

# Problem Exploration with Bias Breaking Ideation for Maritime Emissions Reduction

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**Abstract.** This paper presents a quasi-experiment on the characteristics of innovation teams during the early stages of a project, with an emphasis on number and categories of ideas generated with quality through a bias-breaking ideation exercise. This quasi-experiment raised several interesting questions on the combination of individual and collective ideation and its relationship to more innovative outcomes (e.g., quantity of ideas, originality, transformation potential) than solely individual or group thought. Is there an optimal combination of individual and group work that fosters better outcomes? Further, the timing, quantity and quality of communication between team members is also expected to influence the outcomes of ideation processes, and constitutes another focus of this research. What are the characteristics of communication conducive to innovation?

**Keywords.** Project Teamwork, Innovation, Ideation Workshops, Collective Intelligence, Bias Breaking

## Introduction

Complex challenges require significant collaboration and flexibility to consider new approaches and combinations as compared to conventional solutions. Various techniques are used to promote innovative thinking as such. During these ideation methods there are both individual and collective stages of idea generation, evaluation, and selection.

A teamwork experiment was conducted to challenge participants in teams to ideate about new challenges in the shipping industry practicing the bias breaking methodology. The challenge addressed the maritime shipping industry's imperative to reduce CO<sub>2</sub> emissions, ultimately achieving 0% Emission Shipping by 2050. Multidisciplinary teams of 3 to 5 members reviewed conventional problem and solution spaces in order to identify established biases in the domain. Facts in terms of technology, institutional policies, societal requests, or social constructs were identified, and associated assumptions and beliefs distilled. Then, both individuals and teams were prompted to generate, evaluate, and select ideas that break these identified biases.

In the pilot experiment, teams were encouraged to ideate purely on the basis of creativity (originality, potential for disruption, surprise), without specific consideration of feasibility. The team members used a software platform in order to identify and share facts and ideas (thoughts) with one another in the form of digital sticky notes and links

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(relations) between thoughts. The software collected data of the time and changes on the ideation canvases by each team. Further instrumentation included audio recording and post-surveys.

## 1. Background and Purpose

For addressing challenges with many stakeholders, diverse needs, capabilities and various technologies, this research shares the view of engineering projects as sociotechnical systems. The complexity of problem solving is both technical and social. In combination the collective capability of teams comes from their awareness, attention, generation of ideas, exploration of a solution tradespace. The teams exhibit a collective capability to explore options balancing desirability and feasibility [1].

It is well known that for complex problem-solving, teams struggle given the high dimensionality of decisions with potential tradespaces that are huge. It is not practically possible to evaluate all options. Various uncertainties cloud the decisions. In addition to solution complexity and uncertainty, this paper deals with a third common barrier: *bias*. Bias is defined as “an inclination of temperament or outlook, especially: a personal and sometimes unreasoned judgment.” [2] “Bias, or design fixation, is said to inhibit human creativity” [3][4].

Numerous researchers have studied the effect of explicitly realizing bias to avoid it [5][6][7]. However, the effect is not consistently characterized amongst these studies. Marsh et al. [6] reported that participants failed to edit out their prior knowledge even if they were instructed to do so. On the other hand, however, Chrysilou and Weisberg found that instructions to avoid use of example designs provided to the participants diminished design fixation [5].

In addition, research has tended to study the effect in design tasks in an experimental situation, and whether these insights can be applied to more general situations of creating new ideas is still doubtful [6][8].

This research aims to investigate the result of innovation workshops where participants created a novel business idea and obtain practical implication for introducing avoiding bias to broader situation.

## 2. Research Approach

The general research approach we have followed deploys digital models and communications tools to express a challenge and gather the exploration and response of teams to a challenge. These *instrument teamwork experiments* include classic methods for setting up an experiment with a diverse set of teams, survey-based understanding of the context, demographics, and outcomes, and ethnography for participant-observer contribution to the interpretation of activity in the workshops. General description; field guide reference [9][10].

These workshops have been applied to teamwork for complex problem-solving both in very early problem seeking and ideations sessions [11] and also in the downstream team-based planning and implementation of solutions [12][13][14][15].

