

ENGR. ALIYU, S.J.

LECTURE NOTE: GEC. 226.

GEC226 General Engineering Laboratory II (3 Units)

Laboratory investigations and report submission on selected experiments and projects drawn from introduction to electrical Engineering, Materials science, Applied Mechanics, Applied computer Programming I, and Workshop Technology courses.

LABORATORY INVESTIGATIONS AND REPORT SUBMISSION

REPORT PRESENTATION

❖ **Presentation of your report is very important.**

❖ **Title page should include:**

Lab name.

Experiment number and name.

Student surname, name.

Laboratory group.

Experiment date

Lab. supervisor name

Objective of the test should be briefly explained (**IN YOUR OWN WORDS**)

- **Data**, collected during test, should be tabulated.
- A **sample calculation** will be performed for a selected load condition
- All **results** will be presented in a tabulated form.

Graphs: Selected graphs from the following will be drawn.

- a) Corrected brake horse power
- b) Corrected torque
- c) Brake mean effective pressure
- d) Brake specific fuel consumption
- e) Brake thermal efficiency
- f) Volumetric efficiency
- g) Actual air-fuel ratio
- h) Excess air coefficient

While plotting above graphs on a milli-metric-paper you are supposed to draw the trend lines of the above properties versus engine speed.

- **Discussion & Conclusions:** (Graphical outputs will be your domain for this section. Graphs and reasons for observed performance characteristics will be explained.

Also discuss the possible sources of errors that may be encountered in the experiment.

FORMAL REPORTS

Each formal report is worth 10% of the final grade in the course. All reports must be typeset on letter size paper using one-inch margins on all four sides. The font size must be 12 pt and you must use a “1.5 line” line spacing. The following page limits will be strictly enforced. Information beyond these page limits will be disregarded during evaluation. More detailed information on the structure of the formal report is given below.

Table 1: Page Limits for formal reports.

Summary	One Page
Introductory Material (Including introduction, theory, apparatus, procedure, results. Not including table of contents, list of figures etc.)	Minimum of Eight Pages
Discussion of Results	No limit
Conclusions	No limit
Appendices	No limit

NOTES REGARDING DEADLINES:

The final version of your report will be assessed, a penalty of 25% if submitted up to 24 hours after the time it is due. Reports submitted beyond this 24-hour period will not be marked and will receive a grade of zero. All items are due at 4:30pm on their due dates. Students who fail to submit the required number of final reports, or who fail to submit the Assignments will receive a grade of less than 45% in the course. If circumstances arise which make it difficult to submit a report on schedule, permission to submit a late report should be obtained from the Course Coordinator. In normal circumstances, extensions will only be given for medical or compassionate reasons. The week of midterms does not count with respect to the 2 week due date. For example if you conduct an experiment on the Thursday prior to midterm week, it would be due in 3 weeks as the week of mid-terms does not count. Similarly if your report is due on Wednesday during mid-term week it would be due the following Wednesday. Reports due the week of the mid-term tests can be submitted the following week. Submit final reports to the Course technologist. Remember to indicate the group number, the members of the group, and the date the lab was performed on the title page.

LOG BOOKS

Each student is required to keep a log book. This book must be a hard covered notebook with non-removable pages. They are suitable for recording notes, observations and data, and for sketching diagrams, graphs and tables. A complete entry in the log book should include a brief statement of the purpose of the experiment, brief notes and questions recorded during the reading

of the lab manual and other background material, notes and answers to questions recorded during a meeting with the faculty member, departmental assistant and/or the lab technologist, sketches of the apparatus, an outline of the procedure and notes taken to supplement the procedure described in the manual, a summary of data and calculations, and notes of significant observations, points for discussion and conclusions. These last two items are very important. An entry in a log book is complete when it contains enough information for the author to write a lab report without reference to any source other than the lab manual. The log books of Professional Engineers are frequently entered as evidence in a court of law. The court requires pages to be numbered consecutively and each page to be dated. Information in the log book should be legible and neat. Errors must be crossed out and **not** erased. Notes in point form are appropriate, as are free-hand sketches of apparatus, specimens, graphs and tables. Copies of computer programs and output should be glued to the page. Xerox copies of discussion and conclusions are not permitted. Note that it is not necessary to include all of the data generated by a computer program in a log book. Selection and editing is frequently required.

The following are some specific points to remember when making log book entries.

