

Current human interaction models applied to facilitating a HAZOP analysis

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SUMMARY

There are a number of current human interaction models used in counselling and other disciplines. These models have not previously been applied to the facilitation of HAZOP studies.

The pivotal role of the facilitator can be enhanced or diminished by his behaviour during the study. By focussing on the purpose of the analysis and the role of the facilitator, the analysis will be more effective.

The positioning of the facilitator (interested-disinterest) within the team can be used effectively to encourage the maximum participation from all the people involved and minimise the factors that discourage participation.

The presence of detractors from the task on hand can also reduce the effectiveness of the study. Detractors may include extrinsic factors such as the room layout, the number of rest breaks and the scope of the study; and intrinsic factors such as an unwillingness to contribute, a personality clash and covert agendas. The effect of these detractors can be minimised by strategies such as goal hypothesis, the power of naming, and strategic questions.

Developing a goal hypothesis for each of the participants in the meeting can be used to develop an understanding of the covert agendas that may be held. The process of naming a concern can be used to reduce the possibly damaging effects of side comments and unwarranted criticisms. Strategic questions can be used to bring out and address the covert agendas and inappropriate behaviours that may be present.

The use of human interaction models in studying the role of a HAZOP facilitator will improve the effectiveness of the HAZOP analyses, and thus lead to safer plants.

INTRODUCTION

HAZOP analyses are a mature form of safety study used in the process industries. These analyses identify scenarios in which design limitations and process fluctuations could cause hazards to people and plant. HAZOP analyses are undertaken once the design is essentially complete but before construction has commenced.

The importance of various human factors in HAZOP analyses has been mentioned by a number of authors (1, 2, 3, etc). However, there is a lack of published literature or practical guidance on how to facilitate a HAZOP taking into account current models of human interactions. This paper provides information on ways in which these human factors can be managed by the facilitator in HAZOP analyses.

What is a HAZOP Analysis?

HAZOP (HAZard and OPerability) analysis originated in ICI in the 1960's (3) and is defined as a formal, systematic, critical and rigorous examination of the process and engineering intent of new and existing facilities (4).

A HAZOP analysis is a systematic detailed study following a pre-set agenda. A transdisciplinary team

conducts the study using members from a variety of backgrounds and responsibilities. These members represent all the groups with a responsibility for the design or operation of the process. A HAZOP analysis concentrates on exploring the possibility and consequences of deviations from normal or acceptable conditions and is an audit of a completed design (5).

The popularity of HAZOP analyses is due to the documentation of “due diligence” and their cost effectiveness. While HAZOP analyses have a high initial cost, they have been shown to be cost effective in the prevention of major design flaws, resulting in significant financial savings. It is thus important that the best analysis effort be obtained from the people undertaking the study. Thus human factors need to be understood and utilised in the preparation and performance of the analysis.

The importance of interactions between team members is acknowledged in a recent International Electrotechnical Commission (IEC) Standard. “The success of a HAZOP study essentially depends on the knowledge, experience, honesty and effort of the team members, working under experienced leadership. The technique is not 'an exact science' and its application depends greatly on the interactions between the team.” (1)

Trans-disciplinary "team" as a HUMAN WORK SYSTEM

One of the strengths of HAZOP analysis that helps it stand out against other risk analysis techniques is its use of people with expertise from multiple areas of work. Where a group of people, from differing professional backgrounds, is formed for a common purpose, the group is called a multi-discipline, inter-disciplinary or trans-disciplinary team. In organisational theory, these groups are referred to as human work systems (HWS). It is proposed that in line with recent changes in systemic therapy[‡], a HWS is more than just a collection of professionals from different backgrounds, it is a network of knowledge and beliefs that, when brought together, create a problem solving system (6). In a HAZOP analysis the HWS acts as an inverted problem solving system. Rather than solving a problem, the HWS finds potential problems using an intensive examination of the proposed design via the application of guide words.

In summary, a HAZOP analysis is a process of examining a design for the purpose of finding or identifying problems. This is done within a defined period, by a trans-disciplinary team of people, with a variety of skills and knowledge, conglomerated as a human work system.

