Getting a foot in the door: successes, failures and challenges in accessing and influencing the design process

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Often Ergonomists are brought in to look at jobs where there have been significant injuries or illnesses and the organization is seeking assistance in resolving the concerns. In the oil, gas and petrochemical industries, the work environment consists of networks of piping, valves and other fixed equipment that make design changes difficult without major capital outlay. As ergonomists, we know that integration of Ergonomics/Human Factors (E/HF) early in the design process yields the greatest ability to affect change with the least cost. However, making the jump from the umbrella of health and safety, where an ergonomist is brought in as a reactive measure, to that of the engineering design process where proactive measures can be taken can be difficult to do. Once accepted into the design process, E/HF Professionals have the technical skill set to provide excellent guidance to the design and there are other papers that provide examples of case studies where E/HF has been integrated and that provide recommendations with respect to technical input into the design cycle. There are fewer resources available for practitioners to draw upon in terms of the conversations and actions that failed and were successful in ‘getting in the door’ to be able to influence the design cycle as well as considerations outside of the technical provisions when trying influence design. This paper provides a reflection of the experience of an Ergonomics Consultant, with the assistance of a contracted operations coordinator with respect to what did and did not work well in moving from reactive ergonomics assessments to integrating E/HF into the design process for a large petrochemical manufacturer and the lessons learned along the way.

Practitioner Summary: Despite the numerous benefits to integration of E/HF early into the design process, presenting these benefits is often not enough to entice organizations to do so. In addition to persistence, providing concrete, practical and relevant information that can be directly utilized in the design may have a greater impact. Lessons learned from failed and successful attempts to access the design process so that E/HF could be integrated are provided.

Keywords: ergonomics, human factors, design process, petrochemical

1. Background

E/HF professionals are often utilized reactively in response to injury/illness complaints but within the E/HF community, it is understood that integration of E/HF into the design cycle will yield the greatest benefits. The IEA committee on the future of ergonomics reported in the 2012 paper “A strategy for human factors/ergonomics: developing the discipline and profession” (Dul, J., et.al.) that despite its benefits, the potential of E/HF is underutilized. There is a gap then, in moving into the more proactive domain where E/HF is seen as a necessity to organizations. In trying to overcome this gap, the E/HF professional needs to get his/her foot in the door and understand how to make a compelling case for inclusion of E/HF into the design process. While other papers and books have captured the design cycles and potential points and tools for E/HF integration, this paper is a reflection on the failures and successes in ‘getting in the door’, the non-E/HF knowledge that needed to be acquired/utilized, questions asked and on-going challenges and opportunities in implementation.

The Ergonomist in this case, has been consulting to a large, multi-site petrochemical manufacturing company since 1995, under the direction of an active Occupational Health department. Early experiences were to provide office ergonomics assessments and gradually a corporate ergonomics team focussed primarily on the office environment was developed. Periodically, there would be a need for assessments or physical demands analyses at the plant sites and training for both office based and industrial employees was provided. As employees increasingly understood the services available to them with respect to E/HF both
through the training program and seeing the Ergonomist on-site, the Ergonomist was increasingly brought in to assess industrial tasks following implementation of engineering projects due to complaints from operations and maintenance personnel concerning some aspect of the design that was not working well for them. Note that the organization has a well-developed control room design process that includes human factors and is heavily involved with a research consortium to continuously improve knowledge and operations in this area. Therefore the efforts described here are with respect to physical plant design outside of the control room.

2. Failed Attempt #1

The organization has a mature office ergonomics program that includes both site and corporate ergonomics teams comprised of representatives from health, hygiene, safety, facilities, IT and the Ergonomist as the subject matter expert. The program includes employee training, on-line surveys for discomfort and office-set-up with an alert system where problems are identified. Employee representatives at each site have been trained in performing basic office assessments with some Occupational Health Professionals trained at a higher level and the Ergonomist used for complex cases. High risk groups have been identified based on injury/illness data for a higher level of monitoring and medical management and leadership support is in place. This method allowed for building of capacity for assessments and early identification of issues.

