Pell Frischmann

C|5 corefive

17th August 2017

# **London Stadium Relocatable Seating Support System** – Report on Feasibility

CONFIDENTIAL

Pell Frischmann

Index



Prepared for:

**London Borough of Newham**

100 Dockside Road, Silvertown

London

E16 2QU

Prepared by:

**Pell Frischmann**

5 Manchester Square

London

W1U 3PD

Revision History

Report Ref: 13303-PF-ZZ-XX-RP-S-0004

| *Revision* | *Date* | *Purpose* | *Originator* | *Approved* |
|---|---|---|---|---|
| A | 17th August, 2017 | First Issue | s.40 | s.40 |
| | | | | |
| | | | | |



This work covers the work undertaken during the Feasibility Study of the project to RIBA Stage 1. A description of the main elements of the structure is given alongside the design criteria and parameters to which the detailed design of the project will be completed.

It should be noted this is a concept design and subject to refinement and amendment during the following stages of design.

Information has been provided to allow the Cost Consultant to develop the preliminary project cost plan. This information is preliminary and subject to refinement and amendment during the following stages of design. A suitable cost contingency should be made to allow for ongoing design development, including unknowns and associated risks to the project.

# 1.0 Executive summary

Our brief was to deliver blue-sky technical solutions for the relocatable seating support system, (seating), used to transform the London Stadium from football to athletics mode and vice-versa on an annual basis; achieving the desired transformation time and cost. Our brief excluded incremental improvements to the current relocation methods as this is already being addressed by others.

We began by researching similar stadia with relocatable seating to look at their methods, experience and feedback to see what lessons can be learnt from these case studies. It is apparent that there are relatively few stadia, all employing different methods with varied outcomes and all were designed from the outset to be relocatable.

We have studied the existing London stadium, the methods currently used for relocatable seating, the time-lapse videos of previous relocations, witnessed recent transitions and reviewed the constraints and issues with those currently involved in its implementation.

Guided by the above and our own design thoughts we proposed two primary approaches to the seating and multiple methods of lateral and vertical re-alignment. This is in order for others may make informed decisions when devising a new system of relocatable seating, (see pages ? To ?).

We have sought to avoid modifications to the existing stadium and  the geometry of the existing relocatable seating. These are outside the scope of this study.

For clarification all references to seating include seating, walkways and ancillary components that make up the relocatable seating.

Two solutions are emerging for the relocatable seating, one is steel framed sliding seating and the other is off-the shelf demountable seating. We would not envisage one solution be appropriate for the entire relocatable seating.

The use of smart wheels, air-skates and rails have been reviewed along with two methods for lifting, lifting platforms and scissor seating. Both lifting options benefit from demolition of the existing concrete lower tier.

Locking the existing seating support or part thereof is an option that is outside the scope of this report.

Throughout we have considered the existing constraints and have sought to offer solutions that adhere to these constraints.

# 1.0 Executive costing

## London Stadium - Relocatable Seating
## Stage 1 Cost Model

C 5 corefive

***Order of Magnitude Seating Cost Summary***

| Technology | LOWER TIER (18,694 seats) Cranage / Manual | Horizontal Movement Wheels | Skates | Rails | EAST MID TIER (2,084 Seats) Vertical Movement Scissors | Lifting platforms |
|---|---|---|---|---|---|---|
| **Demountable** | | | | | | |
| Fully Demountable | | | | | | |
| Initial CAPEX (£) | s.43 | ✖ | ✖ | ✖ | ✖ | s.43 |
| 25 Year Cost (£) | | | | | | |
| Transition Time (days) | | | | | | |
| Lifted out in Modules | | | | | | |
| Initial CAPEX (£) | | ✖ | ✖ | ✖ | ✖ | |
| 25 Year Cost (£) | | | | | | |
| Transition Time (days) | | | | | | |
| **Framed** | | | | | | |
| Initial CAPEX (£) | ✖ | s.43 | | | s.43 | |
| 25 Year Cost (£) | | | | | | |
| Transition Time (days) | | | | | | |

