Human Factors Spatial Screening for Evolving Designs: Proportionate Approach to Early Prioritisation

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SUMMARY

This paper describes the application of a proportional, risk-based spatial review screening process to prioritise Human Factors (HF) assessment within a large high-hazard construction project, including the benefits and challenges of this approach. The approach enabled targeted spatial review under time and information constraints, supporting early HF integration.

KEYWORDS

Human Factors, Spatial review, Anthropometrics.

Introduction

Anthropometrics is a well-established Human Factors (HF) discipline describing human body dimensions and physical capabilities across a population. Anthropometric assessments apply this data to evaluate whether specific design features physically accommodate intended users. Spatial assessments or reviews differ in approach taking a broader, system-level view of whether a space, its layout, equipment, and associated tasks collectively support safe and effective human performance. The scope of the spatial assessments is often very wide, with the aim of considering all aspects across lifecycle activities including installation, operation, maintenance, and removal.

In principle, anthropometric assessment could (and often should) be applied comprehensively across all system elements involving human interaction. In practice, however, large industrial and high-hazard construction projects are characterised by evolving design information, complex interdependencies, and staged decision-making. These conditions are typical of early design phases and require HF input to be appropriately scaled, timed, and targeted to support design development without delaying progress, therefore spatial assessments are often undertaken at this stage.

This case study does not seek to propose a new spatial review assessment method, instead, it describes the application of a structured spatial review screening process used as an early HF activity to support proportional, risk-informed decision-making. The process enabled HF practitioners to prioritise spatial review effort, identify bounding cases, and determine where more detailed spatial and/or anthropometric assessment would add value as the design matured, rather than attempting an exhaustive anthropometric assessment of all spaces at an early stage.

The approach was applied at a point in the design where key spatial decisions were being established, but information maturity remained variable. HF practitioner judgement, informed

by task understanding, risk awareness, and professional experience, was therefore an integral and appropriate component of the spatial prioritisation and screening process. While challenges associated with information availability and project complexity are discussed later in the case study, these reflect the realities of delivering HF in large, multidisciplinary projects rather than deficiencies in the design process or HF practice. Although developed within a high-hazard construction context, the principles of proportional spatial prioritisation and screening described are transferable to other complex projects where early HF integration and effective prioritisation are required.

Method

A simplified description of the method that the HF team followed is outlined here and further expanded upon below.

Areas within the design were initially prioritised using a document listing all defined spaces within the design. In this case a room schedule, with a priority status assigned, informed by the HF practitioners' knowledge and judgement of the area and by discussions with relevant discipline Subject Matter Experts (SME). For areas identified as higher priority, a spatial review question set / proforma was applied to support targeted information gathering. The information gathered via both the question set and SME input informed the identification of the highest-risk areas in relation to spatial coordination, with risks captured in a dedicated spreadsheet and recorded in the Human Factors Issues Log (HFIL). The formally captured information fed into a bounding-case criterion, allowing for a high-level spatial review to be conducted using the latest Computer Aided Design (CAD) model.

Room Prioritisation

Due to the size and complexity of the facility, a preliminary prioritisation exercise was undertaken with the aim of categorising rooms and areas into High, Medium, and Low priority for spatial assessment. The room prioritisation criteria were based on the level and complexity of human interaction required for installation, operation, maintenance, and removal. The prioritisation activity was part of the HF screening activity. This enabled a proportional allocation of HF effort and created a structured record of SME concerns, supporting traceability and handover to subsequent HF teams.

The first step involved reviewing a CAD model of the facility, 2 dimensional (2D) architectural drawings, and a room schedule to group areas or rooms into manageable sections. The room schedule listed all areas in the building, as well as the discipline designated as the room owner. Initial location and use-case information was collected through meetings with the identified room owners. This review was used to understand the layout of the facility and to identify natural groupings of areas, or for example, by floor or annex.

