

## Human Factors Engineering at the early phases of a project

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**Abstract.** While Human Factors Engineering (HFE) is starting to be adopted for projects in the oil and gas industry, there is a tendency to leave it until relatively late. This means that opportunities to influence and improve the design are being missed. The reasons for this include a lack of understanding of what HFE can contribute amongst project personnel; and a similar lack of project understanding by the people responsible for integrating human factors. This paper will make the case of doing more HFE earlier in projects, which will improve the way human factors are addressed and result in better design.

**Keywords.** Human factors engineering; oil and gas; design; project lifecycle.

### 1. Introduction

Human Factors Engineering (HFE) has been described (OGP 454, 2011) as the “application of human factors knowledge to the design and construction of socio-technical systems.” The major oil and gas operating companies have recognised that it has an important contribution to ensuring the quality, safety and fitness for purpose of equipment and facilities.

General consensus is that Human Factors Integration Plans (HFIP) with an associated management structure are effective at ensuring HFE is addressed in projects (HSE RR01, 2002). However, to be effective the plans have to be aligned to the lifecycle of a project. The oil and gas industry has adopted the following key stages that can be applied to most projects:

- Stage 1 – Concept/select;
- Stage 2 – Define including Front End Engineering Design (FEED);
- Stage 3 – Execute including detailed design and construction;
- Stage 4 – Commissioning;
- Stage 5 – Operate.

While guidance and in-house company procedures generally make it clear that HFE should be considered from very early in every project, practice is often to leave it to the later stages. This appears to be due to a number of reasons, including:

- Lack of understanding of HFE leading to a perception that it is not on the ‘critical path’ and only gets considered when people realise they need to do something to close out the project;
- An overly narrow view that HFE is mostly related to the physical aspects and so cannot be considered until there are details in the design to review;
- Poorly defined output requirements for HFE activities so that they are done as a ‘tick box’ exercise rather than with the intention of influencing fundamental aspects of the design;
- Lack of people who have sufficient understanding of both HFE and the project to complete more detailed analysis and reports.

## **2. Basis for this paper**

As a consultant I have carried out HFE studies for a significant number of oil, gas and power projects. These have been in the UK and Middle East, ranging from moderately significant modifications to existing facilities through to large green field projects. The timing of these studies has been at all stages in the project lifecycle from Concept (early in the project) through to commissioning (very late, after construction has been completed). This has given me an insight into what can be achieved when HFE is considered early in the project and the problems with leaving it too late.

This paper is based on my experiences and observations. It aims to present the case for better integration of HFE in projects, which I believe is best achieved by giving it greater attention during the early phases.

I am certainly not the first person to raise the issues covered by this paper. Professor Trevor Kletz's first books published in the mid 1980's (Kletz 1985) gave a clear indication of the need to consider human factors in the process/oil and gas industries. Subsequent publications (e.g. McLeod 2015) have presented more scientific and sophisticated justification but have tended to focus more on why human factors is important rather than how and when to apply it in projects. This also applies to a number of standards that specify requirements for addressing human factors, but have been fairly ineffective at driving significant changes in practice.

## **3. My experience of projects**

For many years there was no formal consideration of human factors in oil and gas projects. This was recognised as a weakness by a number of companies that then introduced procedures and standards to drive change. However, although these did at least put HFE on the agenda, it was often left to the later stages of projects, often as a token effort to get a tick in a box. In most cases it was little more than a high level validation that the design was consistent with relevant standards and practice.

### *3.1 Where are we now?*

Things have improved and human factors are generally seen as important to projects and will be discussed in the early phases. Normally, this involves carrying out screening in order to develop an HFE strategy. However, the output from these activities does not always have any significant impact and most HFE work is still left to the later phases of projects.

Typical outcomes from HFE done early in a project are:

- Screening that confirms human factors are important for the project and most (if not all) of its components will require HFE studies;
- A strategy that says human factors are important and shall be included in plans for subsequent stages of the project.

This approach, in my opinion, is a missed opportunity for HFE to make a difference to a project. It perpetuates a perception that it is not critical to the decisions made during a project, and is only useful for validating designs once they are fixed.