1. Leave the first few pages of the log book blank for a table of contents.
2. Date all work. Individually date and number pages.
3. Provide an outline of the experimental procedure or refer to handouts. Especially note any deviations from the procedure in the lab manual.
4. Effective notes should be taken while the laboratory technologist is reviewing the theory, background information, and/or procedure for the lab. **It is not acceptable to obtain a copy of the technologist notes and paste them into your log book.**
5. Always draw a sketch of the equipment used and provide relevant dimensions.
6. Title sections. (e.g. System Head Calculations)
7. Always show units of measured and calculated data.
8. All data **MUST** be entered directly in the log book. You cannot record data on a scrap piece of paper, typeset the data, print it out and paste it into your log book. You can reformat **data already recorded in your log book** and paste it in if you wish.
9. Plan data tables before starting the experiment.
10. Tables should be titled and/or a description of content provided.
11. Indicate whether data is measured or calculated.
12. On graphs of measured data, recorded points must be identified.
13. When possible compare your results with published or known data.
14. If your results are not working out, seek advice from one of your instructors.
15. Note that log books may contain material which has been crossed out or crossed out and corrected.

Log books are submitted to the Laboratory Technologist at the end of the lab period to be graded. The marked log books will be returned within 24 hours to the filing cabinets for record purpose. Log books are evaluated for completeness, overall organization, legibility, quality of the data, and quality of the discussion and conclusions. It is acceptable to add further information and/or discussion after your log book is returned to you, which may be helpful for the final lab exam.

CONTENTS OF A FORMAL REPORT

The general format of the report should be as follows:

Title Page

Summary (Pg. ii)

Table of Contents: List of Figures; List of Tables (page. iii, iv, etc.)

1. Introduction (page 1)

2. Theory/Analysis

3. Apparatus

4. Procedure

5. Results

6. Discussion of Results

7. Conclusions

References

Appendices

More detailed guidelines for each of these sections will be given to you at the various laboratory.

GROUP DYNAMICS AND TEAM BUILDING.

Introduction

The subjects of group dynamics and team building are broad. One can study each of these topics for years and still have more to learn. There are many ways to approach each. A simple Internet search will result in thousands of web sites on either group dynamics or team building. These subjects are important because they influence how productive a group or a team becomes. By understanding group dynamics and by doing some team building, a group can increase how much it accomplishes.

Understanding Group Dynamics

The term “group dynamics” refers to the interactions between people who are talking together in a group setting. Group dynamics can be studied in business settings, in volunteer settings, in classroom settings, and in social settings. Any time there are three or more individuals interacting or talking together, there are group dynamics. A great deal can be learned by observation. If one sits back quietly in a group — any group — one will begin to see certain behavioural patterns emerge. There will be at least one person who tends to take the lead in conversation, offering his or her thoughts and opinions freely. There will be at least one person who remains quiet, sometimes not even appearing interested in the conversation. There may be someone who tends to interrupt other people, someone who wants the conversation to move along faster, or who wants to focus on a different subject. Another person may be concerned about peoples’ feelings and may try to make everyone feel equally welcome. These are only a few of the roles that people assume without even thinking about it when they are in a group setting.

Group roles are largely determined by a combination of a person’s personality and his or her experience with group settings. A person who is shy is more likely to sit back in a group. A person who is impatient is more likely to push the discussion ahead. A person who is very confident will offer more opinions. If such roles are more or less pre-determined, how can the group dynamics be improved? The way a group interacts can be improved in several ways. There are training programs to attend and there are tests one can take to learn about one’s communication style. Perhaps the simplest way to improve a group’s dynamics is for one or more group members to learn to *manage* the discussion, and thus help a group accomplish its goals, much as a conductor manages the many players in an orchestra to produce a blended sound. By “manage” we mean respond to and redirect the behaviour or participation of an individual to a direction that is better for the group. Whether or not the group is managed, group

