IMPROVING CULTURAL UNDERSTANDING AND SPARKING CREATIVITY THROUGH THE APPLICATION OF THE CULTURAL SYNERGY SPECTRUM METHOD

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ABSTRACT
Product engineers need creativity to come up with solutions that have high innovative potential. Today, product engineering often takes place in distributed settings, making tasks that involve creativity more critical. Often, distributed settings come with intercultural teams since talent is recruited from all over the world. The Cultural Synergy Spectrum (CSS) method was designed to support such intercultural distributed product development teams with their creative tasks. This contribution aims at validating the method's success through application in an intercultural team in student project teams. Three teams composed of engineers from different fields of engineering studies in an international university programme worked on solving a practice problem.

Keywords: Intercultural teams, cultural influence on creativity, methods for distributed product engineering teams, supporting creative problem-solving

1 INTRODUCTION
Product engineering has evolved into an increasingly distributed activity. While it once involved teams collaborating at a single location, it is now common for teams to work together across the globe [1]. This shift has brought a greater integration of diverse cultures, creating both opportunities and challenges [2]. Differences in language, preferences, and work ethics can significantly influence collaboration and productivity [3]. Tasks that involve creativity are difficult to manage in distributed work settings (e.g., due to the missing indirect communication signals being transmitted in distributed settings) [4].
To address these challenges and harness the potential of cultural diversity, the CSS method has been designed to enhance the quality of intercultural cooperation while creative problem-solving. By fostering mutual understanding and promoting effective collaboration, CSS aims to turn cultural differences into a strength, driving creativity and improving outcomes, as well as team collaboration in distributed product engineering teams [5].
To validate the success of the method and to find areas of improvement, the CSS method was applied in student engineering teams in a project setting with a creative problem-solving task.

2 STATES OF RESEARCH
2.1 Creativity in Product Engineering
Creativity is central to innovation, forming the foundation of the development activities in product engineering. Various methods, such as fostering collaboration or applying structured approaches to encourage divergent thinking, have been identified to nurture creativity. [6]
A popular understanding of creativity by Rhodes [7] describes it as the four Ps: Product, People, Process, and Press (environment). Stein [8] see creativity as the skill to create something novel and accepted as useful by a group at some point in time. The understanding of creativity we base our contribution on is similar to Stein [8] and specific to the technical context, a separate contribution on this understanding is available by Albers *et al.* [9].

2.2 Cultural Influences on Creativity in Product Engineering and the Cultural Synergy Spectrum Method

Culture significantly shapes creativity and therefore influences innovation [6, 10]. In product engineering, culturally diverse teams bring diverse perspectives and approaches, enhancing creativity but also introducing challenges like communication barriers. [11]

While many models examine the link between culture and creativity (e. g. the process model by Chiu and Kwan [12] or the findings by Shao et al. [13]), no universally accepted framework exists. Research suggests cultural backgrounds influence creative processes [13]. Recognising and leveraging these differences is key to fostering creativity in diverse teams [10, 14]. The CSS method was designed by parts of the author team to specifically support multicultural and distributed product engineering teams by enhancing creativity through the promotion of cultural success factors and the mitigation of cultural barriers. This is achieved by integrating a broad spectrum of cultural perspectives, fostering an environment where diverse viewpoints are effectively harnessed to drive innovation [5]. The cultural dimensions by Geert Hofstede [15–17] build the basis of cultural learning within the method. Furthermore, the 6 Thinking Hats [18] as well as the Nominal Group Technique [19] form the basis for the creative support. Additionally, the fourth phase of the method is open to the application of any creativity method that is suitable for the team's individual problem-solving process.

The method is comprised of the five phases as shown in Figure 1.