### *3.2 The case for better screening and strategy*

HFE screening and strategy are important, and still should be done as early as possible in a project. But they can be done better. Screening needs to do more than saying human factors are important. It needs to provide a clearer demonstration of why this is the case and identify the critical aspects of the project. If screening is improved the strategy for the project can be improved. This results in a very clear plan of what needs to be done during the project to address the critical human factors, how and when this will be done, and exactly who is responsible for achieving an effective solution.

So, while improved screening and strategy can allow HFE to become more integral and useful, there is more that can be done early in a project that will make HFE more influential in the decisions made. This will result in better human factors solutions being implemented.

### *3.3 Human factors philosophies*

One of the challenges with projects is that they can progress very quickly. If HFE input is not available in advance it can mean that the opportunities to influence the design are missed. This is why doing more HFE in the early phases is so important.

One way of communicating human factors aims is by defining philosophies for critical factors that need to be considered in the design. These may include:

- Accessibility and visibility – will the aim be to locate every operable and maintainable item (e.g. valve, instrument) within easy reach or will a philosophy based on frequency and urgency of use be adopted; and what anthropometric data will be used?
- Automation – how will a balance be achieved between what is technically possible, financially viable and sensible from a human factors perspective be achieved?
- Human machine interfaces – will latest standards for the design for interfaces (e.g. graphics and alarms) be applied or is there a requirement to follow an existing design or company standard?
- Staffing – who will operate and maintain the facility on completion, how many people will be required, and what are the implications for competence, organisation and contractual arrangements?

In my experience there can be widely different opinions on these topics between the design contractor and their client. Also, between the project team, management and operators within the client company. Setting out philosophies ensures that the issues are talked about and appear on the agenda for the project. If philosophies are not defined, these differing opinions result in significant problems during the project and can even mean that a design

fails to meet its objectives.

I do recognise that setting philosophies early in a project can mean they become obsolete if design concepts change as the design progresses. However, my opinion is that defining philosophies early allows discussion to take place that can have a fundamental impact on the design, which just doesn't happen if left to later phases. And there is no great issue with having to modify a philosophy as the design develops.

### *3.4 Options selection and ALARP*

One thing that HFE needs to be aiming for is to influence design decisions, including the main concepts set early in a project. To do this it is important that human factors criteria are clearly defined so that options can be evaluated objectively. This needs to identify the preferred solution from a human factors perspective, with a clear justification.

Ultimately, the aim has to be to reduce the human factors risks to As Low As Reasonably Practicable (ALARP). No matter how effective HFE becomes at influencing the decision making process, there will always be projects where the option selected is not the one preferred from a human factors perspective due to other factors (e.g. technical, regulatory, commercial or cost). But we still need to ensure the human factors risks are ALARP, which means strategies have to be implemented during the project to manage the risks. By identifying these early in the project, as soon as the design option has been selected, allows for those strategies to be implemented effectively, which will ensure the risks are ALARP and the justification for this judgement can be demonstrated.

### *3.5 Task Analysis*

In my opinion, the most significant aspect of HFE in design is the focus on tasks. In particular the operations and maintenance tasks that will be performed once the plant is operational. Obviously task analysis is the tool that is used to address the human factors issues. Many people feel that task analysis has to be delayed in projects "until they are sure they have all possible information and design details to hand" (McLeod 2015). This means that it is scheduled for the later stages of a project, which limits the ability to influence the design.

Whilst I agree that a task analysis cannot be finalised until the detail is available, it is still possible and beneficial to perform analyses at the very earliest stages. Very few projects are completely unique, so there is usually information available about similar designs and arrangements that can be used to identify the key requirements. My experience is that quite detailed analyses can be completed very early in projects and they usually prove to be fairly accurate and relevant when the design is finalised. The advantage of doing the analyses has been very great because it has encouraged designers to focus on tasks and ensuring they can demonstrate their design fulfils human factors requirements.

## **4. Backing this up**

Unfortunately most of my experience has been providing HFE to later stages in projects.

However, I have been involved in the earlier stages of a number of projects.

