COMPOSE OR DECOMPOSE - RESOURCE ALLOCATION IN ENGINEERING DESIGN PROJECTS

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ABSTRACT
This is a paper that reviews the planning, execution and reflection of the collaborative writing efforts made by students when composing their final design project reports. Past research has indicated collaborative writing (CW) as one of the most challenging task that could be assigned to student groups [1]. CW is a process that involves project management, including resource allocation and essentially a great portion of writing skill. Whereas numerous engineering design projects highlight the uniqueness and creative aspects brought forward and the process in which this was created – the final piece of the puzzle how the final report was established is a phenomenon that get dimmed. There is dualistic propagation of parallel processes where the 'artifact' constitutes the main design work and where the efforts made to produce a written report relates to the other. A tradition that maybe is obsolete in some places but that has a life of its' own in other domains. The more administrative work involved with compiling a report of 'good enough' character whilst motivating and supporting each other should be balanced against the activities involved in producing the final output/design/prototype. This study is based on interviews and written 'pros and cons' reflections with project participants, project documentation and lecturer's reflections. Early indications show that communication and iterative work processes, allowing cross-checking, validation and confirmation is crucial for engaging greater commitment to the collaborative writing process. Independently of project management style and delegations made; labour intensity and work distribution of activities seem to propagate a skew execution of work. This is especially noticeable when administrative functions are weak amongst project members, which can be a consequence when putting students from various programs/disciplines/schools in a joint exercise of this type. Based on the findings, the paper stipulates a set of preventive coaching tips to guideline collaborative writing efforts and endorsing increased rigor to the final report and its process. Establishing this set of awareness among students would ultimately minimize uncertainties and dilemmas prior to 'entering the boat' – when the ship has sailed so has also its crew and based on how well they master to serve and execute their skills – so will also the trip be remembered – pleasant or horrific – taking them to paradise or hell.

Keywords: Collaborative writing, project work, resource allocation, reflections

1 INTRODUCTION

In engineering, like in many other disciplines, collaborative writing (CW) has been identified as a central practice in both the academy and industry. A number of studies have shown that both students and professionals in this field write most discipline-specific genres collaboratively. Despite its centrality, CW in engineering is considered an under-researched area with very few empirical studies on how it happens as situated practice [2]. Gibson state CW as a founding principle of engineering practice [3], yet suffered in attention as phenomenon by researchers. Past studies have built their strongest statements based on what is phrased as 'talk around text' [4]. This means collecting evidential proofs in a way to direct level of attention beyond what has been written, and rather consider elements of the composing writers perspective about the text.

CW can be described as a social activity by a team of people working towards producing a common document, such as design reports. Lowry et al. (p. 72) have defined it as 'an interactive and social process that involves a team focused on a common objective that negotiates, coordinates, and communicates during the creation of a common document' [5]. Their definition is significant for the study of CW in engineering as it encapsulates its two most essential aspects: the act of writing a common document (e.g. design reports) and the social processes (e.g. group dynamics), which are

fundamental to successful task completion. Similar to challenges arising when compiling design reports, this study builds on what Gimenez and Thondlana phrase as central to CW, i.e. planning [2]. In consequence, this paper tests a similar activity when challenged with compiling design reports. Using a parallel model of writing there is a strong link between model and task. This research is also motivated on the basis of past research that proposes further exploration of CW tasks in engineering [2]. This paper builds on a process oriented approach towards the CW process where open ended interviews with students and their written 'pros and cons' reflections after being participant in a three quarters of a yearlong master level project course. Early indications show that communication and iterative work is rooted in up-front planning events allow step-wise confirmation for engaging greater commitment to the collaborative writing process. The findings have been summarized in separate sections to address individual and group level distinctions, those being more apparent and those deviating from the general opinions. Respondents were those voluntary providing reflections, in all 50% of all project participants. Probing questions were used to more target those contributing more extensively with a variation of impressions. The reflections presented come from two student design projects. In total 10 reflections (G1: 6; G2: 4) including the CW leader reflections. Each reflection is summarized according to the abbreviation; [Ref] and a letter; [A] as indication for unique respondent prior to group affiliation. The two project groups have been labeled [G1] and [G2].

