Work for or Against Players: On the Use of Collaboration Engineering for Collaborative Games

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ABSTRACT
Collaborative games require players to work together on shared activities to achieve a common goal. These games received widespread interest in the past decade, yet little is known on how to design them successfully, as well as how to evaluate or analyse them. To our knowledge no research has looked into applying existing bodies of knowledge on collaboration to games. In this paper, we seek to achieve a better understanding of collaborative processes designed in the mechanics of collaborative games by considering Collaboration Engineering (CE), a discipline that has studied collaboration for decades. The suitability of CE as a theoretical lens is determined by contrasting CE to game design and by discussing its application to two carefully selected case studies. Our insights make clear in what contexts CE is relevant and what kind of role it can play. We conclude that this depends on whether the game mechanics are working for or against players.

Categories and Subject Descriptors
H.5.3 [**Information Systems**]: Information Interfaces and Presentation (e.g., HCI) – *collaborative computing, computer-supported cooperative work;* K.8.0 [**Computing Milieux**]: Personal Computing – *games.*

General Terms
Design, Human Factors

Keywords
Collaborative games, design patterns, Collaboration Engineering, game design

1. INTRODUCTION
Games are known for being competitive. Yet, collaboration is an essential part of many games. In such games, players combine their efforts to manage a challenge that is too difficult to be dealt with by one individual player. Completing a quest with a guild in *World of Warcraft* or defeating hordes of infected people in *Left4Dead* come to mind. In such games players may also have to agree on what decisions to take. This is what happens in the board game *The Resistance*, a variant of the popular *Mafia* and *Werewolves* games, where a group of players are either rebels or governmental spies. The entire group needs to vote which players will perform a mission. The rebels need to make sure no spies are on the team as otherwise the mission can get sabotaged; the spies need to make sure they are not identified while sabotaging the missions. Many other collaborative modes exist, from helping each other to controlling different parts of an object. In truly *collaborative games*, players are required to work together on shared activities to achieve a common goal. Group interests prevail over personal stakes.

Zagal et al. [43] describe that "although the vast majority of games played all over the world are collective in nature, practically all electronic games are individual…[but]…that this is changing" (p. 24).

In a recent review of commercial digital games, Sedano et al. [37] conclude that "although it has been possible to find games that offer the possibility of playing in a collaborative mode in addition to the single-player since the end of the 90s, strictly collaborative games started to appear slightly later, no more than ten years ago" (p. 373). This review excluded the emergent use of location-based games, alternate-reality games (ARGs), and pervasive games, which often have a digital component and are collaborative [33], as well as of serious games [21], which include games that are about teaching collaborative learning and teamwork (e.g., [20]). Therefore, we can safely assert that an increased interest in collaborative games exists across different game industries, possibly fostered by concurrent trends such as crowdsourcing, social media, and cloud sharing services.

Despite the widespread interest, little is known on how to design collaborative games successfully, as well as how to evaluate or analyse them [1,2]. This need is significant, as many collaborative games do not necessarily promote effective collaboration. In fact, players can end up doing their "own thing" or they may end up competing instead of collaborating [43]. So far existing work has focused on drawing lessons from board games [43], examining existing collaborative games [3,5,6], and defining performance metrics to evaluate collaborative play [7]. All this work shares that it has been done from the ground up, by studying collaborative games in isolation from theories and disciplines outside of the domain of games. It also shares a focus on identifying *game design patterns*: commonly re-occurring parts of the design of a game [7].

In this paper, we decided to take an alternative approach: We seek to achieve a better understanding of collaborative processes designed in the mechanics of collaborative games by considering Collaboration Engineering (CE), an established discipline that has studied how to design for effective collaboration for decades. Essentially, CE is a design patterns approach to collaboration, as it attempts to formalize collaborative processes. As a result, several *collaboration patterns* have been identified to design, analyse, and evaluate collaboration in a variety of settings [11]. For this reason, it seems a logical step to consider what, if any, can be learned from CE. Insights from CE could potentially be harnessed for collaborative games, to see how collaboration is and can be supported in the game mechanics. We formulated the research question to address this as "To what extent can Collaboration Engineering (CE) be applied to analyse and design collaborative processes in games?" In this paper we present early work that focuses on the use of CE for analysing games by exploring the CE literature and applying CE tools to two carefully selected case studies.