A “Bias breaking” workshop was held in a class of System Design Management course of Massachusetts Institute of Technology (MITsdm). Twenty-two teams of 3 to 5 people joined the workshop. All of them are students have at least three and an average

of 10 years of professional career experience in engineering systems fields. The goal of the workshop is to create an idea to achieve Zero Emission Shipping, which does not emit any CO<sub>2</sub>, in the maritime shipping industry. The International Maritime Organization (IMO), has recently set very strong regulatory targets for the reduction of emissions over the next century [16][17]. The workshop process is designed as follows to make participants explicitly recognize biases and then try to avoid these biases during generation of new technology and business strategies for the maritime industry.

### *Workshop Steps*

The workshop followed five basic steps as listed below.

#### *1. Listing conditions in conventional problem and solution spaces.*

Participants firstly listened to a presentation by people who had engaged in a project to create an idea to achieve Zero Emission Shipping. The presentation mainly included the background of the project and the conditions for creating solutions. The presentation slide is attached in Appendix. Based on this presentation, participants listed up and categorized conditions such as facts, rules, common sense, and beliefs for achieving Zero Emission Shipping. This would be a candidate of bias when creating an idea. This process was supposed to be conducted as a group work.

#### *2. Clarifying the reason why the condition should be true.*

Next, participants were instructed to think about the reason why the conditions they listed in the first step should be true. They thought about and wrote down the reason for as many conditions as possible. This process was also conducted as group work.

#### *3. Identifying which conditions are not necessarily true.*

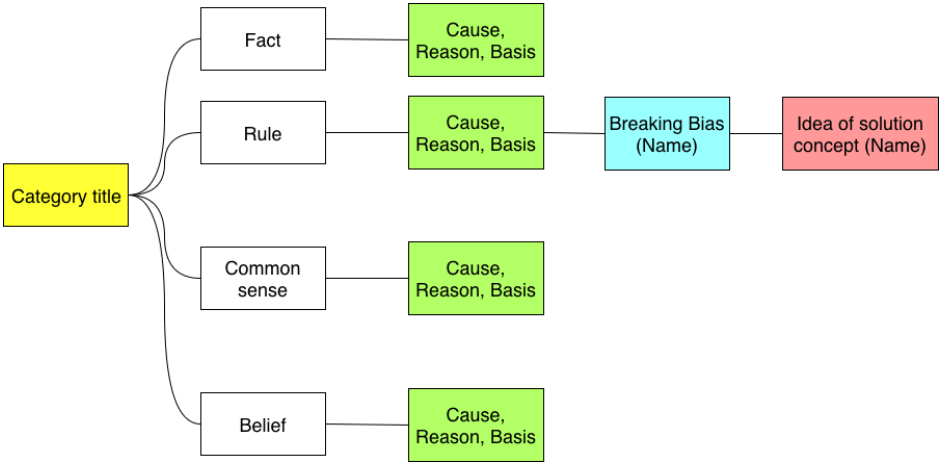
Then the next step was to identify conditions which are not necessarily true based on the result of the step 1 and 2. This process was conducted individually. Each member in a team doubted conditions without discussing with each other.

#### *4. Creating an idea to achieve Zero Emission Shipping without the identified conditions.*

The fourth step was to create an idea to achieve Zero Emission Shipping. The step 3 and 4 were practically conducted seamlessly. After identifying a condition which might not be true, participants kept on thinking individually of possible ideas enabled by an absence of that condition.

#### *5. Idea sharing and evaluation*

The last step was sharing and evaluating ideas. Each member shared his or her best idea to the team, and evaluated that idea as a group. At last, the team chose the best idea as a team and presented it to other teams.



**Figure 1.** Ideation Notes for Bias Breaking Workshop.

*Evaluation of Performance*

For measuring the performance of groups, rather than the final ideas, the “Breaking Bias” notes, which were created in the step 3 were evaluated. The main reason for evaluating these notes is the possibility to evaluate them more objectively than final ideas; the evaluation of ideas is difficult and outcomes may be driven by other intermediate factors. On the other hand, Breaking Bias notes have clearer standards of evaluation on the basis of theoretical background of the breaking bias method. In addition, evaluation of the final idea has a risk to falsely rate seemingly good ideas which were created unrelated to breaking bias as a good idea. To distinguish a successful team correctly in this reserach, only ideas which was created by breaking bias were evaluated.