2 SUMMARIZED REFLECTIONS ON CW

Ref_A_G1: The collaborative productivity is shared cross several of the reflections made, as it allows a lot of text to quickly be developed. It was expressed that writing productivity could be kept high over time while producing texts as a result of dividing specific tasks, i.e. organizing efforts, early on. This meant that while other project members work with editing, others keep track of the structure of the report and proofreading sections. Multiple perspectives were described as a benefit although this had to balance against productivity. In a similar tongue several sources of editing were performed by the project members until everyone is happy. One of the biggest drawbacks is that the more people working on a report, the more finishing work requires. Although all are able to produce accurate and good rapport friendly English requires still a lot of work to get text to flow well between paragraphs, allowing consistent and be able to vary their language in a good way. A rule of thumb: the more people on a report, the more editing. About ten people write a report, it will get ten different people different writing style to boot. Another problem in report writing, which is more general in a major project, is that it is difficult to motivate all people to write in the number of project members is high. Responsibility of participants involved should be aligned to meet agreed upon deadlines.

If project's doing were documented early up-front fewer would have to sit at the end and stressfully compose the report. Consequently, planning could have tripled in amount of involved participants early on in the process. Often, no matter how well you try to prevent it, a large part of a report to be written at the end of a project. With this, the motivation can either increase, in order to see an end to the project, or to reduce, in order to take out to be ready in advance. Motivation can be a difficult part of writing a report for the reason that it can be fairly monotonous trying to get good and a lot of text instead of making other parts of the project, which many often think is more motivating and enjoyable as task, such as the idea generation phase in development projects.

Ref_N_G1: The planning for the writing process was initiated early in attempts to 'guarantee' that report writings would be successful. However, the actual writing process got started relatively late despite the pre-planning efforts. When trying to intensify work on the report, problems arose. In conjunction with internal deadlines prior to final print version frustration became present as everyone 'ran after the ball'. Almost the entire group suddenly wrote intensively on the report and this almost completely ignorant of reporting structure and what the other brought up in their texts.

After the first 'panic' subsided work got more structured and improved that made things to be more related and understood. Responsibilities were distributed and acted upon for continuant writings. It worked fairly at first, but soon started to fuss when the written sections were not delivered on time. The writing process got hampered since no response was taken for when writings got delayed. It began to collapse even more when the writing leader intentionally used a separate room, loosing track of proximity during the work process to the contributors. With intentions to structure the report, vital communication with the rest of the group became impaired and almost faded out completely. The group did not really know what to do and vice versa. Suddenly the appointed writing leader did not know what the rest of the group was writing or how it went. Project managers played a crucial role in

bridging the communication problem, but they were very passive in their role during this phase, further adding to inefficiency at work. Another factor that made the work somewhat ineffective was the fact that many report parts were two people sitting next to each other and would help each other to write. This was more inefficient rather than contributed to the writing process. Much discussion took place between the two that had a report part but very little was in print. It would have been preferable that they got a respective part to write on, or that the parts were divided into smaller parts and then they swapped parts with each other to examine what has just been written. This could probably have made the writing more efficient and created more quality to first input of texts. In addition to this was perhaps the most disastrous in the end, as some of the group decided to sit down and work on report days after the reporting deadline, after already being postponed several times. Unfortunately, this was not communicated to the rest of the group. Consequently, several already written sections were completely removed, without discussing with the rest of the group. Acting independently without approval was a way of stress final outputs, yet by acting autocratic decisions could force last minute changes. This caused clear dissatisfaction among those that considered themselves being sidestepped, and by so having a negative overall effect on the final 'print' version. Lastly, the group agreed on common terms in any kind of template early in the writing process in order to avoid confusion. However, by the time it was sent for print several different expressions were used for the same thing causing inconsistencies and possible confusion for the reader.