roles will occur. By learning about the typical kinds of behaviour that emerge, and how to respond to them appropriately, one can improve the effectiveness of group discussions. The two most common roles affecting a group's effectiveness are the person who dominates and the person who remains silent. It can be as difficult to get the quiet person to speak as it is to get the talkative person to talk less. To manage the dominant person, one might say something like, "You have a lot of good ideas, Akinbolade. I have written them down to discuss later. For now, we need to talk about _____." To the quieter person, one might say, "What are your thoughts on this subject, Toyin?" It is best to ask the quieter person a question that cannot be answered by a simple "yes" or "no." A broad question "casts a wider net," to use a fishing analogy. In any case, a direct and respectful approach is recommended where possible. (Note: In some cultures, directness is not appropriate. In some cultures, directness is acceptable, but only between certain types of people. This is an example of when a reader may have to "translate" a suggested behavior into his or her own culture.) There are a variety of other roles that may emerge in a group. In addition to being influenced by culture, roles are influenced by gender, age, race/ethnicity, religious tradition, and other traits. Finally, one should be aware that the management of group dynamics can emerge from any group member. The person with the authority to lead (the chairperson or group convener) may not be the person who is best at actually managing group dynamics. Any group member who sees an opportunity should *seize* the opportunity to improve the effectiveness of the members' interactions. The entire group is responsible for its own effectiveness and all members share equally in that responsibility. The chairperson or convener has agreed to perform certain duties, but it should not be assumed that he or she is the sole leader. Indeed, we will see below in the section on team building that an effective group or team is one in which each member assumes responsibility according to his or her talents and expertise.

Getting Acquainted

Since group dynamics and team building are based fundamentally on the relationships among the people involved, it is both courteous and sensible to assure that the members all are introduced to each other, and that they are offered opportunities to get to know each other and to build relationships. A group or team with members who know each other well is likely to be more effective. People tend to offer more of themselves when they are with people whom they know than when they are with strangers. It is therefore a good idea to spend some time helping people get acquainted with one another. Often we assume people know each other when they do not. A common feeling among newcomers is that the more senior members of the group are somewhat exclusive. This is because the senior members know each other better and have well-established patterns of communication. They have past experiences in common and they may forget to explain certain references to the newcomers. This can lead to a feeling of exclusion, and if it is not corrected, the newcomers might leave the group. It is the responsibility of the current members to help the newcomers get oriented to the group and to its members. The more one gets to know another person, the more he or she will understand that person. The better people understand each other, the more effectively they can work together. Taking five to ten minutes to get acquainted at the beginning of a meeting is a very sound investment of time.

Clarifying Expectations

Underlying every perception is one's expectation. "Expectation" is that often-unspoken idea we have of how things are going to be, or how people will behave, or how people will react. Many times people are surprised when something happens that is different from what they expected.

They may be so surprised that they are unable to react appropriately to the reality, because they are so caught up in their expectation. In any group of individuals brought together for a purpose, every one of those participants will likely have a slightly different expectation of what is going to happen and how it is going to happen. This underlying expectation may colour an individual's reactions to the stated agenda. Therefore, it is a good idea to spend a minute or two clarifying members' expectations. It can even become a part of the "getting acquainted" stage. A simple, open-ended question can put the expectations on the table: "What do you expect us to accomplish today?"

Group Problem Solving

Groups tend to form for one of two reasons: either for purely social purposes (a celebration, for example) or to get something accomplished. In the latter case, there will be some form of problem solving required of the group. It is when a group is trying to accomplish something that the interactions or dynamics become stronger, especially if the group is under constraints in time and resources. Successful group problem solving depends first on good communication among the members. By "communication" we mean the sharing of information by everyone. Silence does not mean approval. In fact, *we do not know what silence means until it is broken*. We do know that each person has a contribution to make. Members must offer what they know, what they observe, what they think, what they feel for the group to be most effective. The following are some recommendations for effectively solving a problem as a group.

- Each member should understand the total problem or task. Someone, usually the chairperson or task leader, should summarize the task that is to be done. He or she should seek clarification from the members to assure that everyone understands what the group will be doing.
- Each person should realize how he or she can contribute to the solution. Everyone has talent and skills that they were born with, as well as talents and skills they have acquired. Most of us tend to downplay or minimize what we have to offer. Problem solving is no time to be modest about one's talents. All available skills and talents should be on the table for use by the group in solving its problem.
- Each person should recognize the potential contributions of others. Again, *everyone* has talent and skills they were born with, and those they have acquired through education and experience. Sometimes we recognize a talent or skill in another person that they do not fully realize themselves. It is helpful to give that person encouragement to participate.
- Members should be willing to recognize when other members may need more information or assistance, and to offer their help so that each member can make his or her full contribution to the effort.
- Negotiation is important to success. The very differences that bring many talents into a group also bring in different opinions and perceptions. The best solution is one that everyone finds acceptable. The group should make decisions based on what is in the organization's best interest.
- It is the group's responsibility to help manage the group's dynamics; for example, to help the shy person to contribute, and to help the dominant person make time available for others to speak.
- Everyone operates with assumptions and expectations, and it is important to clarify what those are at the beginning, and whenever it may be necessary.