Notes

1. Based on findings in Core Five Cost Model 1 Rev2. Refer to this document for general Basis, Assumptions and Exclusions
2. Assumes full Lower Tier of 18,694nr seats is included (covered in the cranage / manual / horizontal sections).
3. East Stand Middle Tier of 2,084nr seats is included in the Vertical Movement section. The initial capital cost for Demountable and Modular options for this tier will be in the order of £1,000,000 - 3,000,000.
4. Transition costs for the East Middle Tier are based on rates pro-rata'd from the full lower stands.
5. 25 Year cost includes initial CAPEX outlay. This is non-discounted, at current prices and excludes any inflation, finance charges or the like.
6. 25 Year cost includes one annual transition from and to football mode. All other operating costs are excluded, such as maintenance, Utilities, staffing, security, overlay, events, etc .
7. The solutions above exclude any new fixed seating, groundworks (other than minimal foundations to the Framed system), demolitions, MEP, fit-out and alterations to the lower tier.
8. The Framed solution is not based on any particular movement system. However we believe the wheeled solution should be the most cost effective. Further studies and market feedback is required.
9. Vertical movement is for East Stand mid-tier only.
10. Transition time is for one movement of the entire lower tier. East Stand Middle tier is assumed to be transitioned concurrently with the lower tier.
11. All times and costs remain indicative, and it should be recognised the information available at Stage 1 is inevitably limited. Further design development and market engagement is required before Budgets are set.

# 2.0 Design brief

## 2.1 Objectives and key parameters

The London Borough of Newham appointed Pell Frischmann to undertake an investigation to establish the feasibility of alternative viable solutions to the current relocatable seating system that would achieve the original cost and programme brief for transitions between football, athletic, cricket, concert and other potential modes. Together with Core 5, Cost consultants, we have looked at capex and operational cost for the proposed solutions.

Key parameters, to be considered in the feasibility study were;

- Seating technical specification requirements.
- Stadium technical and design standards.
- Stadium currently in operational mode so ability to carry out modifications constrained by committed events.
- Stadium concourse level and general arrangement.
- Extent of roof coverage.
- Respect existing access and egress constraints.
- Limit off-site transition and storage.
- Work within existing physical constraints.
- Publish report by end of May, 2017.
- Provide iterative advice and a Report on Feasibility by Early August, 2017.

The study has to target the key operational requirements;

- Target transition time - s.43 [redacted] per transition
- Target transition cost - s.43 [redacted] per transition

LBN stated our study was not meant to be a review into the current system, nonetheless the current system constraints and operational experience should be considered to inform our thinking.

Throughout this study we have liaised with those responsible for the current relocatable seating design and implementation as well as the multiple stakeholders. The list includes, the LBN, E20, LLDC, GLA and MACE. Our May 2017 Feasibility Study was presented in draft in order to invite and solicit commentary before publication.

# 3.0 The Global Context: Background Study

## 3.1 The Global Context Summary Table

Effective modification of seating  suitable for various events is a common challenge for stadia around the world.

Pell Frischmann conducted a brief analysis of solutions used around the world, including the London Stadium. We assessed their effectiveness in relation to their use and the existing constraints, identifying any relevant experience and the key criteria that were used in the design development and in the operational use.

Technical and financial data on the operational costs and resources needed for the transitions in the different venues are not fully available on public sources, the summary table below attempts only to compare relative KPI's.

| Typology | % of relocatable seating | Venue | Construction cost | Capacity | Transitions | | |
|---|---|---|---|---|---|---|---|
| | | | | | Labour | Plant | Time |
| Movable | M | A | M | 30,000 | L | L | Fast |
| | H | B | L | 50,000 | M | M | Slow |
| Demountable | L | C | H | 71,000 | L | L | Fast |
| | L | D | M | 72,200 | L | L | Fast |
| | L | E | M | 70,000 | M | M | Medium |
| Retractable | H | F | M | 83,500 | L | L | Fast |
| | M | G | M | 81,300 | M | L | Fast |
| | L | H | M | 55,000 | M | L | Fast |
| Hybrid | M | London Stadium | M | 66,000 | H | H | Slow |

Key:

Refers to seating support system, (seating).

Moveable - Whole stand relocated in one

Demountable - Piecemeal assembly and re-assembly

Retractable – Large sections

Hybrid – A combination of demountable and retractable

# 3.0 The Global Context: Background Study

## 3.2 Lessons learnt

The need for multi-purpose venues is a technical and financial challenge which has been addressed on many occasions and in different locations, and it has been approached and solved in a range of different ways, even though a number of common issues and design criteria can be identified in all the cases we studied.