Ref_F_G2: By dividing roles within the project, certain individuals motivated to take on such a responsibility were promoted as 'report manager'. This meant being responsible of structuring and coordinating the work involved with the writing, i.e. project management on communicating the findings in written form. One of the entitled report manager's reported that the more positive aspects of CW included; structure, 'excel sheet was created for the writing of the report making it easy to see who is working on what part and for the purpose of visualizing writing expectancies. Template support through pre-written checklists underneath all major heading and in relation to each chapter, made it easier for everyone in the project to get started with writing, avoiding having same text in several places. More guideline documentation; how to refer, nomenclature report that stated in a clear manner how project members should enter specific wordings and how figures and tables should appear, describe and in cases referred to. Prior to printing the report all participants got individual sections together with an overall version including appendices to proof read to adjust. Two file-extensions of the report were made to better enable a less formatting sensitive version; .docx and .pdf. Each version had chapters separately put together to create a full set of appended files, making it easier to swiftly go in making last minute changes if it would become necessary. This acted to increase delegation of writing duties, allowing team participants to more actively contribute as co-editors while text sections were being refined.

On the less favorable side of CW it was; difficult to write together when variation in style and use of language shifted so much. As 'editor' it became a responsibility to go through two processing steps for each chapter before proofreading the chapter. The final touch; last corrections took longer than expected, fixing with the page numbers, layout and everything before printing.

Ref_E_G1: There are different ways to deal with group writing, everyone in the group can contribute to the writing or it can be split into a few 'appropriate/skilled printers'. However, write all the people with their own personal style, which means that everything has to be stitched together in the same language as you go. One way to "quickly" to create a "common script" is that every text goes through a number of iterations, between different people. It should be pronounced in the early stages of the project, who feel comfortable writing, regarding subject and language. Along it, one can draw up a plan for how the different writing styles should be handled. Not pronounced individual's writing abilities, so there is a risk that the group members did not dare to question or write a useless text, making the iterations of the text does not get a desired effect in achieving a common language. Selection of a few 'suitable persons' where made to write, so it became important that they have good skills in specific subject matters. This of course results in that those who do not write, nor develop their skills in writing. The advantage of selecting a few to write allows those involved to easier keep track of documentation and establish a preferred common language. Projects, regardless of size, are dependent on responsibility. Deliver on time, you cannot deliver on time nor have questions, these must be put forward in good time so that action can be taken with the text. This also applies iterations of texts, the people who have been assigned to the correction of a text does not question the writing to make it better or just rush through the task, so pursuing the not their responsibility and leave the text

largely unmoved, which does not lead to any progress in the writing, but rather becomes a waste of resources when the person does not take responsibility for completing the task. Important is that there is a common goal with the writing, that it is a quality that we agree on and that everyone is doing their best to deliver accordingly. This may be something that initially all agree on, but that is important for all supplies for as the project progresses.

Ref_J_G2: The report writing in this project was a challenging task. Putting together a 200-page report and distributing the workload somewhat evenly across a team of ten team members required planning and a way of providing an overview for all members to see. This was accomplished by setting up a document, namely a spreadsheet, wherein each chapter of the report was given a row with a few columns. For each chapter, members of the team could view the current status – in progress, done, or not yet processed. This proved to be a very efficient and effective way of making visible the current status of each part of the report, which enabled the team members to choose which chapter to work on, without the risk of doing double work. The report itself was split into discrete files corresponding to each chapter and sometimes sub-chapter. Merging of these files into one final report was not done until the very final versions of each chapter had been re-worked three to five times, all which was visualized in the report status document. Iterating the report writing this way and having all team members contribute to all chapters worked great in ensuring the quality of the report as a whole. A document was set up in which all the important wordings and translations were listed; a document containing the appropriate nomenclature. The biggest challenge was communicating how different aspects of the project had been described in different parts of the report. Working on such a large report and making sure everything is described in the same way and in a logical and/or chronological order that made sense for this type of report often required tight communication. This challenge was met by simply making sure all team members worked in a near physical proximity – the whole team often sat in just one or two rooms.