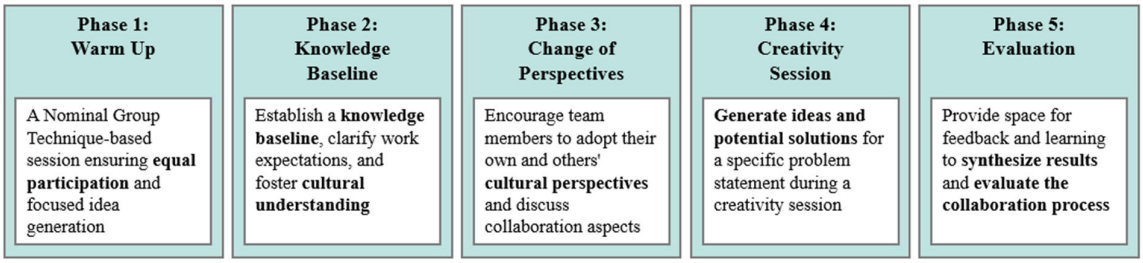

Figure 1 Phases of the Cultural Synergy Spectrum Method [5]

3 RESEARCH PROFILE

3.1 Research Aim and Questions

This contribution aims at validating the Cultural Synergy Spectrum method's success through application in an intercultural team in a student project. The method's goal is to support the creativity of distributed product engineering teams in a culture-sensitive way. The application ensures not only the success of the method but also its continuous improvement.

To reach the aim of this contribution, the following research questions are answered:

1. How should the Cultural Synergy Spectrum Method be applied in student project teams so the CSS method can be validated in terms of its applicability and contribution to success?
2. What is the measurable added value created through the application of the CSS method regarding the improvement of culture-sensitive creative problem-solving for the team?
3. Which potential improvements can be found for the Cultural Synergy Spectrum Method?

3.2 Research Approach and Environment

Two questionnaires and an observational study are used in this contribution. Furthermore, the teams' solutions to the development task are taken into consideration for the evaluation of the success of the method application. The first questionnaire examines the situation concerning the knowledge of the team members on the others' cultural backgrounds and understanding of the cultures represented within the team. The second questionnaire, taken after the application of the CSS, checks if this understanding has been improved. This approach has been chosen since participants are not very likely to be able to correctly rate their cultural understanding themselves. By using knowledge about other cultures, it is ensured that the participants are more honest about their knowledge without feeling tested for their prejudices. The observational study was used in the fourth phase of the CSS method application in which the teams formed sub-groups to creatively solve an engineering problem. Two observers each watched one or two teams to make sure that close monitoring was possible. The observation guideline is shown

in Figure 2. The teams' solutions have been used as an additional measure of the success of the creative process in the fourth phase.

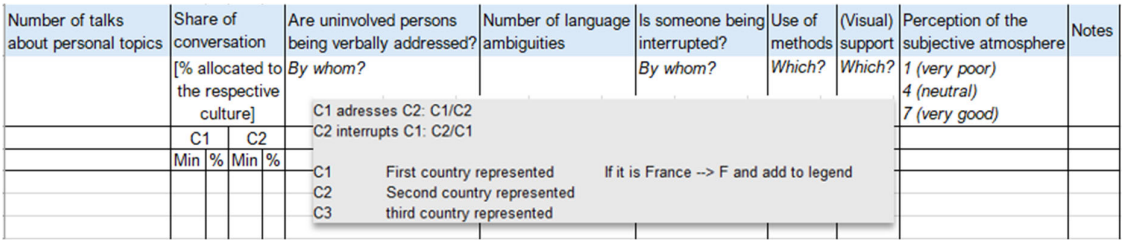

Figure 2. Observation guideline

As a research environment, a student project as a part of an elective course was chosen. One of the authors was lecturing this class and took the role of the moderator for the method application. All of the 13 students elected this course voluntarily and are from a variety of engineering subjects in different master's programmes. Since the course is offered in English, the participants are students from all over the world (Moldova, Taiwan, Switzerland, Germany, Mexico, Pakistan, China, Argentina, Malaysia, and Australia).

4 RESULTS AND DISCUSSION

Even though the method is designed for distributed teams, an on-site setting was chosen to make the detailed observation of the teams possible. While it cannot replicate a distributed setting, on-site observation captures all participant communication signals, providing observers with a clearer understanding of the situation. For this reason, it was chosen to provide insights that would enhance the effectiveness of the subsequent application in a distributed setting.