Given the success of the office ergonomics program, we attempted to replicate this at the plant sites for industrial/field ergonomics. The employees were already participating in training, and now a train-the-assessor program was implemented and site task teams were formed including representatives from health, hygiene, safety, operations, maintenance and engineering and the Ergonomist as the technical resource. It was hoped that by including representation from the end user groups and engineering, that the value of integrating E/HF into the design process would result.

While the teams were successful in completing assessments for a few small projects, the engineering, operations and maintenance representatives could rarely attend meetings due to workload and other priorities and there was sometimes confusion as to which assessment tools to utilize if the Ergonomist was not present. Also, since each site was subdivided for operations, the operations representative would not necessarily understand the issues outside of his own work area. In the end, most teams were unable to maintain momentum and disbanded in favour of utilizing the Ergonomist to work with the direct stakeholders on a project by project basis. It is possible that this strategy might have more success in organizations in which an E/HF Professional is embedded as an employee as momentum might be more easily sustained. While the teams did not work overall in this case, we did develop some strong advocates in maintenance and operations that helped to drive more requests for intervention and pockets of small teams do still exist within the organization.

3. Failed Attempt #2

As requests for assessments increased, it became apparent that the end users were not being fully considered in the design process. This led to investigation of the design processes in place. Per most organizations, the design cycle followed an iterative process that included idea, investigation, development, implementation, operation and decommission phases. The complexity and cost of the project dictated the number of decision gates where the project team would need to present their current status to the decision board. The decision board would determine if the project could proceed, be rejected or whether the team needed to collect more information before they could move onto the next phase of project development. Low cost, simple projects only have one decision gate and start-up approval while high cost, complex projects have decision gates for each phase of the design as well as checkpoints that are required within the phase. We also learned which checklists and documentation were required and which were optional along the way. A document that was a requirement for all projects was a Responsible Care checklist. Responsible Care (RC) was developed in Canada in the early 1990’s through the Chemical Industry Association of Canada as an agreement amongst adopters that includes a commitment to continuously improve environment, health and safety performance. The initiative grew to the point that oversight is now via the International Council of Chemical Associations.

The RC checklist was used at multiple stages in the project to help identify potential risks to be mitigated with respect to environment, industrial hygiene and safety. A few questions asked about the physical demands of the job generally in terms of excessive weight, repetition and awkward postures and one question asked “are there ergonomic considerations that must be applied to the design for maintenance,
operation and emergency response?” Since we had been asked to perform assessments where we had not been asked for up-front design input but were brought in due to issues after implementation, we informally audited the responses to the related RC checklists that had been completed during the project and found that they indicated no ergonomics issues. Clearly there was a gap in the process and it appeared to be a ‘don’t know what you don’t know’ issue.

As a result, we approached the site RC contact to ask if we could provide some additional documentation to assist project teams in responding to these questions. This was agreed to and over the next year, supplementary materials to assist in responding to these questions were developed and refined. While we understood that implementation had occurred, we later learned that this was not the case. No clear answer was provided on what had happened but in hindsight, it is unlikely that the supplements would have been used in the way that we had hoped. In our current work, the project engineers have clearly let us know that they are opposed to more checklists and since the format of our supplementary materials were further questions to consider in responding to the original checklist, usage would likely have been poor.

While this attempt at influencing the design cycle failed, the information gained on the specifics of the design process would prove very useful in the future.

4. Failed Attempt #3

The third failed attempt represents multiple conversations with engineering representatives and employee groups that included design team members on the benefits of integrating E/HF in the design process. The future of ergonomics committee paper provides an excellent summary of these benefits (Dul, J., et al., 2012) relevant to the various stakeholder groups. While participants may have conceptually understood that there was a benefit, there was no follow-up from their end to harness these benefits into what they do. It is suspected that this was due to lack of concrete, specific guidance and request for action. As an aside, in conversations with consulting colleagues who have provided general presentations on E/HF and its benefits to engineering groups, success in converting these potential clients to actual business has been low.