The main criteria we have been able to extrapolate from the background study are:

1. The technology that permits relocatable seating on this scale has only been trialled in a relative few number of stadia.
2. The number of transition per year experienced by other stadia is low.
3. The expected life cycle for mechanical components varies greatly. Our peer study found design life ranged from circa 10-20 years which is relatively low.
4. Conversion to fixed configuration at the end of life-cycle of the equipment is a common solution.
5. Venues have been designed at the outset for variable configurations.
6. The most successful relocatable seating transition systems minimize by design the number of components, quantum of labour, temporary equipment\plant and procedures involved in the transitions.

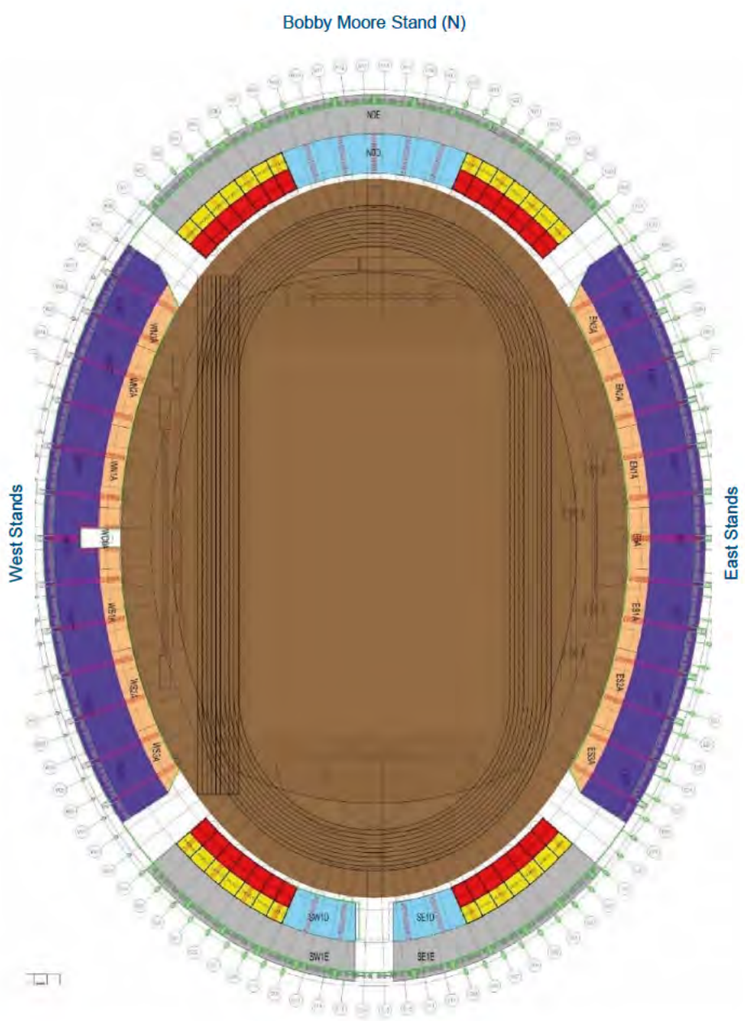
# 4.0 Current approach to relocation

## 4.1 Modes

The relocatable seating layout in the retracted athletics mode, and extended football mode is shown in the diagrams opposite. Other layouts including cricket and concert exist. The transition procedure between football and athletics is broadly as follows;

- The lower tier of the “Bobby Moore” North seating is moved closer to the pitch and rearranged to achieve a more suitable radius; an upper tier is added to accommodate additional seats and the statutory disabled platforms, while the required walkways are installed to connect the seating to the circulation space
- A similar procedure is applied to the “Sir Trevor Brooking” South seating.
- In the West the lower tier seating is moved closer to the pitch, maintaining a similar layout, and connecting walkways are added as required.
- In the East lower tier is seating moved as in the West stand, but a mid tier is added for additional seating.