The method is fully implemented, with participants progressing through all five phases of the CSS method. The process includes working collectively in two phases, dividing into sub-groups for the third and fourth phases, followed by sharing insights with the full group and concluding together in the final phase.

4.1 Results and Discussion of the Questionnaires

Results: The first questionnaire was distributed on the day before the application of the CSS, and the second questionnaire was distributed right after the application to ensure that only the method influenced the results. The questionnaire was designed to assist with measuring the added value. The course had 13 participants, and all of them answered both questionnaires. The average score of the knowledge of the fellow team members' cultural background on a scale from one to five increased from 2,5 to 3. Responses to the question about the major cultural differences between the team members were answered in the first questionnaire on a more superficial level than in the second one. The answers to this question are displayed in Table 1. The first part marked in grey is answers that are part of both questionnaires, and the second part in white is answers that are only part of one of the questionnaires.

Table 1. Answers to the question: What is the main (cultural) difference between you and your fellow team members?

Questionnaire 1	Frequency	Questionnaire 2	Frequency
Language	6	Language	10
Too many cultures / No knowledge → no specific statement possible	3	Too little information → no specific statement possible	2
Food	2	Food	1
Culture and Customs	5	Personality (openness, daily planning)	2
Local origin	2	Problem solving	2
Religion	2	Work ethic	1
Europeans may be more active than Asians	1	Creativity	1
Course	1		

Notably, some aspects mentioned in the first questionnaire, culture and customs (5 mentions) and religion (2 mentions), were not mentioned in the second questionnaire.

In the second questionnaire, personality was mentioned twice as the main difference, as well as problem-solving. The participants were additionally asked what they knew about the different nationalities

represented in the team. A lot of answers were on a superficial level, e.g., Swiss people being able to design nice watches. In the first questionnaire, negative prejudices were voiced, e.g., Malaysians were described as lazy and slow. In the second questionnaire, no negative formulations were found. Differences were mentioned on a factual level, e.g., problem-solving varies. Furthermore, the answers were less superficial and more from a collaborative perspective, e.g., Germans can lead teams. Also, it has been mentioned that there are more similarities than expected.
Responses to the question regarding expectations for the collaboration and work ethics of the respective team are displayed in Table 2.

Table 2. Answers to the question: What are your expectations regarding the collaboration and work ethics of your team?

Questionnaire 1	Frequency	Questionnaire 2	Frequency
Teamwork	8	Teamwork	8
Communication	5	Communication	6
Effectiveness	2	Effectiveness	1
Attention to different cultures	2	Make new friends / network	4
Different views	2	Cultural influences fostering creativity	3
Independent of cultures	1	Language barriers	1
Respect	1	Kindness	1

The answers show that teamwork and communication are the overshadowing aspects of the topic of collaboration. Three participants recognised the impact culture has on creativity. Four participants mentioned in the second questionnaire that getting to know each other is now an expectation, showing that they have grown together as a team.
This question was also part of the second phase of the method application when team members had to set their non-negotiables for their teamwork.
Discussion: The questionnaire results highlight that language differences are a significant issue in collaborative problem-solving, emphasising the importance of a common working language for successful prototyping. Those who felt they lacked sufficient information to answer the question about the main cultural difference may have refrained from providing a stereotypical response, which is a reasonable explanation. The session was a deep dive into culture and allowed learning about the other team members. However, understanding is an ongoing process, and intercultural learning is not confined to a single event. One of the most significant indicators of the workshop's success might lie in the fact that nobody mentioned culture and customs as major differences in the second questionnaire. An interesting finding was that participants recognised culture as a multifaceted concept, not just a label, seeing it as both a success factor and a contributor to problem-solving rather than a barrier. Participants also noted that different cultural backgrounds lead to varying problem-solving approaches, and for these differences to become a success factor, understanding their existence is crucial. It is important to note that all participants are experienced in intercultural contexts, as they have either consciously chosen to study in a new country (Germany) or have deliberately chosen a course in English with the target group of international participants. The results might have looked different with a group less experienced in intercultural contexts. Additional room for improvement of the teaching style could have been achieved by including questions in the style of the VARK questionnaire [20]. Here, it could be learned which teaching format and style is suitable to transmit the information in a suitable style for the participants [20].

