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PRACTICAL TIPS FOR GATHERING INFORMATION

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Engineers working in process plants are problem-solvers. They play a very important role in process-plant troubleshooting. For example, consider the following situation:

> *The quality of a product from a certain unit has been degrading for some time and for some "unknown" reason. You are a plant support engineer and you have been called upon to help. Your job is to identify the root cause, to quantify the business benefits of solving the problem, and then to suggest ways to eliminate the factors causing the problem.*

What is problem-solving, and how does it begin? The verb "solve" comes from the root *solvere,* which means "to loosen, release, or set free." The word "problem" comes from the roots *pro,* meaning "forward," and *ballein,* meaning to "throw or drive." So, problem-solving is a process of proposing and considering questions in a way that throws or drives us forward toward greater freedom.[1]

In their entertaining book, *The Universal Traveler,* Don Koberg and Jim Bagnall define the seven stages of creative problem solving as "acceptance, analysis, definition, ideation, idea-selection, implementation, and evaluation."[2] Clearly, being aware of a problem's existence is the first step. Gathering information about the situation is the next step. One can learn about the situation through literature and document searches, by direct observation, and by gathering information from people closest to the problem. This skill of gathering data from others is a critical success factor for all practicing engineers. Whereas gathering information from literature and the Internet is emphasized in most engineering courses, to the best of my knowledge, training in how to gather information from others is not offered.

The main objective of this article is to share some practical ideas on improving the speed and effectiveness of the process of gathering information from others. It is based on my experience in designing and conducting opportunity and support needs assessment surveys for process modeling in process plants. Although the article will focus on techniques for more organized information gathering (such as surveys and on-site visits), the principles illustrated are equally applicable to informal information exchanges. This domain of designing and conducting surveys has been developed extensively by social scientists. I will begin first by defining the prerequisites for effective information exchange and then I will provide specific guidelines on how to pose the right questions. The article will also include a brief discussion on how one might be able to use this information in a classroom setting.

KEY PREREQUISITES

Early in my career, I learned that communication consists of a message, a sender, a receiver, a medium, a context, feedback, and noise.[3,4] For gathering information, the message is the "questions," and the medium may be a printed survey or a face-to-face interview (*i.e.,* spoken words). I have discovered five key prerequisites necessary for creating the right context, capturing the feedback, and minimizing noise.

Trust • This is the first prerequisite. Thanks to authors such as Peter Senge[5] and Stephen Covey,[6] discussions on trust and trusting are becoming more acceptable, even among hard-core engineers. Trust is the foundation of all effective communication. The survey recipients must clearly understand the purpose of the information exchange. They must know "why" the information is being requested and "how"

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their information will be used.[7,8] It is the interviewer's obligation to pursue the truth and truly believe in doing everything to benefit the interviewees. Of course, trust cannot be mandated, and there are no shortcuts to building trust. Vendors of software and associated services have the challenging task of overcoming a history of "lack of trust" created by their industry—for example, customers do not believe in software release dates. Also, in dealing with process manufacturing plants, the issue of confidentiality of information is very important and must be explicitly addressed prior to any useful information-gathering session.

Credibility and Respect • The second prerequisite to effective information-gathering is the interviewer's credibility in the domain of the specific inquiry. People are more open to answering your questions if you have already established a track record, either with the site or the process or the field of inquiry (*i.e.,* if they respect you). There are pros and cons to this phenomenon. You may be very talented and may have a novel approach to solving problems; but you may not be effective simply because you are new. Also, due to this emphasis on "credibility," it is very tempting to use the jargon of the business superficially to establish credibility, but experience has shown me that instead of attempting to appear knowledgeable, it is better to admit that you are new to the field.

Effective Listening • This is the third prerequisite. Honest and open exchange of ideas is possible only when you have a genuine interest in the views and opinions of the interviewees. One of the best definitions of effective listening comes from Dr. Stephen Covey. He equates effective listening to faithful translation. The main requirement to having a dialogue and not just a discussion is to be completely open to the outcome. This is at the heart of any true discovery process. The word "dialogue" comes from two Greek roots: *dia,* meaning "through," and *logos,* meaning "the word." It carries a sense of "meaning flowing through." The word "discussion," on the other hand, stems from the Latin *discutere,* which means "to smash to pieces." Additional useful information on the topics of "Inquiry" and "The Art and Practice of Conversation" is presented in Ref. 5.

