards were used, shoulder elevations decreased by up to 41% and muscle activity decreased by up to 90% for the dominant arm"; "Lifting a 900mm board decreased lumbar flexion by an average of 11%." (Astins Limited, 2016a). Lifting boards from a trestle will benefit both shoulder and back as the operatives have to be less physical which reduces the possible impact of repetitive stress injuries. The results are very significant which would provide a validated reference to the supply chain in considering producing smaller size boards for the UK market.

<u>Finding:</u> Narrower and lighter boards appear to give packs greater rigidity that results in less material breakage. Smaller boards would have a positive benefit for the operatives' healthy and safety.

**Waiting (for use – storage)**

Traditional storage of boards at a low level may cause breakages as discussed above; in addition breakage/attrition may occur, as a fresh pack of plasterboard stored on the ground makes for a ready-made workbench with the inherent risk of damage to the top board or two; in addition, wet floors can damage the bottom boards. Manual handling challenges as the plasterboards reduce in number also create a hazard for the operatives due to increased bending to lift the boards.

At KH the boards were loaded on to trestles at a height of 600mm above the ground. This resulted in the lower boards in a pack being less damaged and fit for purposes when exposed ready for use.

Another small, but tangible change in the storing of the plasterboard, was the rigorous enforcement of the manufacture's guidelines, to keep the boards wrapped in the polythene until required for use. The guidance given by the manufactures advise this will protect the boards from physical damage and potential moistures ingress. Interestingly, it became apparent to the site team, that as the new plasterboard was wrapped it was harder to get at than unwrapped material. The trick is to 'nudge' operatives to take something more easily available; off-cuts. (see fig 4)

NSGH KH

Fig 4

An interesting side effect of the trestles was that the labourers would take a little more time thinking about where to store the plasterboard as the trestles had to be laid out prior to the trolley being off-loaded. Anecdotal evidence indicates that boards stored in this fashion would be stored in a safer situation in so far as being away from a site traffic route.

Finding: Sufficient storage space and trestles to store boards at 600mm which allows 'improved' storage that has significant benefits in reducing waste and improves H&S.

**Over production**

Plasterboard waste generated from "Over Production" is strongly influenced by client requirements.

A key factor in this is design. For example, one recent project had a slab height of 2.5m; it proved uneconomic to purchase bespoke boards, which resulted in 8% waste being 'built-in' before the project even started. Designs with many board types in a small area (e.g. residential developments in a city setting) contribute to a high wastage figure, as the opportunity for re-using boards is limited. These types of development also have many door openings that will impact upon waste. Late design and design changes can also have a significant impact on waste.

Review of a range of projects indicates that those projects with a higher than average waste figure have had design issues which consequently contribute significantly towards plasterboard waste.

Finding: Design has a significant impact upon waste and is clearly an area where significant benefits are possible; early engagement with the main contractor will facilitate this.

**Over Processing**

As mentioned above manufacturers can have a significant influence on waste.

It is often uneconomic to purchase bespoke material so it is often more cost effective for projects to purchase significantly over-sized boards and discard the off-cuts than to buy boards to size. Occasionally, the lead time for manufacturing bespoke materials can also make them unrealistic for the day-to-day requirements of construction.

In an ideal world, the number of board types could be reduced that would lead to easier use of off-cuts and better transportation & storage of materials.

Finding: Manufacturers should be further engaged to minimise waste arising on site.

**Defects**

Defects have a big impact on quality. Astins introduced an internal QA process called the 85 Point Plan to monitor the quality of work on site. This is in addition to the QA checks carried out according to the Inspection and Test Plan process. The result from the 85 Point Plan – “defects” were analysed and reported to Astins’ monthly QHEST (Quality Healthy Environmental Safety Together) meeting. The average unit length per defect has been analysed to indicate the frequency of the defects appearance. The larger the length per defects indicate the better in quality. The graph below (see fig 5) demonstrates that in 2016 the average unit length per defects are higher than in 2015 which indicate less defects have been identified in each 85 PT plan compared with the results in 2015. (Astins Limited, 2016b)