4.2 Results and Discussion of the Observational Study

Results: Analysis of the observation templates of all three sub-groups in the creativity session (fourth phase) of the CSS method reveals that each group had one person who took up a relatively large share of the speech (> 40%, approx. 6 min). In each group, the individual with the largest share of speech was from a different country (Germany, Australia, Mexico). These results are coherent with the partly one-sided results on the Miro board but also point to an at least partially successful integration of all parties. The Miro board shows that, multiple ideas were noted by all sub-group members. Prior to discussing the results with all participants, the idea most discussed and furthest developed in the two sub-groups was that of the discussion leader. The number of digressions on personal topics is very low, which indicates a productive working atmosphere. The mood was perceived very positively in groups one and two, whereas group three was uncertain at the beginning, with a more neutral mood overall. All three groups were not very communicative at the beginning, which could be due to the participants having to

get to know each other. Interruptions of other participants were seldom, and participants who did not speak much were encouraged to participate actively. This was initiated by team members from various countries and not necessarily by the person with the largest share of speech.

Discussion: Even though all the sub-groups developed a leader of speech quickly, everybody still contributed, which is a positive sign for the team development. Having a person who led the team might have taken some pressure off team members who were less open to active discussion. The individuals leading the teams, as well as the participants with a high share of speech, were from countries with relatively high uncertainty avoidance, wanting to make sure that the team gets to a result that can be controlled (Mexico 82, Germany 65, Australia 51) [21]. Even though the teams were not asked to involve everyone, all teams decided to ask for the consent of all participants in multiple steps. The wish to include everybody could stem from the strength of the CSS, that it helps the team to connect, get to know each other, and understand each other better. For the ones that spoke less no clear common aspect in Hofstede's Cultural Dimensions was found, although the ones that motivated the ones that spoke less were from Malaysia and Mexico, both countries that are more on the Femininity side of the spectrum of the masculinity dimension and therefore tend to value the well-being of the group and harmony which seems to have been encouraged [22]. All teams started quite shy but seemed to be motivated and encouraged to discuss ideas by the creativity methods. The positive perception of the mood is another indicator of the method's successful application.

4.3 Results and Discussion of the Creativity Session on Miro

Results: All sub-groups successfully solved the development problem to think of a product with a high innovative potential. The sub-groups needed to decide on a topic they wanted to work on. Each team came up with a multitude of ideas in the early phase, and all teams narrowed them down and concretised them in the following steps. All ideas were suitable for the problem statement and varied in complexity and differentiation.

Discussion: The creativity of the ideas was not evaluated in detail, as the task was intended as a practice problem. In further applications with actual problems to be solved, an evaluation of the creativity of the solutions generated should be carried out in more detail. In this evaluation, only the suitability to solve the problem and the number of ideas have been taken into consideration. Assessing the participants' self-perceived creativity before the intervention could have also helped to set the creative output into perspective and to collect additional evaluable data from the participants and is another element for potential improvement to answer the third research question.

5 CONCLUSION AND OUTLOOK

The application of the Cultural Synergy Spectrum method in student project teams to validate the method in terms of its applicability and contribution to success was described in Section 4, answering research question one. Although the application was successful, it was conducted on-site to allow for close monitoring and complete observation of the teams. In the next application of the CSS method, the setting must be distributed, as that is the target setting for the method, and proposes specific challenges and opportunities that need to be tested.

The methods' measurable added value regarding the improvement of culture-sensitive creative problem-solving for the team takes place on multiple layers, answering the second research question. The first layer, the improvement of the cultural understanding, was shown through the questionnaire as well as the observational study in Section 4. The support for creative problem-solving as the second layer was also shown through the results of the sub-groups in the fourth phase of the application of the CSS method. Here, the next application of the CSS method should include more comprehensive measures for the creative results produced by the teams. The final research question asking for improvements for the CSS method should be evaluated in more detail during an application in a distributed setting. One aspect is that the evaluation of the creativity of the results by the participants could be included in the fourth phase to create an even stronger bond among the sub-group members if they get to discuss the creativity of their solutions with the other sub-groups.

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