- Sometimes members lose sight of what the original purpose was and may get sidetracked. These “detours” can waste a lot of the group’s time. It is important to keep the purpose, goal, or task in mind, and to bring the discussion back to the stated focus. This is the shared responsibility of all group members.
- Everyone has leadership qualities, and leadership may change depending on the situation or task. Leadership means influence; the person with the most influence is not always the person with the most authority. If a member sees an opportunity that is in the group’s best interest, he or she is obligated to call that opportunity to the group’s attention.
- Not every task is appropriate for a group. Writing, for example, is best accomplished by an individual. Drafting a budget is better accomplished by an individual. The result or product may be approved by the group, but the actual task of writing or calculating should be performed by an individual.

TEAM BUILDING

What is a team? It is a group that has a job to do, whether as paid participants, as volunteers, as researcher, as a student,..etc. It is a group that has spent some time together, whether in smaller increments over a long period of time, or by spending a weekend or more working together on something. It is a group that achieves cohesiveness; a team’s strength is found in the relationships among the team members. It is a group with a common objective, whose members are very clear about working toward one purpose. It is a group whose members are *interdependent*. Whereas other groups may recognize the strengths of each member, team members *rely* on the strengths of each member to accomplish the objective.

An ideal team has a number of distinct characteristics, and they fall into three areas: their feedback and communication behaviours, their behaviour and conduct courtesies, and their ways of approaching tasks and problems.

- “Feedback and communication behaviours” describe how the members talk with one another, clarify their expectations, react to each other’s ideas and offer their perceptions and opinions. In an ideal team, the members:
 - Ask for help from other members when it is needed and do not waste precious time struggling alone;
 - Give positive comments to each other regularly and often, because they know it motivates teammates;
 - Give negative observations when necessary, but do it constructively, for example: “Engr. Komolafe, that proposal you wrote is very good, but it’s a little weak in the evaluation section. Engr. Aliyu has done a lot of evaluations, perhaps he can help”;
 - Receive negative observations from another member without becoming defensive, because they know the comments are not meant to be insulting, but are meant to help the team accomplish its goals;
 - Support other team members in times of crisis, for example: “Dr. Ajayi, I’m sorry to hear about your family illness. Why don’t you go home and I will finish your assignment”;
 - Offer help to others when their own work is completed.
- “Behaviour and conduct courtesies” describe the protocols that the members have agreed to as a responsibility of being a member of the team. In an ideal team, the members:

- Are ambassadors of that team, and represent the team, not just themselves;
- Remain open-minded and receptive to all ideas, however different from their own;
- Give another member time to get his idea out, and paraphrase the idea to assure they understand the intended message;
- Take turns speaking;
- Encourage full participation by all members;
- Do not have side conversations during a discussion, because participants might miss something important (and because it is disrespectful of the others);
- Stay focused on the task at hand, and do not engage in distracting behaviours;
- Call a time-out if they feel another member's behaviour is disruptive;
- Make the team meeting a priority so that attendance is consistent;
- Begin and end meetings on time, so members can use their time most efficiently;
- Obtain closure on topics and get a decision;
- Summarize and clarify the meeting at the end.

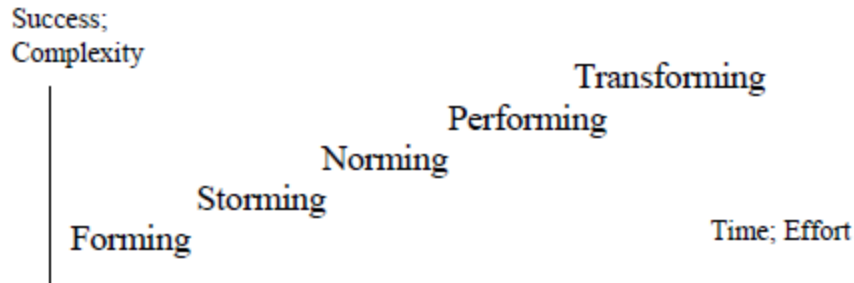
Ways of approaching tasks and problems. In an ideal team, the members:

- Accept every problem as a *team* problem, not one belonging only to one member;
- Never say "we cannot do this," but say "how *can* we do this?";
- Determine the action items that any decision requires, or think through how to carry out decisions;
- Share failures as a team, never blaming only one or two members;
- Look at failures as a way to improve the team functioning, because we can always learn something from failure;
- Share all information, so that everyone is working from the same body of information;
- Use consensus for major decisions, which results in finding the most acceptable decision for everyone, as opposed to voting, in which there are clear winners and losers;
- Stay focused on the purpose of the team, which is to accomplish something together.

A successful team will monitor its own effectiveness and progress. Any member of the team who observes that the team is underperforming has the responsibility to bring it to the attention of the entire group so that appropriate action can be taken to correct the problem. Occasionally, there may be a member of the group who is not really there to advance the group's objective, but perhaps to advance his or her own individual objective. If the person remains unwilling to put the group's objective first, then he or she may have to be removed as a member, or reassigned to a different group that better corresponds with his or her personal objectives. High-performing teams take whatever steps may be necessary to remain focused on their purpose.

TEAM DEVELOPMENT.

Teams and groups are living organisms with certain predictable stages of development. One characterization of the progression of team development has been depicted by a series of steps on a graph. One axis represents success with tasks that are more and more complicated, and the other represents the amount of time and effort that the group has invested in becoming a team. The graph looks like this:



- “Forming” is the initial stage of development, when team members may often have differing ideas about purpose. There is relatively little trust. People tend to be careful about what they say, and how they say it. Everyone is on his or her “best behaviour.”
- “Storming” represents the arguing that will likely occur as the team defines itself. There may be conflict about the purpose, leadership, and working procedures. During this stage people often feel the team will never “come together.” This stage is similar to the human developmental stage of adolescence.
- “Norming” is the stage that occurs when the team members are developing a shared vision and are setting goals and objectives. People are getting to know one another’s strengths and are learning how best to work together. The team experiences more stability and productivity.
- “Performing” indicates that the members now have a clear, shared sense of purpose, high trust, and open communication. The team is effective within the existing paradigm. Camaraderie, relationships, and team spirit are high.
- “Transforming” occurs when the team is at such an effective level of functioning that it can redefine its shared purpose and respond quickly to change. The leadership within the team is shared, trust is high, and communication is open.

The point of knowing about the stages of a team is two-fold:

- (1) It can be helpful simply to know that there *are* stages, and that it is normal to go through these stages;
- (2) One can identify the stage of development for a given group or team, and can assist the progress through that stage by managing the interactions or dynamics between and among the members. If there is low trust, one can arrange for trust-building exercises. If the team is in discord about its purpose, there are techniques for helping to determine the common priorities.

Achieving Group Consensus

Arriving at a decision can be a difficult process for a group. Many groups resort to voting to decide issues. When possible, it is useful to work to achieve consensus. Consensus differs from voting in that it is more a process of achieving maximum agreement. A topic is discussed until every member is willing to agree. That agreement might be more enthusiastic for some members than others, but all members are on the positive side of agreeing. Like problem solving, consensus requires that everyone share whatever information, opinions, facts, or feelings they may have. It is through this pooling of contributions that the group is able to come to a decision that satisfies everyone. There are a number of activities that can help groups practice consensus building. Typically they require each member to answer individually some sort of questions or rank-order a list of items. When each has completed the task individually, the group then sets about making one list. Invariably the group rankings are more accurate than the individual rankings. This is because there is greater knowledge in the group than in any single individual.

Achieving consensus requires some negotiating. Individual members are usually convinced that their original answers are correct. Only through listening to someone who thinks differently can one begin to see something in a different way. Explaining the reason behind one's thought can help others to see its merit.

Finally, when everyone is committed to a common purpose, the task is more easily accomplished. Commitment to a purpose helps one move past one's own initial thinking, and allows one to listen to a diversity of ideas. Through this the group achieves the best result, by benefiting from the best of all of the members.

Conclusion

More can be accomplished with groups than can be achieved by individuals alone, but to be productive a group must remain focused and healthy. One analogy is to liken a group to a motor vehicle. A group, like a vehicle, can get someone to a place faster. Most of us are more interested in our destination than we are in the vehicle that carries us there. However, if we do not pay attention to the vehicle, it will fall into disrepair. A group, too, needs fueling and maintenance.

