Human factors: Step change improvements in effectiveness and safety

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DO YOU KNOW how efficient, effective and inherently safe working practices are in your organisation? Can you determine if changes made to the infrastructure actually achieve the expected benefits? Can you make predictions to compare the most optimum change strategies for your organisation? If the answer to any of these questions is no, then we advise that you read the following guidance, which is intended to explain how organisations can enhance their most flexible and valuable resource: people. We have focussed on the twin themes of effectiveness and safety, because we believe that assessment of human performance has implications for both.

It is a truism to say that you cannot get to where you're going if you don't know where you or your intended destination is. Yet many organisations find themselves in this position regarding the people part of the system. If you ask a company where they are and where they will be at some future point in time in terms of their *technical* robustness, most can tell you. The same cannot be said of their understanding of human resources. If companies are not aware of the detail of the tasks their employees are currently undertaking, how can they possibly anticipate the future? We think that there is an implicit assumption that people will simply fall in with the will of the organisation, because they are paid to do so. Yet this is not the case. Little thought is given to how new technology might be introduced to the workplace and what the impact will be upon the working lives of employees.

Figure 1: HTA as applied to drilling operations

DEAL WITH KICK
Plan 11: Do in order
- 11.1. Shut well in
- Plan 11.1: Do in order
  - 11.1.1. Initial shut in
  - Plan 11.1.1: Do 1 to 6 then 7 if required
    - 11.1.1.1. Stop rotating drillstring
    - 11.1.1.2. Raise drill string to predetermined position
    - 11.1.1.3. Stop pumps
    - 11.1.1.4. Close upper annular
    - 11.1.1.5. Open choke
    - 11.1.1.6. Open kill lines
    - 11.1.1.7. Regulate pressure
  - 11.1.2. Hang off
  - Plan 11.1.2: Do 1 then (2 if required) then 3 to 10
    - 11.1.2.1. Inform other parties of well status
    - Plan 11.1.2.1: Do in order
      - 11.1.2.1.1. Contact Toolpusher
      - 11.1.2.1.2. Contact Drilling Supervisor
    - 11.1.2.2. Pressure test kill assembly
    - 11.1.2.3. Set the compensator at mid stroke
    - 11.1.2.4. Close upper pipe rams and regulate
    - 11.1.2.5. Lower the drillstring weight onto the rams
    - 11.1.2.6. Actuate ram locks
    - 11.1.2.7. Increase operating pressure to 1,500 psi
    - 11.1.2.8. Bleed off pressure
    - 11.1.2.9. Open annular
    - 11.1.2.10. Check that pipe rams are not leaking
  - 11.1.3. Measure pressures
  - Plan 11.1.3: Do in any order
    - 11.1.3.1. Record SICP
    - 11.1.3.1. Record SIDPP
    - 11.1.3.1. Record Pit Gain
  - 11.1.4. Consult others of well status
  - Plan 11.1.4: Do in order
    - 11.1.4.1. Contact Drilling Supervisor and convey pit gain and

11.1.4.10. Discuss with Drilling Contractor (DST)
…..Continued…

D=Driller
T=Toolpusher
BE=Barge Engineer
DS=Drilling Supervisor
NB it is acknowledged that tasks and responsibilities vary slightly from rig to rig

In one interview with a seasoned offshore driller, he explained that he was employed from the neck down, i.e., he wasn't paid to think. Yet inefficiencies and incidents are, more often than not, attributed to people rather than the technological part of the system. This is against a background of enormous investment in equipment and infrastructure with comparatively little, if any, investment in the people apart from salaries and subsistence and, possibly, some initial training.

There are essentially 3 ways in which organisations could enhance the resource that offers them most gains for relatively small expenditure:

- By investing in learning lessons from the past;
- By developing a statement of the present and;
- By predicting the future.

LEARNING FROM THE PAST

It is said that wise men learn from the mistakes of others, only fools from their own. Certainly, past incidents and near misses provide a wealth of data about human performance under a variety of situations that could be harnessed to improve the effectiveness and safety of your own organisation. We have found that outside of major disasters the quality of these data are poor. In many cases the data are simply not collected. So whilst it is possible to recreate the technical process (e.g., well pressures, mud weight, etc) it is not possible to identify what people were saying and doing. The missing vital ingredients to the assessment of incidents means that, ironically, we can only learn from major disasters. Would it not be better to learn from near misses to help prevent more serious incidents?