**Retracted (athletics)**



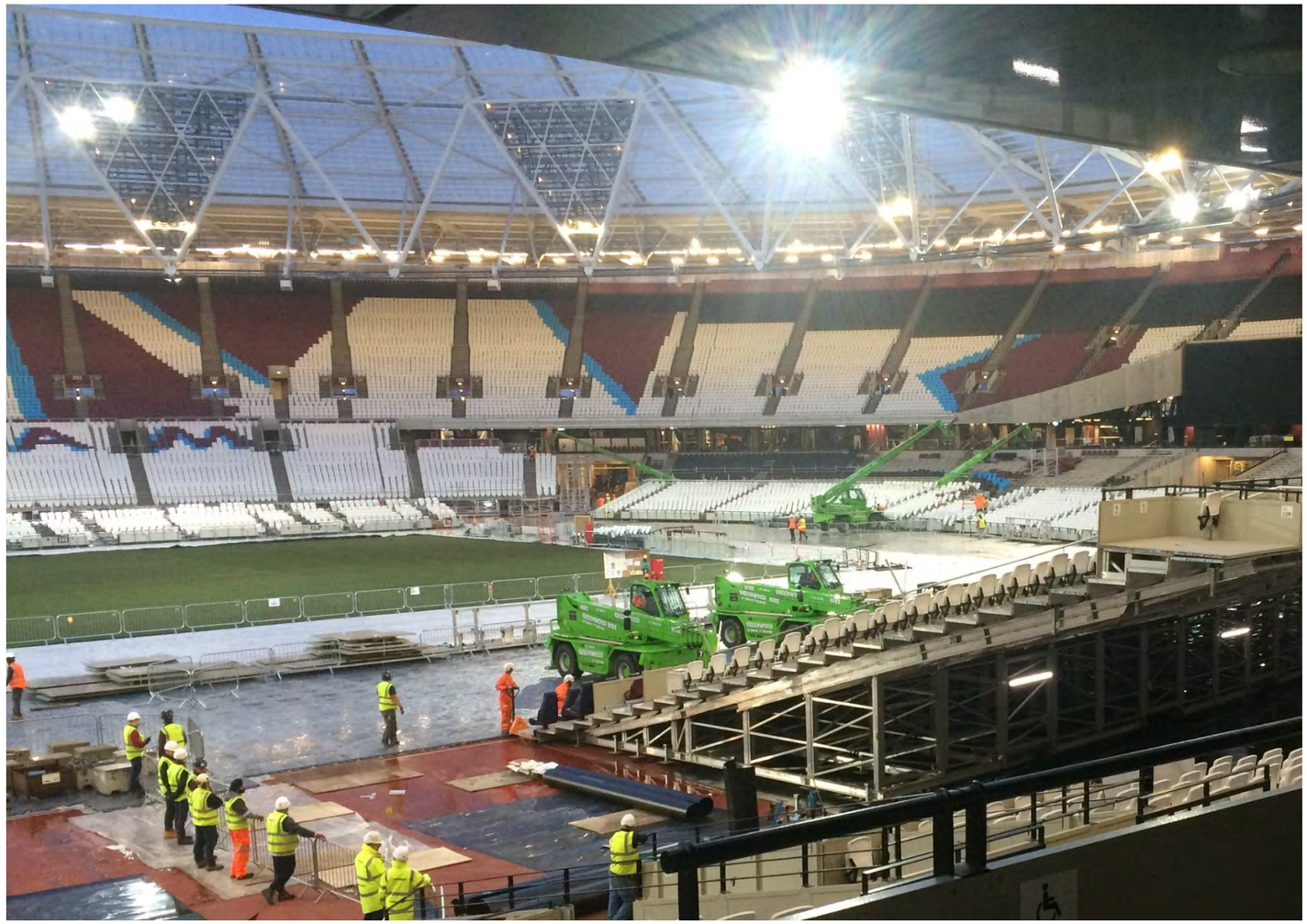

**Extended (football)**

# 4.0 Current approach to relocation

## 4.2 Our observations

Pell Frischmann reviewed two time-lapse videos, taken on September 30th 2016 and witnessed the recent post football to concert mode transition in 2017, see photo opposite. Both were useful to understand the complexity of methods, people and temporary plant employed to facilitate the transitions. The procedure, as appears in the videos, when transitioning from athletics to football is as follows:

- North stand: Stands are not moved, but demounted and then reassembled using 4 wheeled cranes. The central portion of the extended stands is assembled on site using elements delivered to site.
- South stand: West-end half of the lower tier is moved as a single segment using 3 fork lifts; then additional seating modules are assembled and added using a heavy duty mobile crane. The East-end half of the lower tier is moved using fork lifts, then it is demounted and reassembled in its final position. The central portion of the stand is assembled on site using elements delivered to site.
- East stand: the track is covered with protective layers, 3 fork lifts are used to sequentially move the stand. 2 heavy duty mobile cranes are used to install the walkways. A third mobile crane installs the additional seat modules.
- West stand: the track is covered with protective layers, 3 fork lifts are used to sequentially move the stand. 2 heavy duty mobile cranes are used to install the walkways.