Another analogy is that of a garden. One plants a garden and then tends to it, giving it water and nutrients, removing the weeds, and with sufficient time and attention the garden flourishes. A group, too, needs nourishment, and to have its "weeds" (e.g. inappropriate behaviours) removed. One cannot take a group for granted, any more than one can take a garden or a vehicle for granted. To do so invites problems. It is far better to give some time and attention to the group's dynamics from time to time. By doing so, a group can sustain its forward development and achieve its full potential.

INTRODUCING PRACTICAL DESIGN EXPERIENCE IN CLASSROOMS.

Guided designs projects aim to bring practical design experience into the classroom. Often conducted over a period of a semester, the projects give students an opportunity to work in a team environment, apply theory learned in the classroom.

Scope

Guided design projects are appropriate for any level, but are often reserved for junior and senior levels. As with the case method, choosing a project is typically the hardest part. Using guided design projects usually requires a lot of preparation by the Lecturer/Technologist. One of the best ways to have students appreciate the industrial design methodology is to have them redesign existing systems or products.

Strategies

The following are some tips to remember when using a guided design project:

- Realize that the project is not as important as the thought processes that go into determining a design. It is not important that the students determine an optimum design. What is important, however, is that they experience the design process.

- Starting before the semester, determine the scope of the projects and the goals for the class. It is important that the scope of the project is reasonable, and care must be taken to ensure that the students are not overloaded.
- When possible, divide the design into sections. This spreads the work for the students and the grading duties over the semester. Design teams of two or three students are frequently used. This allows for in-depth projects, reduces the grading load of the Lecturer/Technologist, and promotes interaction among the students.

Example: Redesign of a parking garage gate

The following guided design project was used in a course on the mechanics of materials. The goal of the project chosen for this class was to redesign a gate at a parking garage so that it deflected on impact from a car. The gate is required to deflect upon impact in order to avoid serious structural damage to the car. The project was divided into three parts so that the work would be spread over the semester. The first part involved brainstorming to determine the best methods to meet the requirements. The students worked together in teams generating ideas. Then the entire class spent part of a lecture discussing the various ideas. In the debate, the Lecturer/Technologist guided the class towards a consensus about a design that would satisfy all requirements and yet be easy to complete. The student assignment for the first part was to write up and hand in a summary of their two best designs, the advantages and disadvantages of each, and which design that they would choose and why. The second part of the project involved determining the loads on the gate. This required the students to synthesize knowledge from several courses that they had taken earlier. Also, the Lecturer/Technologist had to devote extra time in class and during office hours to explain methods for determining loads on a structure. The final part of the project involved actual measurements and safety considerations. Having determined the loads, the students proceeded to complete the final part of the project where they determined the actual sizes of the various components used in the design. As a last step, the students used failure theories discussed in class to ensure the safety of the design.

Conclusions

The student response to this project was encouraging. They said that they enjoyed the project despite the fact that they had to work harder. The students felt that the class had a clear purpose and that the practical design aspect of the project improved their understanding of the theoretical sections covered in class.

BRAINSTORMING

Encouraging Creativity

The brainstorming technique is widely used in industry and academia to encourage participants to generate ideas in an unhindered manner. In an academic context, brainstorming encourages

students to participate actively in idea-generation exercises and experience benefits of a multi-dimensional approach to analyzing problems or solutions.

Scope

The brainstorming technique is applicable to all levels of the engineering curriculum and to all teaching scenarios - labs, lectures or discussion sections. It is especially useful in design courses since it calls for a multiple-answer-multiple-dimension methodology rather than the usual single-answer approach to problems. The brainstorming technique can be implemented in a number of different ways as follows:

1. Structured: The whole class is given a topic to discuss and each student is called upon to contribute an idea. The advantage of this method is that all students participate and the more vocal students tend not to dominate the discussions. The disadvantage is that the discussions usually do not flow freely as in an unstructured session, and can make some students feel pressured and uncomfortable.

2. Unstructured: Students are allowed to contribute ideas as and when they think of them. This approach allows for a freer flow of ideas and a more relaxed environment. The drawbacks to this approach are that it can lead to the students not responding at all or to a few students dominating the discussions.