Proper Timing and Setting • This is the fourth prerequisite. One of the biggest challenges for engineers and operators in process plants is to make time available for surveys and audits. Hence, the surveys must be aesthetically designed and the participants should be given ample time to complete them. In a face-to-face information-gathering session, the room in which interviews are conducted should be comfortable and open, with several whiteboards and easels. During a scheduled plant turnaround, a plant is typically shut down for several weeks. This period is used to make major modifications to the process and to install new plant equipment. Many of these new items have to be ordered six to nine months in advance, and it takes about three to six months to develop detailed specifications for major items. So the best time to conduct opportunity assessments is about nine to fifteen months prior to a scheduled turnaround. In this manner, the recommended revamp-type projects can be implemented during the turnaround period.

Gratitude • This is the fifth prerequisite. It helps immensely if your demeanor conveys a genuine sense of gratitude toward those from whom you collect information. In today's atmosphere, it seems that everyone's agenda is full all the time, so even if you do not find some of the responses to be useful, it always makes sense to thank the interviewees or survey participants for their time. It is also important to publicly acknowledge any contribution made by others to the success of your projects.

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GUIDELINES FOR POSING QUESTIONS[7-9]

After having satisfied the above prerequisites, one may still not be effective in conducting surveys and on-site interviews. This is where the "science" of asking questions comes into play. The following quotes and events signify the importance of questions and questioning:

- "You can tell whether a man is clever by his answers. You can tell whether a man is wise by his questions."
  Naguib Mahfouz
  Winner, Nobel Prize for literature, 1988[1]
- When Richard Feynman was a child, his Mother asked the future Nobel Prize winner the same question every evening at the dinner table: "What did you ask at school today, Richard?" (Feynman won the Nobel Prize for physics in 1965.)[1]
- Hammurabi of Babylon changed the course of history by changing the representation when dealing with the problem of an inadequate water supply. Instead of asking how to get the people to the water, he asked how to get the water to the people. This led to the invention of canals.[10]

Creation of the proper context is necessary for both printed surveys and on-site interviews. In a printed survey, the content and the order of the questions must be carefully selected. In a face-to-face interview, in addition to the choice of words and their sequence, proper tone of your voice plays a very important role.

I will begin with a brief discussion of different types of questions. Then I will provide guidelines on wording of questions and maintaining a flow for the on-site interviews.

Types of Questions

In his book *Just So Stories* (1902), Rudyard Kipling (who won a Nobel Prize for literature in 1907) had this to say about types of questions: "I keep six honest serving men. They taught me all I know. Their names are What and Why and When and How and Where and Who." The "how"-type question is the most open-ended. The "why"-type question may put the interviewee on the defensive. At some point in time, the questions beginning with "why" are essential to finding the cause of the problem; initially they may not be very effective, however.

Yet another method of classification also results in six types of questions. They are questions pertaining to experience/behavior, opinions/values, knowledge, feeling, sensory, and background (or demographics).[9] For each type of question, one can ask about the present, the past, or the future.

Questions pertaining to experience or behavior or actions are easy to answer and should be used first. Sensory- and background-type questions are mundane and should be dealt with toward the end of the on-site interview. Questions pertaining to participants' opinions/values and knowledge are very important for identifying symptoms and causes of problems, but they require proper context-building prior to their use. It is important to gauge the level of an individual's knowledge about a given situation without making it seem that you are testing him. Engineers, in general, tend to shy away from "feelings"-type questions and, hence, they should be kept to a minimum.

For the time-frame, it is always appropriate to start from the present and then move to the past and then to the future.

GUIDELINES ON PROPER WORDING[8,9]

Basics • First, ask truly open-ended questions. "How satisfied are you with the performance of this heat exchanger?" may seem like an open-ended question, but it is not. Second, it is important to ask a "singular" question (*i.e.,* refer to only one idea per question). A good question should be relatively short, clear, and unambiguous. Do not run a string of questions together. If you want to ask a string of related questions, then ask one at a time and get a response before proceeding.[11] The question, "How often do you measure the pressure drop across this exchanger, how good are the measurements, and do you know the cause of the sudden increase in the pressure drop?" should be split up into three separate questions.

The third basic rule is to use the terminology and language of the interviewee or survey-recipient. Be careful of acronyms such as QIT, BIP, PIP, etc., because they may have different meanings at different plants. If you do choose to use acronyms, it is always beneficial to define them.