5. Success…and Continued Challenges

5.1 Development of a Pilot Program

In the fall of 2013, Occupational Health at one site was approached by a contracted Operations Coordinator (OC) about accessing ergonomics services for input into a project with which he was involved. The OC acts as the liaison between the project team and the operations, maintenance and construction representatives. This OC had worked with another company that had E/HF specifications available to their project teams with the expectation that they would be utilized. After being involved with a few projects, he noticed that end users were not always at the table in the design reviews or if they were there, they were not being questioned about their interface points in the design. In investigation of whether the teams were using any objective E/HF guidelines, team members reported that they typically relied on past experience. He also checked with the third party design firm and found they also did not utilize any guidelines. He received push back from contacts charged with the design process and change management tools to the effect that incorporating E/HF would affect project costs negatively. He then found out that ergonomics services could be accessed and contacted the Occupational Health representatives to discuss his concerns and arrange a meeting with the Ergonomist.

The OC also went to his team leader to share his previous experience and in this discussion the team leader reported that his biggest frustrations with the projects his team completed were rework due to inoperability/maintainability issues and employee injury related to the project scope. The OC was able to pull from his previous experience with examples of relevant E/HF guidelines to show how E/HF input could help to mitigate these issues and with the support of the team leader, was able to utilize the Ergonomist to develop objective technical specifications specific to a current project the OC was involved with. The Ergonomist also participated in a design review with the project team with whom the OC was working. While the project manager had concerns about the time this would add to the review, the additional time taken was minimal and a number of changes were made to ensure that the final design would be more usable for the operators and maintenance personnel upon implementation. For some items captured, actions were assigned to the Ergonomist to determine appropriate specifications. From this process it became clear that more detailed recording of the part/item/location needed to be maintained (e.g. valve number) as in several
instances, lack of reference resulted in a longer than necessary follow-up as team members struggled to remember which valve needed the further investigation and the Ergonomist, not having intimate familiarity with the project, was not able to assist. This project manager became an advocate through this experience and reported on both her initial hesitation and actual positive outcome with the design process during the roll out to the project teams.

The technical specifications made all the difference in attaining buy-in to continue down this path. Recognizing that ownership for integrating E/HF into the design process needed to reside within the engineering teams, we asked the department team leader (DTL) to lead a pilot project for this integration with in his project teams. The Ergonomist continued to develop the technical specifications around items that had the greatest immediate need for the projects in process.

We also needed to address the gap identified in failed attempt #2 that it was not obvious what issues the project teams needed to investigate in order to properly answer the RC checklist questions. An additional issue with the RC checklist is that sign off was only required by the designated site environmental steward and the site industrial hygiene representative. Unless one of these individuals knew what further questions to ask around E/HF, issues would go undetected. Since initial indications were that we would be unable to influence the RC checklist, and despite the project engineers indicating that they were not keen on utilizing another checklist, we could see no other way than to develop one that was more detailed to appropriately respond to the RC checklist. To that end, we adapted an existing checklist contained in the International Association of Oil and Gas Producer’s “Human Factors Engineering in Projects” document.

As we were developing this additional checklist, we began to receive indications that the Facilities Change Management (FCM) team, owners of the RC Checklist corporately, might be open to changes as other stakeholders were finding deficiencies with their sections as well. We took advantage of a visit by the corporate FCM team leader to the local site to arrange a meeting where we reviewed the technical specifications, checklist and discussed what we were trying to accomplish. Not only did we want to add the additional questions directly into the RC Checklist, but we wanted Occupational Health to be added as another sign-off on the form any time issues in the E/HF section were identified. We received a very supportive response and at this time are working with the FCM team on making the desired changes to the RC Checklist. In order to address an anticipated gap where the site Occupational Health (OH) representatives would not have the knowledge to ask the project team appropriate questions depending on the answers on the checklist, a meeting with the corporate OH team was held to determine a flow through process to the Ergonomist. The number of forms that may come in is an unknown at this time so the process may need to be adjusted in the future.