Theoretically, good Bias Breaking notes should state that a condition which is implicitly held by people and limits solution space is reasonably false. Hence Bias Breaking notes fulfilling this would be a good Bias Breaking. Looking into the detail of notes which were created in the workshop, there are four types of bad Bias Breaking notes. The first type does not state that a condition is false in the first place. This includes a note which rather supports a condition, or is simply not understandable.

The second type is that a statement lacks reliability. This type includes a note which points out the possibility that the statement may be false, such as “technological advancement might make this condition false.” This type can lower feasibility of a final idea because the doubted condition might still be true.

The third type is that the way a note doubts a condition has already been already common. For example, even if a condition that ships should use oil as main energy source had been doubted by mentioning a renewable energy, this might not create new idea because utilizing a renewable energy has been considered widely. Thus, this type can lower novelty of a final idea. The fourth type is that a doubted condition might not limit solution space in the first place. For example, the fact that CO2 emissions will increase by 50% to 250% in 2050 may not limit an idea to reduce CO2. This type is mainly the reason why Zero Emission Ship is needed. Doubting this kind of point will not lead to an appropriate idea to achieve Zero Emission Ship.

Therefore, a Bias Breaking note will be rated as bad if it can be categorized into one or more of the four types. The rest of the notes will be good notes.

Although the criteria are set, it sometimes requires relatively subjective judgement. Hence all the Bias Breaking notes were evaluated by at least two people. Four people joined the evaluation in total. One member evaluated all the idea and each of three other members evaluated one-third of the ideas. If the evaluation did not match, all of the four members discussed together and decided the evaluation of that note.

Through this evaluation of Bias Breaking notes, the number of good notes was identified for each team, which serves as an indicator of a performance of the group. Following analyses were conducted to explain the difference in performance of each team.

### *Categorization of Workshop Topics*

Since effective Bias Breaking notes are defined to point out that a certain condition is false, whether a team could list up a condition which might be false is important. Thus, the number or the type of notes about conditions might correlate with the performance of each team. For verifying this hypothesis, the number of white notes created in the workshop was counted for each team. Also, all the notes about conditions were categorized into seven categories and twenty-seven subcategories. These categories were decided by grouping notes which share similar topics multiple times. Then the number of notes by each category was compared with the team performance.

## **3. Workshop Results**

### *Workshop Implementation*

Among twenty-two teams which joined the workshop, sixteen teams agreed on joining this research. Hence voice recorders were placed on the table where these sixteen teams worked. Because one voice recorder turned out to be broken, voice records were collected from fifteen teams in the end. Some of the voice records only contains discussion after the second process, which is clarifying the reason why the condition should be true, due to practical reasons. Also, the data of activity in Apisnote were downloaded for these fifteen teams and used in this research. Additionally, interviews to some participants were conducted after the workshop. This research mainly utilized three types of data mentioned above.

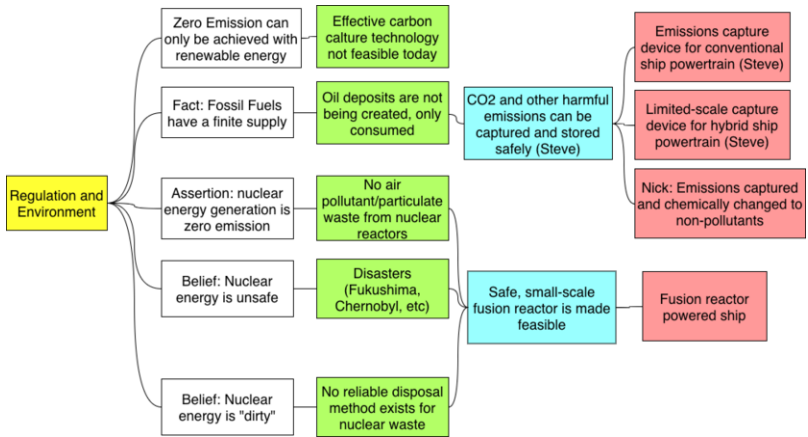


Figure 2. Sample Notes from Bias Breaking to Achieve Zero Emission Shipping.