ROLE OF THE HAZOP FACILITATOR

The facilitator of the HAZOP analysis has a pivotal role within the HWS in helping it through the process of problem discovery. All participants have significant roles to play but the facilitator has the primary function of keeping the process on task (that is without distractions) and the members participating so that the end product is of value. The facilitator conducts the analysis process by leading the people into becoming an integrated network of mind (7, 8). An integrated network of mind is an ideal state where the people work so closely together that they are like one person with the sum of knowledge and experience of all the individuals.

The facilitator

The facilitator best fulfils his[§] role by continually posing himself a series of questions. This technique of asking questions is called curiosity (9, 10) or may be called "the art of not knowing" (11). The curiosity or “not knowing” technique is based on the questioning style of Socrates as presented by his disciple Plato (see for example *The Meno*). The facilitator stimulates the functioning of the HWS by the technique of curiosity or “not-knowing” always encouraging the participants to focus on problem finding.

[‡] Systemic therapy has its origins in systems theory, as presented by Von Foerster (12) and applied to human interaction by Bateson (7). In summary, systems therapy views human interaction as as though people are part of a system where understanding of a particular phenomenon is larger than what one individual may see. Systemic therapy practitioners consider that problems are best understood by having multiple perspectives (13).

[§] Although HAZOP facilitators may be of either sex, the masculine gender is used throughout this paper for ease of reading.

In one HAZOP study (on a batch chemical plant), the facilitator had extensive knowledge and experience of similar plants. However, it would have been harmful to the group interactions, if the facilitator acted as both facilitator and expert. The facilitator was able to elicit the points of knowledge from the group by asking questions such as: "What would happen if the glass vent gas line cracked during the reaction?". By not telling the group the results, the facilitator prompted problem finding within the group while maintaining his role of facilitator.

There are many things that a HAZOP facilitator needs to remember in the process of fulfilling his role. Perhaps there are two themes that need to be remembered above all else especially when using the questioning technique. The facilitator is advised to remember:

- The purpose of the analysis (Why are we here?)
- The role of the facilitator (What is my job right now?)

Within the tradition of Socratic questioning, it is suggested that the facilitator keep in mind these key points in the form of questions. By answering these questions of himself during the analysis, the facilitator will ensure that he keeps himself on task and will be continually helping the HWS fulfil its purpose in the HAZOP study.

Purpose

As previously stated the HAZOP analysis exists for a purpose, that of discovering/ identifying problems. When all the facility has been studied, and all the identified problems formulated, then the analysis is completed. Alternatively, if it becomes evident that the HWS cannot effectively identify problems then the group should disband. If the participants veer too far off the purpose of the study for too long, they are not fulfilling the task at hand. Sidetracks may be interesting and in another context useful (e.g. socialising or redesigning aspects of the plant) but they are out of place in a HAZOP meeting.

Role

Just as the HWS or "team" exists for one purpose only, the role of the facilitator exists for one purpose. That purpose is to see the successful completion of the study. The facilitator should not have a personal stake in the results of the analysis but is present to ensure that the participants effectively work towards producing the best possible results. In fulfilling this broad objective the facilitator must be looking at strategies to:

- Help participants focus on the task,
- Help participants be effectively involved or engaged in the task.

Focus

In facilitating an effective analysis, the facilitator will look at what needs to happen to ensure that the participants are able to be focused on the task and not be too distracted by other (covert) agendas. No one can remain focused ad infinitum so, after a period, participants will need to veer off the task or take a break. While the facilitator must allow this and sometimes encourage it he can not afford to let the digressions go too far. Neither can the facilitator himself lose focus for too long. If focus on the task can not be established then the facilitator should simply adjourn the meeting and recommence another time.

Involvement

Since involvement by all members of the HWS is necessary - almost by definition of a HAZOP analysis - the facilitator should be asking himself how he might get everyone to be constructively involved. This issue is briefly discussed below when we look at aspects that help distract people but will be more fully explored in a subsequent paper on techniques for managing difficulties that might arise in HAZOP studies.

POSITIONING OF THE FACILITATOR: INTERESTED-DISINTEREST

The questions of how the facilitator best keeps the analysis team on task and fully participating are tackled within the context of another presuppositional question. This presuppositional question focuses on the strategic position that the facilitator wants to take within the group.

The pre-suppositional question for a facilitator who wants maximum participation from the analysis team should be:

How do I position myself so I can:

- encourage maximum participation from all people involved, and
- Minimise (or ideally eliminate) the things that discourage participation?