Ref_J_G1: Appointed as report manager it involved co-responsibility for the final report, this meant putting up a template, layout and overall structure of how to write. The weak aspect of the report writing was the lack of rotation in the final stages of the writing which led to an uneven work burden. Mainly two persons (the person responsible of the report and another person) worked for three consecutive days before handing the report in. Other team members were not notified how the work went and could not contribute. The delegation of work tasks was nonexistent at this point. The deadline got pushed forward twice by the responsible person and there was indication that the person in charge of the writings had come to be nearly stressed out. There were moments of joy in earlier in the process, at times when all team members could contribute with their texts and the delegation of work tasks went well because they could ask the responsible for the report for new tasks. The spirit was high the week before the first deadline. But the final days were chaotic. In future collaborative writing tasks a well learned lesson is that the appointed person needs good organizing skills.

Ref_M_G2: CW allowed increased input speed, larger information coverage and to put together a rich extensive report. The process was kept structured and all ‘how to’ writing routines were kept in separate documents so that work could be performed in parallel to each other. Both self-perceived quality of the report and the ‘mental health’ of the project team. In contrast, there were a few difficulties when writing together; size, connectivity to co-writers, content overview, style of writing, downsizing for crucial finalizing efforts putting overall group size as a less important criteria.

Ref_M_G1: During the entire writing process an open flexible approach to take in input data, exceeded dramatically than was initially planned, due to such experience in retrospect there would have been useful with a procedure to handle this. The team leaders involved two report coordinators that supported the process facilitating different report task, i.e. proof reading and distinctions of areas to further write up about. Allocation of the report tasks with extensive data were handed out to the most suitable report writers in the group, by that using the team resource in a valuable manner. Some team members were more suitable for calculations and modeling and some team members were more suitable for extensive report writing, due to that the team resources and knowledge could be utilized in an efficient and sustainable manner. It is always a tradeoff regarding what desired outcome the responsible parts is aimed to accomplish. Group members could develop in different areas by having flexible delegation of tasks, due to that also is responsible of writing the part that they execute. By allocating the re-writing task to few team members, the final report will have a leveled and user friendly writing style, and due to that more desirable from a readers perspective. CW involved

complexity in organizing and with different writing style putting arguments forward to minimize participants involved in final editing.

Ref_Mi_G2: Preplanning efforts allowed 'only positive experiences' as one participant expressed were the group already in spring and early autumn worked out a template, guidelines and expectations. This provided a solid foundation, which allowed for the writing to run smoothly, and kept at a high productive level thanks to the structuring of the report manager as the same student expressed. Due to the fact that all project members were more or less equally involved in the project this allowed for everyone to also contribute to a range of areas, resulting in a cheerful mode and joy. Perceptions on distribution of workload internally was alternating from views that 'it was relatively evenly distributed across the group, thanks to the well-designed report template without any need to sit crying late into the night'.

Ref_R_G1: Being able to write efficiently together is considered by many a difficult challenge. Keeping text coherence, i.e. having the text written in similar style/language, is a crucial aspect to this. However, as several project members had different views and thereby agendas on how a proper technical report should be written; this created a vicious cycle of corrections that became fruitless and basically lead to nothing. This scenario, when closing in on deadline deliveries led to having some sections of the report being written over and over again, and in total, up to about five to six times.