# 4.0 Current approach to relocation

## 4.3 Typology

The retractable seating is built from bespoke lattice framed aluminium alloy components, as is the additional seating. Additional walkways, conversely, use traditional demountable steel scaffolding.

To convert from retracted athletics mode to extended football mode retractable seating slides, in segments, on air skates propelled by heavy duty fork-lift trucks. Additional seats, disabled platforms, walkways and the rest of the accessory elements are demountable, brought to site by road when needed. Their installation requires pitch-side assembly, and lifting into position using mobile cranes.

Demountable systems of this type are least suitable to horizontal relocation. The action of forces and stresses induced in transition is causing damage and will reduce the design life. Safety inspections and repairs are\will be required on an ongoing basis.

# 4.0 Current approach to relocation

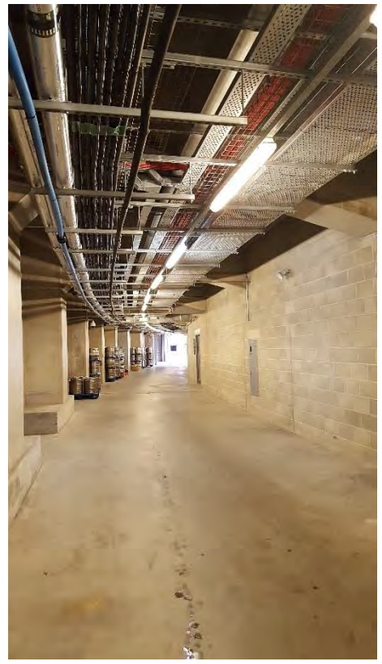
## 4.4 Existing physical constraints.

There are various physical constraints that should inform any future re-design, namely;

1. Existing MEP plant and services.
2. Contaminated land capped by existing surfaces.
3. Athletics track, not suited to air skates or rails
4. Camber of athletics track, hinders air skates.
5. Lower concrete tier, used to house MEP plant and infrastructure.
6. Access and egress constraints.
7. Access for seeding the pitch.

Stadia regulations are non physical and include;

1. Roof coverage to seating.
2. Existing sight lines.

# 4.0 Current approach to relocation

## 4.5 Our observations.

The transition methodology for the London Stadium is affected by a number of issues that severely limits its efficiency, namely;