To prioritise the areas for further spatial review, SME's were asked about factors including:

- Intended room purpose
- Layout and size
- High-level equipment requirements and associated operational or maintenance activities
- Any areas expected to involve human interaction that may necessitate spatial consideration

The HF team reviewed the responses and assigned a Red, Amber, Green (RAG) status.

The assigned RAG status used the following criteria:

- Red – High priority for detailed spatial screening and spatial review in the current design phase.
- Amber – Requires awareness during the current design phase but is lower priority and suited to higher-level spatial review.
- Green – Suitable for spatial review at a later design phase.

Assignment depended on the potential spatial risks indicated by the responses and whether any areas of HF interest have been raised. For example, if large, heavy equipment needs to be lifted into place and moved through the facility; if frequent maintenance or system checks are required, or if undesirable postures such as crouching or lying down are expected.

Spatial review questionnaire

A systematic questionnaire was developed to build on the results of the prioritisation activity, focussing on areas assigned Red. This question set was designed to support a broad and structured exploration of spatial, task, and operational factors. The question set did have some over lapping areas, as some questions were not applicable in certain contexts or having already been addressed in previous sections.

The question set is organised into four sections encompassing high-level contextual information; spatial and physical constraints; task-related operational and maintenance risks, and any additional considerations not captured within the preceding categories (see Table 1).

Table 1 - Summary of Question Set Sections

Section	Focus	Information Collected
Overview	High-level contextual information	Purpose of the room; frequency of use; user groups; types and quantities of equipment.
Ergonomic Considerations (Max/Min Parameters)	Spatial and physical constraints	Operator positions (sitting, standing, lying, crouching); spatial requirements for fixed and portable equipment; movement of personnel through the space; sight lines; largest and heaviest equipment; PPE considerations.
Deeper System Understanding	Task-related operational and maintenance risks	Safety considerations; single points of failure; lifting or carrying requirements; multi-user tasks requiring operation or interaction with systems; workstation requirements.
Catch-All / Additional Information	Additional considerations not captured elsewhere	Remaining risks or issues identified by SMEs; recommended additional SME contacts; supplementary contextual information.

Meetings were then held with the room owners, with the questionnaire used to extract and record the required information. These meetings followed a semi-structured interview format, with the HF team leading the discussion and recording responses against the questions within the questionnaire. Meetings were conducted via Microsoft Teams and were recorded for later reference, this was done to increase efficiency and ensure technical accuracy and to capture any omitted information.

Due to the bespoke nature of this project, a tailored question set was created grounded in prior project experience and professional judgement, and was aligned to information maturity and decision needs. Formal pre-deployment validation of the question set and interview guide

was not feasible within project timescales; instead, the materials were iteratively refined as design information matured.

Bounding case identification

Where applicable, bounding cases were established to represent the most demanding or constraining conditions associated with the identified tasks following the spatial review questionnaire. For example, in the installation of a large and heavy item of equipment, the bounding case was determined by identifying the worst-case scenario, including the largest anticipated size of the item of equipment and the postures and physical movements anticipated by end users. These bounding-case dimensions and associated task demands were defined and formally recorded to inform subsequent stages of assessment.

High level spatial review

The defined bounding cases were then referenced against the available 2D drawings and CAD models to inform a high-level spatial review, considering whether the required tasks could be accommodated within the available spatial constraints.

Risk identification

Following the spatial review questionnaire and high-level spatial review, all areas requiring spatial consideration due to anticipated human interaction, but not yet represented in the developing spatial design, were identified and recorded in the project HFIL.

Discussion

This case study illustrates how a proportional, risk-based screening and prioritisation approach can structure early HF input within a complex project environment. The overarching aim of the prioritisation and spatial screening process was to identify areas expected to involve human interaction and of which require spatial consideration and ensure that the space available would not become a contributing factor that may hamper a successful outcome of a task. For example, ensuring the room is large enough for the required number of people, as well as the largest equipment to be used or housed in that room, including the transport of that equipment in and out. Prioritisation informed by task demands, equipment characteristics, and operational risk allowed HF effort to be directed to the areas where it would have the greatest impact at the specific design stage. Establishing this aim up front provided a consistent reference point for the subsequent spatial review and later HF activities.