5.2 Gaining Leader Support – Site Level

Multiple meetings were held with the department team leader (DTL), another engineering lead, the OC, an OH representative and the Ergonomist in which a plan was developed to roll out the E/HF guidelines and checklist through the DTL’s teams and a procedures document that provided the roles and responsibilities of the various stakeholders was drafted. The procedure referenced the checklist and guidelines. Prior to the pilot roll out, we held a meeting with the plant site area team leaders and the site engineering leader to gain their support. We presented examples of site projects where operations and maintenance tasks were found to be difficult for the end users post implementation, went through the benefits of integrating E/HF into the design process and reviewed the procedure, guidelines, checklist and roll out plan. We were also clear that the E/HF guidelines where there to partner with the engineering standards, not to replace with them and that there would invariably be conflicts between them that would need to be resolved. For example, we knew that not every valve could be placed at a good height and that criticality needed to be considered. However for those placed in non-optimal locations, a mitigation plan would be expected (e.g. if the valve is to be rarely used and accessed by scaffolding when needed, the design team would need to ensure that there is enough space for the scaffolding and that there is clearance for the manual operation and any needed tools). Not only did we get the approval from this leadership group, we obtained a great ‘sound bite’ from one of the leaders that we used during roll out to the project teams; “This is what will make a good project a great project”. The site engineering leader indicated that he believed that the E/HF guidelines should be integrated into the corporate engineering standards.
5.3 **Pilot Roll-out and Challenges Identified**

We then did a short presentation to the project team managers to prepare them for the more detailed roll out to their project teams. This presentation was similar to the one for the area team leaders. Each project team was scheduled for a 1.5 hour presentation to roll out the project and tools to them. This included use of scenarios to practice using the E/HF guidelines and checklist. It was important during these presentations to ensure that examples of designs that were problematic were not used in any way to blame or shame the project team members. Rather, this was presented as an opportunity to partner for the best possible project outcome. We found that it helped to use examples from other areas of the plant or other sites within the organization so that the examples were relevant but where project team members had not been the related designers. We also discussed the use of 3-D CAD modelling in projects and the increased ease that this provides for end users and the Ergonomist to evaluate the design in comparison to 2D isometrics. Unfortunately not all existing areas of the site have been scanned to allow for 3D modelling but we did encourage the teams to build scanning into their budget in these cases. Since not all end users are trained in reading isometrics, project teams were reminded to take this into account so that assistance can be provided for reading the drawings as needed. Moving to 3D modelling whenever possible was encouraged.

The detailed design work is most often completed by 3rd party firms and therefore one of our current challenges is how we will roll out the E/HF guidelines to these firms. In addition, a 6 foot, 2 inch tall simulated man was being utilized in the 3D modelling to test the design which is not representative of the end user population. As part of the guideline package, anthropometrics were given for 95th percentile males from the tallest ethnic population data and 5th and 50th percentile females from shorter ethnic populations to be utilized in future modelling. Teams were also encouraged to physically view the area as the models do not always show adjacent equipment well and field run installations for cables, heat trace, etc. related to the instrumentation and electronics used to monitor the system are not on the drawings. As a result, the designers were encouraged to block out areas to be kept clear for operations and maintenance access on the drawings. Otherwise, good access could easily be cut off by the cable trays and cabling installed after the main design implementation. As well, invariably in construction, design issues crop up that must be dealt with on the spot. Ensuring that the construction leads on the project teams are trained in the E/HF guidelines was seen as critical to ensuring that good decisions could be made in the field when these situations arise.

Within this site project group, there can be up to 300 projects per year. This group deals with projects below a certain cost and large projects are held within another group. As the Ergonomist cannot be at all design reviews, building capacity to identify issues for the end users was attained by providing additional training to the operations, maintenance and construction representatives on the project teams. This 3 hour training was provided by the ergonomist, OH Representative and DTL. The DTL was particularly effective in creating an environment of openness for the participants with an up-front discussion on barriers and then a review of those again at the end of the session to determine which had been dealt with and how the remaining barriers could be addressed. He also made a commitment to meet with the participants again in 6 months to review the status and any continued issues. The participants also understood that they could access the Ergonomist any time questions came up or when they were unsure of what to recommend for a particular design problem identified.

