Evaluating System Complexity

This document provides guidance on group problem solving, reaching consensus, and avoiding biases. Then, several techniques and approaches that may aid system complexity evaluation are described.

You do not have to use the techniques or approaches listed here to evaluate system complexity. When evaluating the complexity of a system you are encouraged to use any technique or approach that you feel is suitable.

1. Group problem solving

Research has demonstrated that groups gathered to solve a problem often follow a process that tends to move through time from a relative emphasis on *orientation* to the problem, to *evaluating* the problem, and subsequently to *control (Bales & Strodtbeck, 1951*). While emphasising *orientation*, participants in a group problem solving setting tend to show solidarity with each other, tension relief (e.g., jokes, laughter), and tend to offer agreement (e.g., concurring with each other, demonstrating understanding). As emphasis shifts to attempted answers to the task at hand (*evaluating* the problem), participants tend to give their suggestions, opinion (e.g., analysis, expressions of feelings), offering and asking for repeats or clarifications from other participants, and asking for suggestions from other participants. As groups move into an emphasis on *control*, participants tend to start showing disagreements, tensions and antagonism.

Group problem solving requires careful management of not only solving the problem at hand (that is *orientation* to the problem, *evaluation* of the problem, decisions, etc.,) but also managing tensions and integrating different viewpoints.

Bruce Tuckman *(Tuckman, 1965)* developed the "forming-storming-norming-performing" model of group development. This model argues all groups follow this process sequentially although different factors affect the duration of each phase. The "forming" stage is about the team gathering and introducing themselves and each other, setting goals, and beginning to tackle the task at hand. The "storming" stage is where the group starts to mobilise more readily and develop trust to tackle to the problem at hand, often with participants raising their opinions and perspectives which can lead to potential conflicts. It is during the "norming" stage that resolved disagreements and clashes result in a greater intimacy and co-operation within the group. Finally, during the "performing" phase, participants can turn their focus to achieving common goals and solving the problem at hand, having already established group norms and roles. It should be noted that not all teams progress through all four phases, due to various factors. Later research *(Tuckman & Jensen, 1977)* added a fifth and final stage to the model, entitled "adjourning", which emphasises completing the task at hand and breaking up the team.

2. Reaching consensus

Organizations often assign problem-solving tasks to a group of people, as opposed to an individual, as it is generally assumed that groups perform better at some complex tasks; perhaps because there is too much information for an individual to handle, or because a range of perspectives are required *(*Stasson et al., 1991*)*. Group problem solving can provide additional benefits to an organization, such as leveraging increased "buy-in" to the eventual solution. Further, group problem solving allows participants to learn from others in the group, potentially enhancing individual problem-solving ability. Within a group problem solving setting, some high performing teams have been found to build a consensus on a decision. This emphasis on building a consensus can be contrasted with

decision making done by voting, where candidate ideas and solutions have clear "winners and losers". Instead, building a consensus may develop a richer understanding of the problem by seeking trade-offs and compromising in an attempt to satisfy group participant's concerns.

There are several approaches to building a consensus, ranging from the simple to the complicated. First, participants in a group may simply enter into a group problem-solving situation with a deliberate, or conversely an unconscious, awareness of group consensus. Secondly, organizations that set the problem to be solved by the group may specify a form of consensus as a criteria to be satisfied in the problem solving. Third, approaches such as the Delphi Technique can be adapted to develop and build consensus. The Delphi Technique was developed by the RAND Corporation in the 1950's *(Rescher, 1998)* as a technique to support forecasting. The technique is based on the premise that estimates, or evaluations, from structured groups are more valid and likely more accurate then equivalent judgements from unstructures groups; where biases may hinder the discussion. In the Delphi Technique, participants are asked to provide an evaluation or estimate anonymously to a central facilitator, this facilitator collates evaluations from all participants before distilling them down and feeding back to the every participant the results; agreements, disagreements, etc., all whilst maintaining the anonymity of each participant. The participants are encouraged to revise their evaluations based on the feedback they have seen and the process repeats until a pre-determined exit criteria is met (i.e., a consensus, a stable result, a time deadline, etc.). It is argued that by providing participants with anonymity and structured communication, the group can avoid biases such as; "anchoring" to the first idea or estimate, assuming that more senior roles have more accurate estimates, and reducing the role of individual ego. The Delphi technique can be adapted to be conducted virtually in a distributed

sense or to take place face-to-face. The performance of the Delphi technique over conventional approaches is contested in academic literature.

Building a consensus is not necessarily a desirable constraint to place on a group in a problem-solving setting. Further, aspiring towards or achieving consensus does not guarantee an improved solution to the problem or improved group performance. Building a consensus is affected by various other factors and can introduce additional challenges and biases.

3. Avoiding biases

A bias can be defined as "cause to feel or show inclination or prejudice for or against someone or something". There are several biases which may affect group problem-solving. Some of these biases may be conscious or unconscious. It may be argued that an awareness of common biases can help guard against impaired decision-making or problem-solving. The following are adapted from *(Lebowitz, Lee & Business Insider, 2015)*:

- Anchoring Bias. People may be over-reliant on the first piece of information they hear. E.g., in a salary negotiation, the first offer establishes a range of possibilities in each person's mind.
- Availability heuristic. People may make decisions based on information or recent experience that is readily available to the, whether or not that it is the best example to inform their decision.
- Bandwagon effect. See also "Groupthink" (*Janis, 1972)*. The probability of one person adopting a belief may increase based on the number of people who also hold that belief.