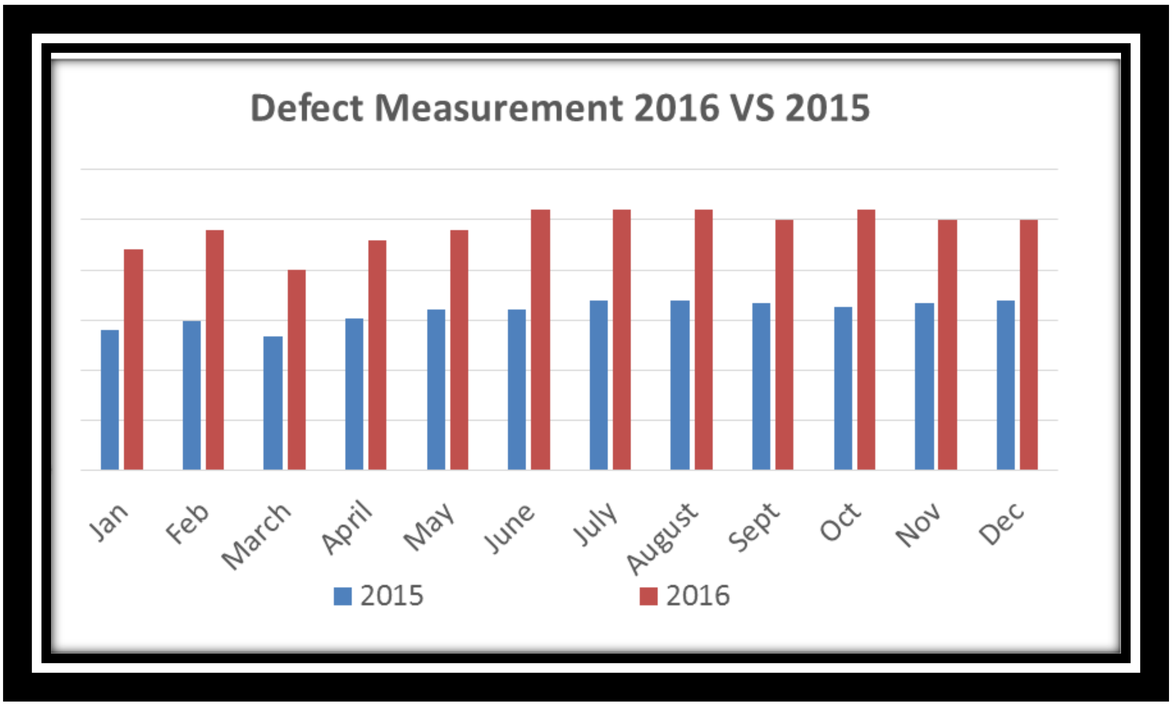


Fig 5

In the KH project an independent quality inspection system was introduced. Defects are recorded in a similar fashion to the 85 Point, hence it is to complement with the 85 Point Plan to monitor the quality of the work. The graph below (see fig 6) clearly indicates a higher figure from the measurement at the KH project compared with another earlier project; this suggests that less defects correlate with a lower waste percentage (Astins Limited, 2016c)

Typically, plasterboard waste data is collected from the weight of the plasterboard in the waste skip. This method is not entirely reliable as others with similar materials may dispose of their waste in the same skip. In addition, rainfall can add considerable weight sometimes more than 20% to the total weight of the waste.

It became clear that if Astins are to continuously reduce the generation of plasterboard waste, the methodology of recording waste must improve.

To remove the variability of measuring waste through the system used at NSGH Astins have transitioned to a 'formulaic method'. The formula is:

*Plasterboard Installed M²/Plasterboard Purchased M² = Plasterboard Waste %*

Allowances are made for materials that are a work in progress.