All of the processes above were conducted with Apisnote, a web application of a shared sticky note. A user can write and post a sentence, and draw a link between each note. Every action of a user is shared in real time to the other users who are using the same worksheet. The contents of the notes were recorded and tagged with an identification number of the participant who created it and the time when it was created. Fig. 3 shows how the result of the work was supposed to be placed.

Instrumentation and Data used a digital platform called ApisNotes, which can apply to ideation workshops of various types. Not only allows collaborative real time usage, but also then records the process of creation, spatial layout, categorization, changes, and associations over time. An example of the interface for Apisnote as used in this workshop is shown in the figure below, and additional examples for the workshop making approach can be seen in source [18].

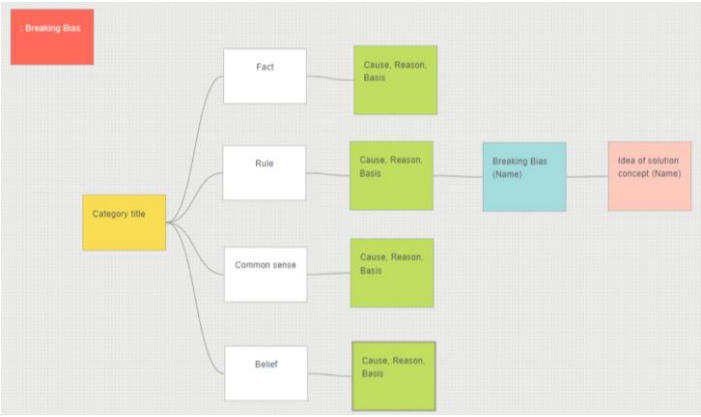


Figure 3. Example Apisnote software as used in Workshop.

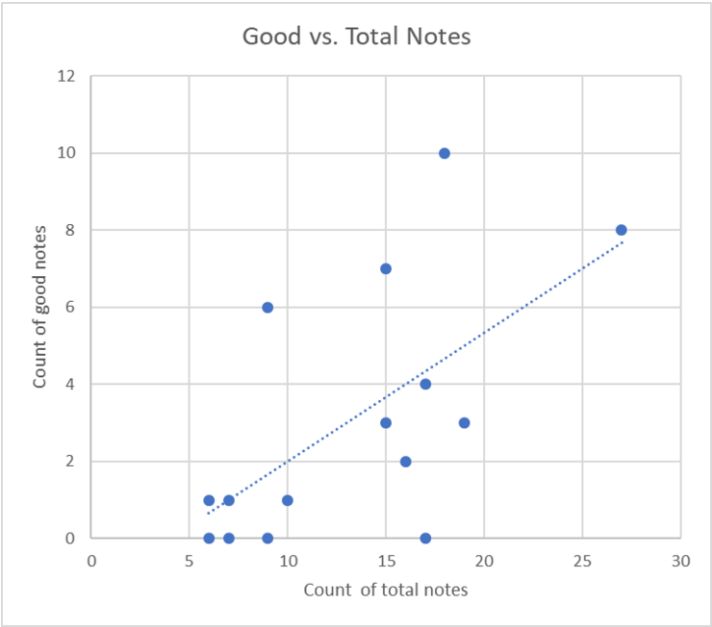
Evaluation of “Breaking Bias” notes

- The result of evaluation was summarized in Table 1. One hundred and ninety-eight notes were evaluated in total, and forty-six notes were rated as good notes.

Table 1 and Figure 4 show the number of good notes and the percentage of good notes respectively.