3. Group: This is a structured approach except that the class is broken into small groups and each group presents its ideas after an allotted amount of time. The advantage of this method is that the students are likely to be more at ease and willing to express their ideas. This also promotes synergy and communication among the students. One obvious drawback to this method is that it more time-intensive than the other two methods.

Guidelines

The following guidelines should be followed with any of the above methods:

- Make sure that everyone agrees on the question or issue being brainstormed. Write it down on a chalkboard, for example, or give handouts.
- Never criticize students' ideas or allow students to criticize each other.
- Do not allow students to reject ideas initially. Ideas should not be weeded out until the brainstorming is completed. This keeps the solution path from becoming prematurely narrowed.
- Write every idea down. Use a flip chart, blackboard, overheads, post-it notes, or other visual methods.
- Use the words of the speaker when recording; do not interpret.

Conclusion

Brainstorming provides a forum for students to express creative ideas. It encourages students to be open-minded when analyzing problems, an attitude that is required for solving most real-life engineering problems which have multiple solutions.

GROUP DISCUSSION TECHNIQUES.

It is often assumed that the best form of group discussion is that which has one person at a time speak to the whole group. This is true for some discussions. But, sometimes, other techniques of group discussion can be more productive and efficient than whole group discussion. The following are some of the more common and frequently used techniques. These could be suggested by anyone at the meeting. Therefore, it is a good idea if everyone is familiar with these techniques. Again, be creative and adaptive. Different situations require different techniques. Only experience reveals how each one affects group dynamics or the best time to use it.

Identification

It is good to address each other by name. One way to learn names is to draw a seating plan, and as people go around and introduce themselves, write their names on it. Later, refer to the plan and address people by their names. In large groups, name tags can be helpful. Also, when people speak, it is useful for them to identify themselves so all can gradually learn each other's names.

Whole Group

The value of whole group discussion is the evolution of a group idea. A group idea is not simply the sum of individual ideas, but the result of the interaction of ideas during discussion. Whole group discussion can be unstructured and productive. It can also be very structured, using various facilitation techniques to focus it. Often, whole group discussion does not produce maximum participation or a diversity of ideas. During whole group discussion, fewer people get to speak, and, at times, the attitude of the group can be dominated by an idea, a mood, or a handful of people.

Small Group

Breaking into smaller groups can be very useful. These small groups can be diads or triads or even larger. They can be selected randomly or self-selected. If used well, in a relatively short amount of time all participants have the opportunity to share their own point of view. Be sure to set clear time limits and select a note taker for each group. When the larger group reconvenes, the note takers relate the major points and concerns of their group. Sometimes, note takers can be requested to add only new ideas or concerns and not repeat something already covered in another report. It is also helpful for the scribe to write these reports so all can see the cumulative result and be sure every idea and concern gets on the list.

Brainstorming

This is a very useful technique when ideas need to be solicited from the whole group. The normal rule of waiting to speak until the facilitator recognizes you is suspended and everyone is encouraged to call out ideas to be written by the scribe for all to see. It is helpful if the atmosphere created is one in which all ideas, no matter how unusual or incomplete, are appropriate and welcomed. This is a situation in which suggestions can be used as catalysts, with ideas building one upon the next, generating very creative possibilities. Avoid evaluating each other's ideas during this time.

Go-rounds

This is a simple technique that encourages participation. The facilitator states a question and then goes around the room inviting everyone to answer briefly. This is not an open discussion. This is an opportunity to individually respond to specific questions, not to comment on each other's responses or make unrelated remarks.

Fishbowl

The fishbowl is a special form of small group discussion. Several members representing differing points of view meet in an inner circle to discuss the issue while everyone else forms an outer circle and listens. At the end of a predetermined time, the whole group reconvenes and evaluates the fishbowl discussion. An interesting variation: first, put all the men in the fishbowl, then all the women, and they discuss the same topics.

Active Listening

If the group is having a hard time understanding a point of view, someone might help by active listening. Listen to the speaker, then repeat back what was heard and ask the speaker if this accurately reflects what was meant.

Caucusing

A caucus might be useful to help a multifaceted conflict become clearer by unifying similar perspectives or defining specific points of departure without the focus of the whole group. It might be that only some people attend a caucus, or it might be that all are expected to participate in a caucus. The difference between caucuses and small groups is that caucuses are composed of people with similar viewpoints, whereas small group discussions are more useful if they are made up of people with diverse viewpoints or even a random selection of people.