A Few No-No's • In the beginning, avoid questions that result in "yes" or "no" responses. The whole idea is to get the participants to "open up." Also, avoid "why" questions in the beginning. From our childhood, we have been conditioned to associate some type of blame with the word "why." ("Why" did you break this vase?) The objective of gathering information from others is accomplished when you make them feel comfortable about the situation and encourage them to have a dialogue with you.

Proven Techniques • Presupposition-type questions are good. For example, "What is your most important idea regarding the cause of fouling?" This question presupposes that the interviewee is capable of having several good ideas about the cause of the problem. Questions pertaining to tough topics or questions that seem too direct can be softened considerably either by role playing (*i.e.,* putting yourself in a new role in the question) or by simulation (*i.e.,* putting the interviewee in a new role in the question). Rather than asking, "What do you do in the plant in the morning?" ask, "If I were your colleague accompanying you in the plant, what would I observe?" And, instead of asking a unit engineer, "What are the goals of the entire plant?" try, "If you were the plant manager, what would be your top priorities?"

Keeping the Flow • It is very important to keep the on-site interviews flowing smoothly. This depends on several factors. Establishing rapport with the individual and maintaining neutrality toward the information they provide are very important steps for keeping the flow. It always helps to make transitions smooth rather than abrupt by making specific announcements before the transitions. Prefatory statements such as, "The next question may seem a bit vague," are very useful to ensure that the interviewee is not under undue pressure to look for a precise answer. Elaboration, clarification, and contrast-type probes are very useful in getting some individuals to talk. Of course, thanking the interviewee for providing a response to a tough question is also effective in keeping the flow of the process. In general, it is very hard to get engineers to converse openly with you, but occasionally you will come across individuals who try to monopolize the conversation and will not stop talking. In such cases, it is important to emphasize, in a conversational tone of voice, that everyone's time is important. The flow of the process can be easily disrupted by long-winded or irrelevant comments.

CLASSROOM APPLICATION OF THIS MATERIAL

One easy way to make students aware of the issues involved in gathering information from others is to ask students to read this article and spend about an hour discussing the topic in the classroom. As an additional homework assignment, you may ask students to watch the 1996 Twen-

tieth Century-Fox movie, *Courage Under Fire,* which clearly demonstrates that the same event (or a problem) can be perceived very differently by different people. Since the right psychology and information may not exist readily in most chemical engineering classrooms, the only way to directly practice the techniques prescribed in this article is by simulating a few real-life situations in a classroom setting and requesting students to play specific roles. One such approach, which requires a fair bit of preparatory work, is described in the Apppendix.

CONCLUSION

Engineers and managers are problem solvers. An important step in identifying and defining problems involves gathering data. Since every situation is unique, it always helps to gather information about a situation from the people who are closest to it. The techniques for gathering information from others are very important for process-plant troubleshooting and are not emphasized enough in formal chemical engineering education.

The main point is that one will be able to easily acquire useful information from others by ensuring that the prerequisites such as trust, respect, effective listening, proper timing, and gratitude are met and following the guidelines for correct wording, sequence, and tone of the questions. Practicing the techniques without the prerequisites is possible, but only results in manipulation and deception and should be avoided at all costs.

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APPENDIX
An Experiment for Testing the Ideas in a Classroom Setting

Preparation • At the beginning of the experiment, divide the students into groups of five. Provide each group with a handout or script describing a specific situation. Examples of such situations include safety incidents, environmental excursions, product quality problems, etc. You may use the published case studies from books, such as those by Lieberman,[12] Saletan,[13] etc., to create the specific scenarios. On each team, assign one of the following roles to each student

- Operator
- Plant Engineer
- Tech-Support Engineer from a Central Group
- Plant Manager
- Chemist

Assigment • To identify, define, and solve problems faced by all the other teams.

Rules • Give students about four weeks to complete the assignment. Request that the students

- Not reveal the actual script or handout to anyone outside of their team
- Play the assigned roles as faithfully as possible
- Only answer the questions being asked while remembering the mindset of the role they are playing
- Document their strategy for gathering the required information
- Document their feelings, thoughts, and any other reactions to the mode of inquiry used by each of the other teams.

Criteria for Grading

- Number of problems identified
- Number of problems solved
- Nature of the means used to obtain information
- Impact on the feelings of others during the process of gathering information
- Quality of the document describing the strategy used to acquire information
- Quality of the document describing the feelings and thoughts during the inquiry by other teams. ❐