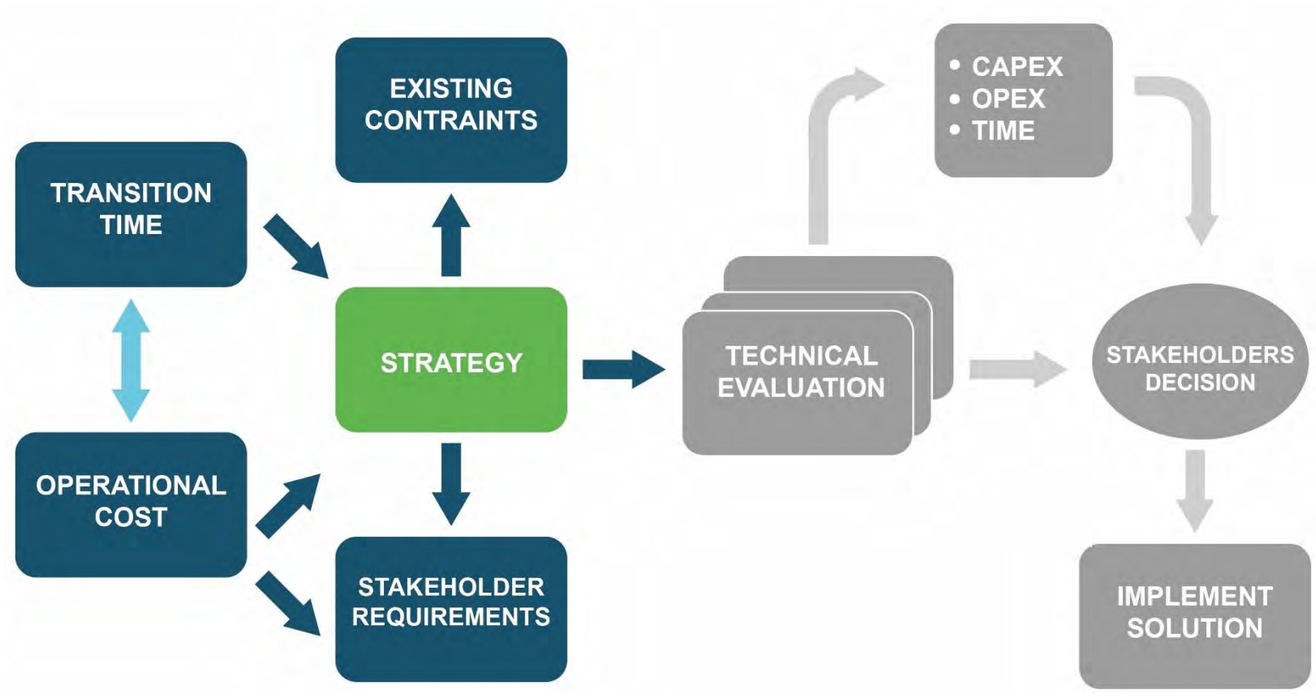
- Large number of different seating typologies, systems and components with a substantial lack of standardisation.
- Lack of intrinsic stability during transitions.
- The lack of directional control of the seating in transition.
- The camber of the athletics track hinders transition.
- The quantum of the required workforce.
- Significant preparation work prior to transition.
- A bespoke methodology for each seating system.
- Varied, multiple and heavy temporary craneage and plant.
- Transport to and from the venue of the demountable elements.
- The bespoke hybrid systems in use and the less than satisfactory methodology for sliding and lifting all contribute to the failure to fulfil the original time and cost targets.
- Aluminium alloy makes up the bulk of the demountable systems and has three times less strength and stiffness compared to steel. It is three times lighter, hence ideally suited for demountable systems; however its lack of stiffness and strength makes it unsuitable for relocatable seating and prone to damage.
- Off-site storage.
- Substantial and repeated training process for changeable labour force.
- Frequent risk damage resulting in inspections and component replacement.
- Multiple seating configurations, should be rationalised for increased standardisation.
- No discernible strategic engineering leadership or monitoring. The seating in-use is essentially falsework which demands a high quantum of skilled engineering input for efficiency and safety.
- Frequency of regulatory inspections, repair and maintenance likely to escalate year on year.

# 5.0 Proposed Relocation Feasibility Study

## 5.1 The way forward

The review of the current transition methodology leads us to the following recommendations;

- Minimise the number of seating types in-use
- Minimise the number of components in any system.
- Design the modules to be stable transition.
- Eliminate off-site storage.
- Minimise pre-transition preparation works.
- Review available technology as alternatives to air skates.
- Minimise temporary plant.
- Test, in-situ, all proposals prior to implementation, including full-scale in-situ prototype testing.
- Use standard dismountable component seating not bespoke.
- Reduce management, training, monitoring and overheads by design.



## 5.0 Proposed Relocation Feasibility Study

[redacted]

## 5.0 Proposed relocation feasibility study

s.43

## 5.0 Proposed relocation feasibility study

s.43

S.43

[redacted]

# 6.0 The Next Design Stage

## 6.2 Key thoughts

The next step should be the detailed design of the preferred solutions to an updated client brief for relocatable seating.

Prototype(s) should be tested in-situ, performance measured, lessons-learnt and a cycle of design development and further testing to a final solution. Value engineering and stakeholder approvals to be sought at key pre-agreed milestones. All prior to final tender, procure and implementation.

The process should include operational requirements, frequency of changes, agreed budgets, life to first maintenance, design life, risk and timescales for relocation. This will then provide the key drivers for design evolution.

# 7.0 Risk register

## 7.1 Key risks

[redacted]