To determine the suitability of the use of CE for collaborative games, in the next section we will elaborate what we mean by collaborative games and provide the necessary background on design patterns as a

whole and CE in particular. From there we discuss in Section 3 our methodology, including the choice of the two case studies. In Section 4, we applied the insights from CE to the case studies, which in return provide us insights into how CE is of use for collaborative games. We end by discussing in what contexts CE is relevant and what kind of role it can play. We conclude that this depends on whether the game mechanics are working for or against players.

2. BACKGROUND

We use the term collaboration the way it has been addressed in Software Engineering and Computer Science: "A process in which two or more agents *work together to achieve* shared *goals* [28]. Based on this, we define a collaborative game as a game in which two or more players, either co-located or distributed, work together to achieve shared goals. In the industry and in the recent literature [3,5,7,40], the term *cooperative games* is more commonly used. Although cooperation and collaboration are used interchangeably, a technical distinction exists. Cooperative games model a situation where two or more individuals have interests that are "neither completely opposed nor completely coincident" [34]. Therefore, in cooperative games players have different goals, whereas in collaborative games each player has the exact same goal [43].

What obfuscates the distinction is that in various instances in cooperative games players collaborate in the form of groups to achieve their individual goal, which happens to be the same as the rest of the players in the group. These win-win opportunities occur when a group of players are given a single quest with a shared goal, such as in *World of Warcraft* [39]. We focus on collaborative games, but our insights on the use of CE may apply to cooperatives games, and in particular for the collaborative activities in such games.

Whether a truly collaborative game or a cooperative game, working together as a team is a challenging process. Each collaborating player needs to deal with the dynamics of the team as well as the game environment. The challenge for designers is that this collaboration should be encouraging and enjoyable. To encourage collaboration and prevent frustration, groups of players may need to be provided with the appropriate support to face the challenges of a game. The means for providing such support need to be identified at the design stage of collaborative games, when mechanics and rules of collaboration are decided. CE can possibly help in this design stage as well as with analysing existing games in order to extract best practices or improve existing practices. As CE provides a pattern language for collaboration, we will first provide some background on what design patterns are, especially in the context of games, and what prior work has been done. From there we will provide more detail about CE.

2.1 Design Patterns

Design patterns provide a convenient common language for communication and offer a basis to design larger systems based on individual patterns. According to Coplien [38] a wide range of benefits exist for using a pattern approach to design artefacts. These include: (1) patterns enable designers to communicate at a higher or more abstract level; (2) they introduce a new vocabulary and ease in communication of design issues across the development teams; (3) they simplify documentation of the designs and enable reuse of architecture and the design; and (4) they simplify giving expert knowledge to non-experts. Patterns and pattern languages have been applied to many different areas such as e-business [2-17] and software design [1,5,18,37].

Patterns have also been applied to game design. The need for accessing a language to analyse, evaluate and criticise game design has been argued for by researchers for a number of years [42]. This need for a pattern language has been addressed in different ways: (1) Hunicke et al. [22] presented a formal approach to understanding games to bridge the gap between game design and development, game criticism, and technical game research; (2) Zagal et al. [44] provided an ontology to identify abstract elements capturing a range of concrete designs, which led to a framework and vocabulary for describing, analysing and critiquing games; (3) Björk and Holopainen [8] developed a template for describing Game Design Patterns, which others have adopted and applied to defining patterns in games[1]; and (4) Zagal et al. [42] looked at Dark Game Design Patterns which are used by game designers to create a negative experience for players that is against their best interest and happens without their consent. In their paper they also refer to anti-patterns. These patterns result in less-than-ideal solutions to a certain game design problem and therefore should be avoided.