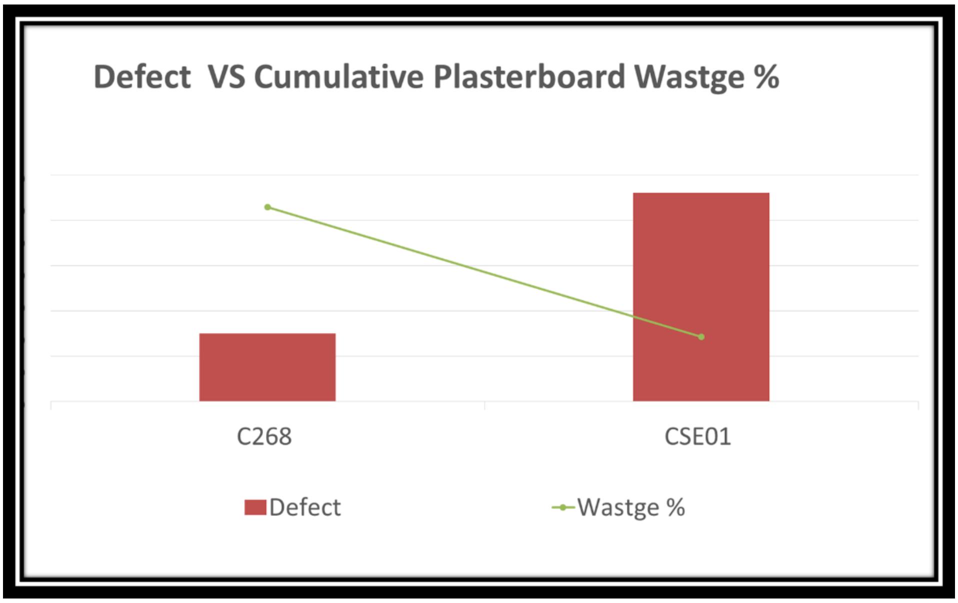


Fig 6

More recently in 2016, an improved internal QA system has been implemented across all sites. It works in conjunction with the 85 Point Plan and independent inspection to ensure that Supervisors are inspecting the operatives to work to the correct and required standard. Results are analysed and feedback given to the monthly QHEST meeting for further discussion and lessons learned.

Finding: The higher value of the average unit length per defect indicate a lower frequency of defects hence the less plasterboard waste is generated. A good quality control management system is effective in reducing and indeed preventing the defects that lead to plasterboard waste.

**Skills**

Having the right person to do the right work and improving the operatives' skills will reduce defects and thus plasterboard waste.

We have found that training labourers in plasterboard waste has a significant impact on the overall waste and indeed the culture of the business – they are the ones that ensure fixers have the right boards in the right place, that the boards are stored correctly and off-cuts are easily available.

Astins runs a Training Institute where we support dry lining operatives to NVQ level 2. The Institute also trains and develops apprentices and supports the apprentices on site. The trainers support projects with site inductions and if required, carry out skills assessments of new (to Astins) operatives. In NSGH, Astins trainers helped the operatives to successfully qualify to SVQ (Scottish Vocational Qualification) level 2.

Astins also have a 2 years training programme for the site operatives. The fixers have the opportunity to learn the practical skills and also the conceptual and theoretical knowledge; the programme is run both in our Institute and on site. This helps fixers build up their knowledge in a structured way.

Skill is also considered at the management and supervisory level – Astins run seven in-house modules that include waste, environmental and sustainability management. The company also provide the personal development plan (PDP) for each employee.

A good example is the project leader at KH who requested and was trained in the 5S methodology: 5S stands for sort, set, shine, standardize, sustain. It is a housekeeping technique for enhancing productivity, quality and safety in the workplace (intracen.org, 2016); the successes from this was shared across the company.

Finding: Improving skills and understanding at all levels of the business contribute to lessening the waste overall.

## 4. Conclusion

The Eight Wastes model from Lean is a useful tool to analyse plasterboard waste generation and it can be seen that all elements contribute towards the waste. A significant effect of this model is that it can help to raise the visibility of the influencing factor the impacts external suppliers. This creates an opportunity to engage the supply chain to support the overall reduction in waste.

Astins have reduced waste by 40% over the period of this study. Despite the success so far, there is still variability between sites – the design has significant impact (both positive and negative) upon waste. Consideration at the ‘input’ stage (design) has significantly more influence than at the ‘output’ stage (re-use of off-cuts).

Further significant reductions in plasterboard waste will come from a greater collaboration with the Astins supply chain.

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