- Confirmation bias. People may listen to, or focus on, information that confirms their preconceptions.
- Conservatism bias. People may prefer or support prior evidence over new evidence.
- Ostrich effect. People may make a decision to ignore or down-play negative information by "burying" their head in the sand like an ostrich.
- Outcome bias. People may rate a decision based on the outcome, as opposed to how the decision was made at the time it was made.
- Overconfidence. People may rate their own abilities higher then they actually are, causing them to take additional risks.
- Pro-innovation bias. People may over-value the usefulness of innovations and under-estimate the extent of its limitations.
- Recency. People may weigh the most recent information more heavily then older information, even if both are of equal importance and relevance.
- Stereotyping. People may expect a group or individual to have certain qualities or behave in a certain way without having real information about the person.

4. Groupthink and "thinking outside of the box"

Groupthink (*Janis, 1972)* is a term coined relating to the notion that group members tend to take on the mindset of the other group members. While it can seem natural, or even desirable, for the group to reach the same conclusions when attempting to solve a problem, groupthink can result in people giving up their valid observations or individual problem-solving in favour of the group view. Groupthink can also act an inhibitor to group problem-solving more directly by hindering individual thinking. A well known example uses the "dot experiment". In this experiment, a group are presented with nine

dots lying on a grid that is three dots across and three dots wide, on a piece of paper. The group are asked to draw no more then four, consecutive lines that connect all the dots, without lifting the pen from the paper. Typically, one or several individuals within the group will create an additional constraint in their own mind, that the pen cannot leave the confirms of the grid itself, leaving no solution available to the problem. Once this additional constraint, or assumption, is demonstrated or discussed with the group, the group can quickly all adopt the same view of the problem, hence allowing Groupthink to hinder their problem solving. It is believed that from this experiment the term “think outside the box” was derived.

5. Techniques that may aid complexity evaluation

The following are potential techniques that may aid an organisation in evaluating the complexity of a system and identifying approaches to managing the issues presented by such complexity.

5.1 Brainstorming

To begin the brainstorming process, you must assess the risks that could impact your project. This starts with reviewing the information you have available and thinking about historic data and lessons learned from relevant previous experience. Anything that can provide insight into issues that might occur during the execution of the project could be important. Personnel are encouraged to share their ideas in a group setting. Brainstorming provides a free and open environment that encourages everyone to participate. All ideas are welcomed and built upon, and all participants are encouraged to contribute fully, helping them develop a rich array of creative solutions. Brainstorming brings team members' diverse experience into play. It increases the richness of ideas explored, which means that you can often find better solutions to the

problems that you face. It is important to approach brainstorming with an open mind and a spirit of non-judgment. Once everyone has shared their ideas, the group can discuss to further develop other people's ideas, and use them to create new ideas. Building on others' ideas is one of the most valuable aspects of group brainstorming. Everyone is encouraged to contribute and to develop ideas.

5.2 Stepladder

The Stepladder technique is an approach to brainstorming that helps ensure equal participation in the process, helping to mitigate feelings of shyness and mitigate biases such as Groupthink. The technique should help to ensure a broad range of ideas and perspectives are considered and provides an equal voice to those who may be hesitant to vocalise their judgements in a less structured, open setting. To utilise the technique, first, everyone is the group is explained the problem they are seeking to solve. Then, two members of the group discuss the problem and their evaluations, judgments, opinions and solutions. The remaining members of the group must quietly listen during this discussion and may not interrupt. Next, a third member is added to the group, this third member can propose ideas, judgements, opinions, etc., based on what they have already heard. The group of three members can then discuss all of the ideas together. The process repeats, with a fourth member added to the group, following the same rules as before, until all members of the group have been added. Finally, once all members have been added and allowed to present their ideas, the group can make their decision or final evaluations. The Stepladder technique is summarised as the following five steps:

(1) Explain the problem

(2) Build the ladder

(3) Continue the process

(4) Complete the ladder

(5) Make a decision

5.3 SWOT Analysis

SWOT stands for Strengths, Weaknesses, Opportunities, and Threats, and so a SWOT Analysis is a technique for assessing these four aspects of your situation. Draw a large box with four quadrants, one for each of the headings (Strengths, Weaknesses, Opportunities, Threats) and look to fill in each quadrant with relevant observations. Brainstorming may further aid the population of SWOT analysis. Once ideas have been populated, the group may find that they can add further observations by considering other perspectives existing observations; for example, perceived strengths may be interpreted as weaknesses, or perceived weaknesses may be perceived as opportunities for improvement.

5.4 Root Cause Analysis

Root Cause Analysis is a method of problem solving for identifying the root cause of an issue or problem. Root Cause Analysis can be thought of in four steps: (i) Identify and describe the problem clearly, (ii) Establish a timeline or sequence of events from the normal situation up to the time the problem or issue occurred, (iii) Distinguish between the root cause and other causal factors, (iv) Establish a causal graph between the root cause and the problem. The “Five Why’s” may help determine the root cause, by iteratively repeating the question “Why?”.

5.5 PESTLE Analysis

PESTLE Analysis is a simple and widely used tool that helps you analyse the Political,

Economic, Socio-Cultural, Technological, Legislative and Environmental changes in your environment. This helps an organisation understand the "big picture" forces of change that it is exposed to, and, from this, take advantage of the opportunities that they present. It can help you to identify various risks and opportunities, potentially providing warning of significant threats. PESTLE analysis can be used to identify potential sources of complexity and may identify approaches to mitigate potential issues resulting from that complexity. PESTLE analysis can start by brainstorming suggestions under each of the headings and recording the observations for each.