We have used techniques such as the Sequential Timed Event Plotting Procedure (STEPP), which is an incident analysis method, to piece together incidents. The method distinguishes between actions and communications by people, events on the rig, and the status of the well. This method is excellent for drawing a fine toothcomb through the sequence of events and identifying underlying root causes. Imagine how much more effective the process would be if we weren't looking over serious loss, but picking up on problems before they got too far. Findings from a recently undertaken STEPP analysis showed that:

• Some procedures are inadequate and others had become outdated;

• There were communication difficulties and poor relations between different parties;

• There were disagreements about diagnoses of problems amongst the key players;

• The lines of authority were unclear;

• There was a lack of relevant training and poor decision making.

All of these problems can be fixed and the incident was preventable, but you have to work out what is wrong first.

Figure 2: SHERPA applied to drilling operations

Task step	P	C	Error mode	Description	Consequences	Recovery	Illustrative remedies
11.1.1.1	L	!	A8	Omit to stop drill string rotating	Drill string still rotating	No Recovery Equipment Damage!	Checklist in prominent position in dog-house (D) Shut-down panel, containing all necessary switches in logical sequence (D)Automation of shut-down sequence (D)
11.1.1.2	L	!	A4i	Fail to raise drill string high enough	Drill string too low	Potential major problem	Sensor from well showing exact position of drill string together with optimum position for dealing with kick on display in dog-house (D)
	L	!	A4ii	Raise drill string too high	Drill string too high	Potential major problem	Sensor from well showing exact position of drill string together with optimum position for dealing with kick on display in dog-house (D)
	L	!	A8	Omit to raise drill string	Drill string not raised	Potential major problem	Sensor from well showing exact position of drill string together with optimum position for dealing with kick on display in dog-house (D)
11.1.1.3	L	!	A8	Omit to stop pumps	Pumps still running	No Recovery Equipment Damage	Shut-down panel, containing all necessary switches in logical sequence (D)Automation of shut down sequence (D)

P = Probability (H = high, M = medium, L = low)

C = Criticality (!) (all or none)

THE CURRENT POSITION

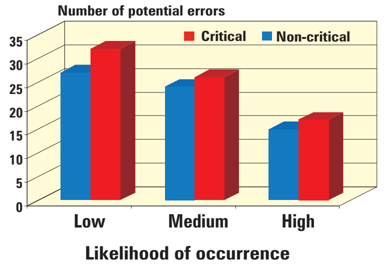
Most organisations have a clear sense of the technology they use and have policies on capital replacement, yet have little idea about how effectively the people they are employing use this technology in their working practices. To undertake such an assessment requires that organisations develop a clear understanding of the tasks undertaken by the employees and how this fits in with the general goals of the company. We have undertaken some studies using a technique called Hierarchical Task Analysis (HTA). This approach uses a hierarchy of goals, to describe the purpose of the tasks, and identifies individual contributions toward the overall process (Figure 1).

The technique is invaluable as it removes the ambiguity from complex processes and enables the organisation to ask itself why it does things the way it does. This scrutiny can in itself provide a useful self-analysis and lead to the identification of areas for improvement. HTA has many application areas. For example, the description of tasks and goals can be used to design person specifications for selection of personnel, to design training programmes for new personnel and refresher training for existing personnel, and to scrutinise the robustness of working practices for examining the potential for human error.

This latter aspect of HTA has been embodied in a human error analysis technique called SHERPA (Systematic Human Error Reduction and Prediction Approach). The description of activities developed using HTA is taken task-by-task and scrutinised to determine what can go wrong. SHERPA works rather like a human HAZOP. Each task is classified into one of 5 basic types (i.e., checking, selection, action, information communication and information retrieval) and then a taxonomy of error-types applied. The immediate consequences for system performance are recorded (Figure 2).