The position suggested is one of "interested-disinterest". In terms of being disinterested, it should be clear that while the facilitator may conduct and direct the meetings he does not actually do the analysis. The facilitator did not design the plant, will not have to work the equipment, does not own the company and probably will not have to suffer the consequences of the analysis. The facilitator does not necessarily have the expertise to fulfil any of the analysis functions to the standard of the participants. The result of this is that the facilitator is superbly disinterested in the outcome. The facilitator is a visitor to the project who looks on with curiosity and distant empathy, and then leaves (14).

On the other hand, the facilitator is supremely interested in the process of the analysis. Managing the process of the HAZOP analysis is the facilitator's primary, and possibly only, function. Doing it right is why the facilitator exists in that group of people, at that time and place, for that purpose and in that role.

Constructionist therapy is a development of systemic therapy and advocates team leaders not attempt to solve the problem but be experts at managing the team. This suggests, for HAZOP analyses, that the facilitator of a problem solving system become an expert at not solving the problem; whilst remaining an expert at managing the development of the HWS (6, 15, 16).

It is a paradoxical situation where the facilitator is very interested in the analysis process and is necessarily disinterested in the content of the analysis. The facilitator has the position of both belonging to the group and yet not belonging. This is called being in a "meta position" as the facilitator always stands away from the group or "behind" the process and yet is intimately involved (17, 18).

In taking a meta position while conducting the process of a HAZOP study, the facilitator appreciates that while the participants may overtly adhere to the purpose/goal of the study (overt agenda) the participants often have another purpose (covert agenda). The facilitator does not necessarily see this as either good or bad but acknowledges that it exists and must be taken into account in running the study.

PREPARING FOR DISTRACTIONS

There are many things that can help participants get off task or distracted, for the facilitator it may sometimes seem like the main intent of the participants is to get off task. Aspects that help people get off task can be classified into two broad groups. This is not a perfect dichotomy but it helps in thinking and planning for the analysis. There are those factors that can be considered external (extrinsic factors) to the participant or group such as layout of the room. There are also factors that people bring with them (intrinsic factors) into the room, such as beliefs about the value of HAZOPs, disagreements they may have with other participants or feelings resulting from a fight with their partner at home. Extrinsic factors are mostly concerned with the physical environment, and how conducive it is to focusing on the task. The intrinsic factors are much harder to identify and deal with, as they involve minds, personalities and beliefs. While it is possible to guess what beliefs or other agenda people may be bringing into the room it is impossible to be sure.

Extrinsic factors

The following is a list of extrinsic factors that are relevant to HAZOP analyses.

1. Room layout

2. Numbers of copies of drawings and notes
3. Presence or absence of a table
4. Recording medium (butchers paper/ whiteboard/ computer with or without wall display)
5. Focus of attention - choice of guidewords not too broad or too focussed
6. Duration of meetings and number and duration of breaks
7. Number of participants
8. Adequacy of scope definition - keeps the participants concentrating on the relevant aspects
9. Adequacy of design description - gives the participants enough information to understand fully the design.
10. Understanding of guidewords meanings
11. The extent or the scope of the study.
12. The agenda for the study.

These extrinsic factors have been extensively discussed in the literature on ergonomics, etc and will not be re-addressed in this paper (see for example Kroemer (19)).

Intrinsic Factors

Some of the common intrinsic factors that are found to be relevant in this type of study are:

1. An unwillingness to contribute to the process: perhaps because of a lack of ownership of the process or fear of being embarrassed.
2. "Personality conflict", conflict between persons in the group whether because of past dealings or different styles of working.
3. Incompatible covert agendas for the meetings. It can be assumed that everyone has, to some degree, another agenda to the stated one.
4. Conflict, both individual and corporate (company politics)
5. Ignorance of the intent of the meeting or the HAZOP process

STRATEGIES FOR THE FACILITATOR TO HELP PARTICIPANTS KEEP ON TASK

Several strategies may be employed by a facilitator to keep the HWS on task and effective. Three are presented briefly here and will form part of a later paper that particularly explores the difficulties encountered in conducting a HAZOP analysis as well as current systemic therapy techniques for managing them.

Goal Hypothesis

To manage the differences between each of the participants' desires/ needs/ covert agendas, the facilitator may develop a goal hypothesis (16, 20). The facilitator may hypothesise about what else a particular participant wants to achieve in being in the group. Often the unspoken agenda is compatible with the official agenda of the study but sometimes it is contrary to the study's goals. If it is the former then it may be possible to achieve both but if the latter then the facilitator will need to address the conflict and have it resolved.