One area where HFE is being considered relatively early in projects is accessibility, although in the oil and gas industry this is mostly restricted to valves. By setting a 'sensible' philosophy some very good design decisions have been made. Whereas in the past the provision of access was left somewhat to chance i.e. access was provided if it was easy to do, it is being specified as a requirement. However, this has resulted in some cases with a fixation on providing access, which has been expensive to implement and e.g. the consequent building of platforms has somewhat ironically caused problems with access in turn. Adopting a sensible policy early in projects has allowed decisions to be made to allow temporary access to be used when it is required infrequently, whilst also ensuring the designers understand why access is required so that the type of access provided matches task requirements.

One design feature picked up early in a project was the adoption of automation in a start-up sequence. The designer had concluded that a fully automated solution was available and must be the best option. However, the operators when asked stated that, while a fully automated start was fine for routine situations, they would always prefer the ability to 'step through' a sequence with manual hold point, particularly when starting up after maintenance. By identifying this difference of opinion early in the project we could give the operators (end users) what they wanted, without creating any significant extra workload or cost to the project.

Human machine interfaces can cause problems with projects, particularly where they are a modification to an existing facility. Vendors of equipment like to be viewed as leaders in technology, and want to supply items consistent with latest standards. This includes the design interfaces. However, this can cause major operational issues if people have to start using different interfaces with different designs. This was going to happen where an additional workstation was being introduced to an existing control room to control new plant. It was a much more modern design and had much greater graphics capabilities. However, the standard offering from the vendor would have introduced a number of inconsistencies with the existing system. The solution was to specify to the vendor that the design features of the existing control system had to be followed.

One issue that is often overlooked by projects until near the end is operations and maintenance staffing. Designers and project personnel generally do not see it as their problem or responsibility. However, assumptions made about staffing can influence the design and many projects have struggled due to insufficient, competent people being available to commission and operate them on completion. As well as making sure reasonable assumptions are made about staffing by designers, another reason for considering early in a project is that it can take a long time to address, given that it may require recruiting and training new personnel.

## **5. Discussion and Conclusion**

The question now is how do we ensure HFE receives more attention at the early stages of projects? Although existing guidance and standards are not very explicit, they do allow for this to happen but it is not always interpreted like this. Where more details have been

provided for including HFE projects (e.g. Edmonds 2016) this can be interpreted as saying only that planning for HFE takes place early in a project and analysis but input to design should or can be delayed until later.

The current requirements tend to be described as screening and strategy. Better definitions of what these should involve and result in could assist. But they will always be open to interpretation.

Involving operations personnel is another important aspect, but there needs to be direction. As well as providing human factors advice, people in an HFE role can be very useful in a mediation role between such personnel and the designers i.e. driving a user-centred approach. However, to achieve this those in an HFE role need to:

- Be invited to participate at the early stages of the project. This requires an element of selling, to demonstrate to the project managers that there are benefits in doing this;
- Understand the project. This requires knowledge of similar projects, plant and technology; including operational aspects. This can be challenging because, by definition there is not much information available at the early stages of a project;
- Be clear about the human factors requirements and opportunities. To do this they need to demonstrate that they are being objective and willing to stand by their advice.
- Provide solutions. Project teams have lots of issues to consider. If human factors become a problem they will tend to drop down the priority list. However, if human factors provide solutions to other issues they may well become top priority.

The problem with how human factors is often described is that it can, to engineers particularly, appear to be ‘psychobabble.’ It is not that they don’t view it as important, but they are already very busy and feel unable to take the time to understand what is being said and (more importantly) what it means to them and their design. Telling them to e.g. be aware of “System 1 and 2 behaviour”, the “normalisation of deviance” and the need to support a “high reliability organisation” does not usually help them design pipes, valves, vessels, structures etc. This is where HFE specialists need to take the lead. Their job is to translate the psychobabble into practical steps that can be incorporated into design.

I am convinced that better consideration of human factors in projects will result in better design. To do this HFE has to start early in the project, but this requires people working in HFE to demonstrate their ability to be effective and efficient so that they add value and solve rather than cause problems. Clear project philosophies and procedures backed up by plans with tangible steps will be far more effective than setting high level human factors goals.

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