3 DISCUSSION

Different perspectives from the active participants engaged in CW allows for an inside-out perspective of an implicit 'taken for granted' process that is enlisted on most design education programs. Writing up, and reporting put emphasis on division of work, which was clearly strengthened by the responsibilities shared among project participants to finalize the final reports the students composed. The supporting evidence, the individual reflection reports, showed that independently of views it is important to screen these comments in light of the factual reports composed. While showing distinct variation in what is brought forward there could be distinct deviations extracted from the two projects, consequently the two groups, investigated. The first group struggled and really pushed themselves to have all writings ready in time for final presentation, whereas in the other group stated early that the report would be able to be prolonged beyond the final presentation. The second group also put key up writing electives that controlled the process separately rooted in a pre-set template, structure and responsibility set up for phases and sections involved with CW. The second group, in response to deadline delivery never pushed for a printed report at their final presentation. In addition the second group's report where nearly twice the size than the first group, while providing more depth in a range of areas the first group forced themselves to streamline and put more weight in the words and sections involved and really focus on what could be taken out as something in common, both groups showed a tendency that those responsible for the report writing process had a positive view, yet biased view on the execution of work and division of work involved. Seeing themselves as carriers and legitimizers of the work performed their reflections also portray an idealistic blueprint of wishes on CW for future work. Indicated by the findings and particularly expressed in group one, a more skew autocratic approach was forced upon to get things done when wrapping up became an absolute deadline, causing internal discontent and risk of portraying fragmented sections.

Detailed planning and role allocation would be able to add to the efficiency of collaborative writing. Versions handling is argued from participants as a possible feature that could minimize double work. Roles involved and type of processes that structures and symbolizes the work of CW has been researched upon earlier. Provided with student reflection the aim has been to isolate 'pros and cons' involved in the process of CW that explicitly focus on work distribution in-between roles taken and those less taken. Resource allocation concerning CW has opened up a continuation to roles enacted in the earlier studies, were planning and structure has been portrayed as key aspects. As to the nature of CW in engineering, the results of this study have shed some new light on the role of planning in CW. As previous research has indicated [5], planning, which includes agreeing on the aims of the writing task, breaking the task down into manageable sub-tasks and assigning each of the sub-tasks to different group members, is central to CW. In this study, it is shown that CW is a complex activity. Planning was vital for both groups, especially as were denoted in attempts to write sequentially after implementing version handling system. CW was shown highly cyclical in nature and that group members had to be ready to get involved in various cycles of composing and editing. This process allowed the writing to have a more homogenous and consistency in style and language. This meant

that on writing some sections of a design report (e.g. testing, prototyping, ideation, CAD), participants would first compose their individual sections, which would then be combined and edited in an iterative way to match the desired style of expression.

Provided with a necessity to structure work division, the idea behind complex work setting for solving complex problems have been a key driver in the project course. However, rather than putting emphasis on 'what's next' a detailed analysis of role distinction and allocation of roles would provide a plan for putting either the best person for the job – performance based, or the person that wishes to learn to synthesize and put together the text better – learning based. Meeting the reasoning by Wolfe [6], a learning stance was adopted among overall activities in the project, yet performance related in the selection of appropriate and most suitable person to lead the delegation of writing tasks. In contrast to what earlier studies have stated about phenomenon of CW, role allocation can support a polarized yet appreciated division of writing duties. This meant that participants accepted delegation of activities, e.g. writing, editing, proof reading, structuring and re-writing to not necessarily be shared equally among group members as stated by past studies [5]. The study indicates that certain individuals take on a more central role, and thereby responsibilities to allocate roles of CW activities by skill, talent and genuine interest.

4 CONCLUSIONS

The study shows that CW could gain understanding for events taking place by using reflections reports in combination with text analysis and interviews with participants. The phenomenon of CW should be taken more seriously from an educational perspective especially as this is assessed in many cases for grades and remarks that are of concern for the students. Role allocation in engineering design projects is based on composition of student groups, internal division of work roles and how individual beliefs and responsibility dispositions usually is expressed in level of subject interest. In consequence, it would be fair to state assessment on what grounds? Should lecturers even consider the distribution of the work involved with composing documentation involved with the parallel activity of producing the desired artifact finally displayed? Based on the reasoning hitherto, this paper argue that role allocation in student design projects pay attention to CW as somewhat of a subordinate activity. CW is dedicated to performance, resulting in selection of leading writers' being the most skillful composers. However make sure to have roles and processes clearly outlined to avoid autocratic and stressful behavior as processes come to an end. Productivity is arguably shown dominant in comparison to dedication to learn and promote individual writing skills, which by students' rationale concerns avoidance of unnecessary rewritings and editing.

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