One recent HAZOP analysis was initiated by a company constrained by a fixed price contract for the design. They were concerned that the HAZOP analysis, while being conducted properly, did not introduce extensions to the design of the plant, which would have increased the cost of the plant. Conversely, the representatives of the client wanted to ensure that the plant being designed was adequately safe and able to be operated without difficulty or expense.

The facilitator hypothesised that the goal of the designing company participants was to accept the design without modification. The facilitator was then able to interact with the participants in a more effective way by suggesting that particular aspects were genuine safety hazards. Similarly, the facilitator hypothesised that the goal of the client participants was to improve the design. Thus the facilitator was

able to advise that other particular aspects being suggested were a nice-to-have feature but not essential to the safe running of the plant.

Confrontation - The Power of "Naming"

Within the context of a HAZOP analysis it is at times appropriate for the facilitator to confront team members, particularly if their goals are incongruent with the goal of the analysis. The act of confronting is perhaps the thing that the facilitators most fear when working within the HWS. Fortunately, there are several effective ways to deal with these goal incongruities. "Naming" is one such technique, which has been shown to be particularly effective in group interactions (17, 21, 22, 23). This is illustrated in the example provided below.

During a break within an extensive HAZOP analysis, one participant remarked, as an aside, that "of course, when the HAZOP team writes an action commencing with 'Consider installing a...' the design team will ignore it". During another break, the comment was made that "You really skated over some of the important issues there". Although each of these comments was made in an informal venue, they had power to change the opinions of the participants against the process of the HAZOP analysis. In each case, following the break, the comment was detailed, or named, by the facilitator. This forced the participants to discuss the comments openly and determine whether they were of concern. The comments lost their force to disrupt the analysis through being addressed formally by the team. In the first instance, the project leader was asked for his assurance that all recommendations would be seriously considered and not treated lightly. In the second instance, the team re-examined the previous section and considered that all the issues had been adequately discussed and that the recommendations were appropriate. By naming the concerns, their ability to disrupt the flow of the HAZOP analysis was nullified.

Strategic Questions

If the facilitator takes the stance of curiosity or purposely not knowing then he will naturally be asking questions (10). Questioning is a natural part of HAZOP analyses (e.g. How can excessively high flow occur in this section of the plant?). However, the questions referred to in this section are those associated with the process of the HAZOP study (e.g. Why are you attacking the ideas of the other participants?). These questions become more sophisticated when testing out a goal hypothesis. Hypothesis testing questions are called "embedded questions" (24). This is discussed below in the context of an example.

In a HAZOP study, there were two groups within the HWS, one responsible for the design and the other responsible for the operation of the plant. As the study progressed, the facilitator developed a goal hypothesis that the designers thought that the operators wanted the plant over-designed to make it easy to operate and give them an easy life. To test out this hypothesis without directly attacking any of the participants, the facilitator asked, of one of the designers: "If I ask the operators, what his main concern could be about this design, what might he say?". This, rather convoluted, question forces the designers to verbalise their thoughts that the operators wanted an easy life. After this acknowledgment, the group could face and discuss the different views and overtly appreciate the differences between them. In most HAZOPs, this will reduce the tension level and help to refocus the attention on the plant being studied, rather than on the other group.

The question, asked by the facilitator, was an embedded question because it contained the thought that the operators wanted an easy life but did not commit the facilitator to that thought. If the goal hypothesis was not accurate, the answer to the question would have enabled the facilitator to refine his hypothesis of the participants' goals.

CONCLUSIONS

There is a significant body of knowledge related to the interactions of people in groups. This knowledge has been used in other disciplines but has not been previously applied to HAZOP analyses. By using current systemic therapy techniques, a HAZOP facilitator can improve the group's effectiveness. The specific techniques recommended for use in HAZOP studies include:

- positioning the facilitator as interested in the process of the study and not in the outcomes,
- the use of goal hypotheses to understand the participants covert agendas,
- the use of naming to address and defuse attacks on the process, and
- the use of strategic questions to test goal hypotheses.

The use of these current systemic therapy techniques increases the ability of the HAZOP team to find problems in the plant being studied and thus increases the ease of operation and reduces the risk of accidents.

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