For each error type, an additional assessment of likelihood (how likely the error is along the ordinal scale of low, medium and high) and criticality (would the error be critical in system terms, where critical is defined as serious loss in plant, product or personnel) is made. We have found that it is essential to use experts in the domain in question when forming these judgements. Finally potential recovery tasks (i.e., those subsequent occasions when the error might be trapped) and remedial strategies (i.e. ways of preventing the error, or at least, minimising the consequences) are identified. This latter assessment is used as a focussed way of looking at changes that could be made in the organisation to make the working practices more robust. Remedial strategies can include changes in equipment design, procedures, training and organisational policy.

Figure 3: Error potential in drilling



The analysis provided by the SHERPA can be summarised into a table showing the dimensions of likelihood and criticality (Figure 3). This summary provides the organisation with an overview of the safety of its working practices, which can be used as a baseline with which to compare. In addition, groups of activities may be compared to see the extent to which some working practices are inherently more risky than others. The critical-high likelihood category would be given priority when developing remedial strategies.

Whilst SHERPA analyses the robustness of activities of people, it says nothing of their attitudes to effectiveness and safety. For this reason, we have developed the ESQ (Effectiveness and Safety Questionnaire). The ESQ taps into individual perceptions of the organisation's effectiveness and attitude to safety. The ESQ distinguishes among 12 main areas:

• Safety priorities (the commitment of people to safety);

• Communication (degree of openness of communication channels);

• Training (the relevance and effectiveness of training);

• Environment (level of physical comfort);

• Individual (people roles in safety and production);

• Procedures (effectiveness of rules and procedures);

• Design of work (planning of tasks and balance of work load);

• Design of equipment (appropriateness of equipment and ease of use);

• Management (effectiveness and responsiveness of middle and upper management);

• Investigation (effectiveness of current audit systems);

• Emergencies (practicability and practice of emergency scenarios);

• Maintenance (maintenance planning and availability).

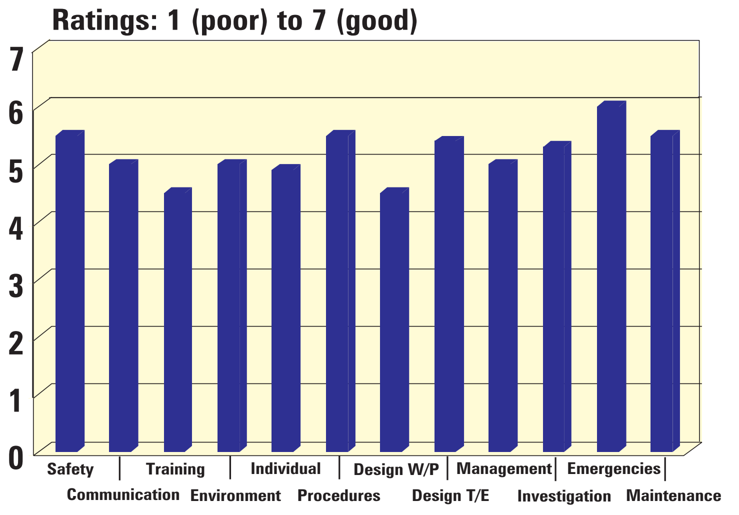
This provides a comprehensive analysis of the organisation's status (Figure 4).

The ESQ summary shows the employees' view of the organisation's performance. This analysis provides a barometer to the health of the organisation, but more diagnostic information lies in the subscales (i.e., scales under the 12 areas) and analysis of the information by department and job level within the organisation. This information can be particularly useful in trouble shooting particular problems (such as communication problems between departments) and identifying subcultures within the organisation.