Some of the barriers identified by the operations, maintenance and construction representatives during the session were:

- For some fast track projects with few decision gates, the operator, maintenance and construction representatives did not see the design until it was too late to make any substantial changes.
- Lack of maintenance resources means that not all project design teams currently have a maintenance representative.
- Designers are not aware of hands on issues. Too much credit is given to the 3D models and they are not always correct, particularly with respect to showing grade and elevation. Designers need to get out in the field to see the area and the work as done.
- Third party inspectors do not have E/HF knowledge to catch related problems before issuing approvals.
- Changes to "off the shelf" skids/modular units made by third parties often don’t have good E/HF and changes can increase cost significantly.
5.4 Gaining Leader Support – Corporate Level

A presentation was then made to the corporate Responsible Care leadership team consisting of leaders of all plant sites across the organization as well as some of the corporate vice-presidents. This was completed by the Ergonomist, DTL and OH representative involved in the pilot and the leaders were all given copies of the checklist and E/HF guidelines (note that the organization’s communications department had turned the draft guidelines created by the Ergonomist into a professional document with organization branding). Again, having something concrete and tangible to review as well as using video clips to demonstrate problematic designs that had been implemented was very impactful. The presentation was similar to that given to the site area leaders and was well received to the point that, during the meeting, the plant leaders provided contact names of engineering leads at their sites with whom to coordinate roll out at their locations.

5.5 Frustrations, Future Plans and Opportunities

While the above makes it seem that the planning and roll out was seamless, in reality there were numerous delays and set-backs. The DTL was not able to maintain deadlines agreed upon due to other issues and priorities that came up. The OC’s contract came to a close prior to the roll out and although we were able to retain his services to assist with development and implementation of the training, fewer requests for direct input by the Ergonomist have been received since his departure. Teams have indicated that they are utilizing the guidelines. However, until the RC checklist modifications have been made to allow the Ergonomist to better monitor the projects, it will be difficult to determine how appropriately the guidelines are being utilized.

Plans are now being made to determine how to best roll out the project to the other sites. With the support of the site leaders and having had some initial discussions with a few of the site engineering contacts provided, there appears to be good support to move forward with a corporate roll out. We had originally planned to form a corporate oversight team to plan the roll out to the other sites, but this now appears unlikely due to personnel changes. On the other hand, an opportunity for support that has since occurred is that the pilot site engineering team leader who was very positive about this process has been promoted to engineering team leader corporately.

Another opportunity that arose was to influence the E/HF section of a course for new engineers in the company that focuses on designing for safety. The section that formerly used older accident models in which the humans sit outside of the system and are to blame for accidents through human error has been replaced by the Ergonomist with resilience engineering principles and the need to move from a culture of name, blame, shame to one in which people are part of the system and need to be supported through human centred design and continuing to work towards a culture that encourages openness and captures how good decisions are made as well as ones, that in hindsight, are perceived to be poor.

6. Conclusions – Summary of Lessons Learned

There have been many lessons learned over the years with respect to getting in the door to influence the design process. This is a summary of those from the Ergonomist involved with the hopes that other E/HF practitioners will find them useful:

- The Ergonomist had presented the benefits of E/HF, such as improved health and safety and better performance, a number of times to the engineering group over the years but this was not enough to inspire action. Once we had developed the specific E/HF guidelines laid out in a way that made them easy to use (to the point, by type of design feature, and using diagrams when possible to show, for example, ranges that were appropriate and that were not recommended, and integrating pictures from within the organization of problematic designs relevant to the specific guideline) buy-in was much easier to attain. During the training sessions, reviewing how the information for the guidelines was obtained was important in establishing the document as a credible source (e.g. what anthropometric data was used and why, what force data has research data to back it and which was extrapolated due to lack of data and how this was done, etc.)