A key function of the screening activity was to determine which areas required more detailed spatial review and which could be deferred until information maturity increased. By combining prioritisation and spatial screening activities, the approach enabled the HF team to identify which areas warranted detailed spatial review while avoiding exhaustive assessment across all spaces. This proportional approach ensured that HF input aligned with the specific needs of the design phase while maintaining flexibility for future refinements.

The importance of this approach becomes clear when considering the variety of design activities and lifecycle phases involved. Design stages, such as installation, maintenance and removal, introduce distinct spatial demands. The initial screening process can also support identification of areas with high safety concerns. These areas can then be assigned a higher priority as more detailed analysis will be required. In these areas, performance shaping factors (e.g. access, clearance, distractions, lights, and visibility) will need to be more carefully managed to ensure the task can be conducted without distraction, thus reducing the risk of human error.

Benefits

Several benefits emerged from applying the method outlined in this case study. Early HF engagement with SMEs enhanced the quality of information obtained and understanding of room-specific requirements, which helped identify additional considerations that might not have been evident from design documentation alone.

Outputs from the screening and prioritisation activities were formally recorded within the project's HF documentation, supporting traceability and enabling coordinated follow-on action across disciplines. This structured capture of information ensured that emerging issues, or areas of HF interest, could be revisited as the design matured, without relying solely on personal recollection or informal communication.

This was evident in the practical activities undertaken during the spatial screening process. In this case, bounding-case dimensions were overlaid onto the developing design to assess materials handling, clearance, access, and posture feasibility at an early stage, providing confidence that the spatial layout could accommodate the anticipated operational requirements. Outputs from the prioritisation and spatial screening activities were also systematically recorded in the project's risk-management documentation, ensuring traceability and supporting coordinated follow-on action across disciplines.

Constraints

The approach, however, was shaped by practical constraints inherent to large-scale, high-hazard design environments. Evolving layouts, provisional equipment information, and varying equipment supplier options created uncertainty in some prioritisation decisions, particularly where equipment size and maintenance requirements were key determinants of spatial consideration.

Project documentation also played an important role in supporting the screening process, but at other times created a level of constraint to the screening process. The room schedule provided a useful overview of defined spaces and supported cross-checking activities. Its effectiveness was reduced by the absence of unique identifiers and the inclusion of repeated generic spaces. Such documents are therefore more effective as supporting material rather than as the primary driver for prioritisation. For documentation of this type to be fully effective during screening, labelling and alignment with the developing CAD model would be beneficial. Alternatively, direct room or area list exports from CAD could also provide a suitable and more consistent basis for early spatial screening.

Conclusion

Despite these challenges, the method provided clear value at this design stage. Applying bounding-case dimensions within the developing CAD model allowed the team to assess materials handling, clearances, access, and posture feasibility while design flexibility remained high. This method helped provide confidence that the emerging spatial layout could accommodate potential spatial considerations while design flexibility remains high This allowed time for redesign and reduced the likelihood of costly or, in some cases, impracticable late-stage changes.

Overall, the case study demonstrates how a proportional, risk-based screening approach provides a practical and defensible means of directing HF effort within complex, evolving design environments. The approach offers greatest value when applied during design stages where spatial decisions are still being established but information maturity remains variable, enabling early identification of potential spatial risks while sufficient flexibility for redesign

still exists. Although its effectiveness is shaped by contextual constraints, such as information uncertainty, SME availability, and multidisciplinary interdependencies, the approach demonstrates how early screening can streamline subsequent HF activities and enhance traceability, thereby supporting more efficient and targeted spatial review across large, high-hazard projects.

This approach can be challenging when working on large scale projects and in some high-hazard industries. If successfully utilised, the screening process can provide significant benefits such as reducing time and effort, lowering project costs, and supporting assurance that HF has been integrated into the design.