PREDICTING THE FUTURE

Whilst some scoff at the idea that the fu-

Figure 4: Effectiveness and Safety Questionnaire



ture can be predicted, others suggest that making some calculation about relative alternative possibilities allows the organisation to choose between alternative courses of action. As STEPP, HTA, SHERPA, and the ESQ offer a statement of the present, it is also possible to use these methods to present views of the future. HTA requires that appropriate changes are made to the task structure to reflect how working practices will look after the changes. The goal hierarchy is quite useful in this respect, as they may not change very much despite dramatic changes in tasks. For example, different personnel might take over duties, mechanisation might remove some tasks, and new equipment might introduce new tasks. Alternative task structures could reflect the alternative strategies that an organisation might wish to investigate. This information could be assessed in terms of the error potential of the new working practices using SHERPA. The SHERPA analyses could be compared to see which solution is the most robust and if any areas need to be further resolved. A SHERPA analysis of the current situation offers a series of remedial strategies to make the work system more effective. In the predictive mode, a new analysis could anticipate the effects that these changes would have on the new working practices. The ESQ make it easy to compare system safety under a variety of regimes. The ESQ enables organisations to focus on those areas that come below par. Whilst it is true to say that improvements in all areas is desirable, most gain is likely to come from addressing the areas of greatest concern. It is acknowledged that peoples perceptions are much slower to change compared to working practices, because people need time to accept and adjust to the new culture. In previous studies we have noted changes occurring over 3 years and feel that this is quite realistic. Finally, the STEPP analysis allows an organisation to revisit an incident and test whether it could recur with the new working practices, reduction in error potential and changes in culture. If the organisation has been successful, the answer should be negative.

The approach presented would make the organisation well placed to implement change. The HTA would enable them to develop appropriate person specification and training programmes, so that they could ensure that the right people had been selected and they were trained to the appropriate standard. The SHERPA would help in producing the safety case, together with the relevant engineering information. ESQ provides a focus for determining which aspects of the organisational culture need to be addressed, so planned changes can occur. Finally, STEPP should provide some reassurance that the changes have led to a better system of working.

WHAT NEXT?

At the beginning of this article we how effective your organisation was in terms of assessing its working practices and making predictions about change. Given the information that you are now armed with, we suggest that you are in a position to answer those questions. We have emphasised effectiveness and safety throughout. The 2 concepts go hand in hand. Scrutiny along the lines we have laid out will optimise both, and ensure that the organisation has more control over its destiny, rather than inadvertently following a path without knowing what options are available. ■

Trainers Corner

Advanced well control curriculum breaks mold on traditional training

Randy Davis, Aberdeen Drilling Schools

SINCE 1997, ABERDEEN Drilling Schools have been conducting advanced well control training. The program was originally developed in cooperation with **British Petroleum** to enhance the understanding and in-depth awareness of senior supervisors and managers.

The mold was broken on traditional well-control training. With the theory of enrollment through engagement and interactive exchange, the days were split to achieve 2 objectives.

First, the theory of abstract and technically challenging well control is undertaken in an open discussion classroom atmosphere. Led, encouraged and stimulated by a resident PhD nuclear chemist, the class contributes equally by bringing their varied experiences to a peer assistance and lessons learned environment. The classroom sessions, due to the intensity of subject matter and technical exercises, were limited to the mornings only.

The second session provided a hands-on practical session to realistically simulate field conditions. This was achieved with an in-house, full-size drill-floor simulator. The value added by the small class size (limited to 6) is in allowing all to have equal opportunity and experience in the different roles and responsibilities during a well control situation.

Equally beneficial to the learning process was the ability to re-create and replay situations that did not always have the desired outcome, in order to achieve the necessary results. The simulator sessions were designed to give realistic, relevant, scenarios to which people could relate and if necessary utilize in the field. The focus of the week being off- bottom kicks, a number of scenarios are developed to examine the benefits of certain well-control methods. The various possibilities with either a subsea stack or surface stack are examined throughout the week. In combination with the variety of equipment, various technical challenges are added to really stretch even the most experienced personnel. With current industry trends toward horizontal and deepwater drilling, it was obvious to elevate the learning curve towards these high profile risks to give depth to practical knowledge as well as to operational risk assessment procedures. The aim was to not only benefit the practical address of well-control situations but equally to enable the planning process with a more robust process.

The results of the first 2 years have shown a much stronger commitment and equally a different procedure for achieving such an important industry goal. On the learning front, the testimonials are numerous as to the benefits of advanced technical training focused at learning and not at passing a job required exam. The added value to drilling operations will be better well planning and a more integral approach to well-control situations.

ABOUT THE AUTHOR

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