**Table 1.** Table Evaluation of “Breaking Bias” notes.

Team	Number of good notes	Number of bad notes	Total	% of good notes
1	6	3	9	67
2	7	8	15	47
3	1	5	6	17
4	4	13	17	24
5	0	7	7	0
6	3	12	15	20
7	0	6	6	0
8	1	9	10	10
9	3	16	19	16
10	10	8	18	56
11	0	9	9	0
12	8	19	27	30
13	2	14	16	13
14	0	17	17	0
15	1	6	7	14
Total	46	152	198	23



**Figure 4.** Trend of Good Notes to Total Count for each of 15 teams.

Analysis of notes about conditions

By categorizing every note based on the similarity of the content, seven categories and twenty-seven subcategories were created. Tables 2 and 3 show categories and subcategories, and the number of notes which was allocated to each subcategory.

**Table 2.** Number of Notes by Sub Category.

Category name	Sub-category name	Number of notes
Renewable energy	General renewable energy	12
	Solar or wind	12
	Nuclear power	5
	Other renewable energy	8
Conventional energy	Coal	4
	Fossil Fuels	6
	Batteries	4
	Diesel	1
Zero emission	Definition or needs of zero emission ship	13
	Technology for zero emission	10
	Impact of zero emission	17
CO2	Dealing with CO2	3
	Current state or future projection about CO2	25
	Reduction of CO2	12
	Effect of CO2	3
Ship system	Hull	20
	Operation	14
	Propulsion system	10
	Power	7
	Infrastructure	2
Ship business	Company	26
Macro or general topic	Shipping industry	42
	Public opinion	15
	Policy or rule	16
	Economy	2
	Technology	13
	Nature	4

**Table 3.** The number of notes in each category for each team.

Team	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Renewable energy	2	5	2	1	3	2	4	1	1	2	2	4	1	3	4	37
Conventional energy	2	3		1	1	1			1	1		2	2		1	15
Zero emission	2		2	3	4		3		10	3	2		4	1	6	40
CO2	2		4	5			1	3	8	1	3	7	3	4	2	43
Ship system	7	7	1	3		10	2		1	5	2	12		2	1	53
Ship business			3	2		1	3	2	4	1	2	1	2	3	2	26
Macro or general topic	9	1	9	8	1	4	8	7	4	2	9	6	6	6	12	92
Total	24	16	21	23	9	18	21	13	29	15	20	32	18	19	28	306



For each category, the relationship between the number of notes and the performance of the teams was analyzed. Table 4 shows the result of Pearson's correlation analysis. The number of notes about Conventional Resources and Ship System were strongly correlated with the number of good Bias Breaking notes.

**Table 4.** Correlation of Ideation Topics to higher quality bias breaking notes.

Category name	Correlation coefficient	P-Value
Renewable energy	0.1267	0.6527
Conventional energy	0.6623	0.0071
Zero emission	-0.1845	0.5104
CO2	0.0460	0.8708
Ship system	0.6973	0.0038
Ship business	-0.4967	0.0596
Macro or general topic	-0.3878	0.1532

#### *Exploration about the reason for creating important conditions.*

In the process of creating conditions, teams listened to presentation by people who had engaged in a project to create an idea to achieve Zero Emission Shipping. Hence, conditions are possible to come from the presentation slide. However, few conditions which were categorized in Conventional Resources or Ship System were written in the presentation slide. Thus, successful teams created conditions by their own and generated good Breaking Bias notes from them. To identify how they could create conditions by their own, interview will be conducted to members of both successful and unsuccessful teams. The result of interview will reveal the characteristics of teams or members which lead to the success of teams.

## **4. Discussion**

This research clarified the correlation between the number of appropriate bias breaking and the type of conditions which groups listed up in an idea creation workshop using bias breaking. Because there were little research that tried to explain factors influencing group performance in idea creation workshops using bias breaking method, creating promising hypothesis is still a crucial step for further investigation. Through this research, several information are found to be important to create hypothesis and prove it. First, to clarify actual process of creating conditions, voice and video data of the first process should be recorded. These data will provide the information such as whether the group listed up conditions individually or by group discussion, what materials group members used for reference, and how these behaviors changed over time. Second, information about participants should also be collected to explain the reason why each team took different process. Examples of valuable information would be professional background like an engineer, manager, leadership experience, or team building experience, personality such

as extrovert or introvert, and cultural background. These data should be collected the next time when a similar workshop is conducted, to obtain meaningful implications.

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