- If you are hoping for action, make the request, concrete and actionable. In this roll out, when we asked for support from the leadership, we didn’t just say “we need your support”, we gave them specifics around what support would look like and our expectations of them.
• Learn the engineering process used and its variations as well as the organization's terminology. Most design processes follow an iterative Concept/Idea→Investigation →Development→Operation→Decommission process but terminology for these steps and sub-steps within them can vary. Find out if the same groups look after all projects. We have been working with one group in this organization but it is a completely separate group that manages high capital cost projects and we will need to capture them as we continue to roll out the integration. Find out what documentation is required optional in the design process and try to influence the existing documents rather than build new ones whenever possible. Chances are, there is some aspect of E/HF that is supposed to be considered. Find out how the design team E/HF currently and demonstrate your value by bringing more detail to them in a form they can utilize. Understand where decision gates are in the process, who is involved, and their criteria for evaluating the project at the respective stage.

• Learn the language that is critical to the stakeholders involved. In some industries, “quality” is the word that will get the attention of the engineers and management. In this organization, operability, maintainability and constructability were high value words.

• Make guidelines specific. For example, we could have provided general height ranges for heavier work but the Ergonomist looked for specific research, considered the site population (e.g. aging, increases in female operators, multi-ethnic population) and created guidelines for specific activities/components (e.g. 2 handed valve handles, one handed valve handles, low point drains, sample points, instrument enclosure boxes, filters, etc.). Some data was available other design specifications, such as ASTM 1166-07 however it did not always match our population or it needed to be updated with more current data from research. We also ensured that there were operations and maintenance review of each guideline before it was issued. Their feedback was invaluable to how work was actually performed and how it sometimes changed with, for example, time pressure, weather issues from summer to winter and component variations.

• Be persistent and patient – the OH representative and Ergonomist had to frequently send reminders to the Department Team Leader and others, or drop in unexpectedly to push ahead on next steps. The roll out of the pilot was 6 months later than our original time line.

• Be prepared to take advantage of opportunities when they arise but don’t expect them to all lead to success, or at least your original version of what success is. Take the lessons and information to better inform future opportunities.

• Expect plans to change and potentially go off course. Changes in personnel, leadership, process issues, the economic climate and resources will inevitably occur, necessitating regrouping, changes in strategy and delays. At the same time, opportunities may come up that need to be capitalized on immediately or be lost. The Ergonomist and local contact need to be agile and quick to respond. For Ergonomists who are consultants, a good local contact within the organization that is willing to drive the E/HF integration is key.

• Take time to determine the goals and frustrations of the various stakeholders in the design process and be aware that these can conflict. For example, the Department Team Leader indicated that he had a frustration with rework due to inoperability on implementation while the project managers had a mandate to keep their projects on time and on budget.

• The DTL did not initially see the benefit of E/HF in the idea stage of the design process. However, If the scope definition, which is set early does not include something the Ergonomist can see is going to be an issue on implementation, getting the scope changed after it has gone through the first decision gate for approval is very difficult. As well, a solution may have already been presented with the request for design and E/HF integration at the idea stage could be helpful in supporting or refusing the request.
• For upper management, driving the point home on poor design through short video clips showing work as it is currently done was very impactful. Pictures were good but video was better.

• The integration of E/HF into the design process has to be presented and seen as a partnership. It is important that the ownership to taken on by the designers. As an outside consultant, the Ergonomist needs to let go of any desire for getting credit in favour of getting results. Most people on the design team are familiar with the paradigm of know what you know, know what you don’t know and don’t know what you don’t know. We presented our tools as designed to fill the “don’t know what you don’t know” gap.

• Find out who actually performs the detail design work. Is it in-house or contracted out? If it is the latter, a plan to transfer knowledge to the contracted group will be needed.

• If you are a consultant ergonomist working with an organization that has little or no in-house ergonomics expertise, determine who your eyes and ears are going to be in the design process and provide them with appropriate training.

• Encourage project managers to use video and photos at the decision board meetings so that the board members have a clear perspective of the issues identified.

• Encourage field visits for vendors and designers to see the work area and work as performed.

References