The majority of the work in formalizing game design by means of formal approaches, frameworks, and design patterns has been done from the ground up by observing a variety of games and in isolation from theories and disciplines outside of the domain of games. Exceptions exist, such as the work by Lewis [30] who used theories about motivation and from behavioural psychology and economics to describe motivational design patterns in games. An isolationist approach has merits, for not being biased and for developing a language that is specific to the domain, yet in formalizing game design much can potentially be learned from existing bodies of knowledge outside of games. With regards to collaboration this is what we aimed to explore by considering the use of CE for collaborative games.

2.2 Collaboration Engineering

de Vreede and Briggs [14] define the scope and key elements of Collaboration Engineering (CE) as follows: CE is an approach to create sustained collaboration support by designing collaborative work practices for high-value recurring tasks, and deploying those as collaboration process prescriptions for practitioners to execute for themselves without on-going support from professionals facilitators. According to CE, a successful collaboration should be supported by a procedural step-by-step process, which is explained according to the patterns of collaboration, and ultimately by a facilitator who intervenes and takes the role of the leader to direct the team towards a goal.

The central idea of CE is that by systematically combining suitable best practices of collaboration into a work process, a group can achieve its goals effectively. The collaboration best practices, called thinkLets [45], are tested collaboration techniques. A thinkLet is a named, packaged facilitation technique that creates a predictable, repeatable pattern of collaboration among people working towards a goal. A thinkLet is meant to be the smallest unit of intellectual capital required to be able to reproduce a pattern of collaboration among people working toward a goal [32]. The essence of thinkLet is embodied in a set of rules that specify actions that people in particular roles should take under certain constraints using certain capabilities [23]. Full documentation of a thinkLet requires three to five pages of detail. A brief description of a few number of thinkLet scripts can be found in [4]. ThinkLets are tested collaboration techniques to predictably invoke one or more of the following six validated patterns of collaboration described below [11]:

1. *Generate*: Move from having fewer to having more concepts in the pool of concepts shared by the group.
2. *Reduce*: Move from having many concepts to a focus on fewer concepts that the group deems worthy of further attention.

[1] http://gdp2.tii.se/index.php/Main_Page

3. *Clarify*: Move from having less to having more shared understanding of concepts and of the words and phrases used to express them.
4. *Organize*: Move from less to more understanding of the relationships among concepts the group is considering.
5. *Evaluate*: Move from less to more understanding of the relative value of the concepts under consideration
6. *Build-consensus*: Move from having fewer to having more group members who are willing to commit to a proposal.

An important merit of the six collaboration pattern framework is its modular view of a collaboration process. That is, each collaboration pattern is considered a functional independent module, or a building block to serve a single purpose in a collaboration process. A collaboration process consists of activities, which are described according to one or more patterns of collaboration. Overall, a collaboration process is a sequential chain of a number of patterns. Therefore, compared with the previous literature, it is argued that the six collaboration pattern framework provides more granular characterization of collaboration processes [35].

An example will help to illustrate how collaborative processes are designed or analysed with CE and how the collaboration patterns relate to the thinkLets [4]. At the highest and most abstract level CE is concerned with collaborative *processes*. A process is generally described as the series of actions that are taken in achieving a goal. Such a goal could be "user requirements elicitation"[4]. Within a process it is possible to identify one or more *activities* that take place. An activity specifies what has to be done to obtain the goal. If more than one activity exists, we can group and delineate sets of actions that are associated with achieving a specific sub-goal. In the context of user requirement elicitation, one activity is to "identify relevant user requirements" and another to "analyze features for each group of users and categorize user requirements".

Then, for each activity we can use or identify one or more *collaboration patterns* that support that activity. Brainstorming activities seem important for the activity to identify relevant user requirements and therefore this activity is predominantly associated with the generate collaboration pattern. The analyze features activity, on the other hand, is predominantly associated with the organize collaboration pattern.

At the lowest level, the "atomic" level, we are dealing with the thinkLets. As aforementioned, thinkLets are techniques to establish a collaboration pattern. For the generate collaboration pattern we can use the thinkLet *Free-Brainstorm*. This thinkLet describes a set of rules for having participants freely voice their opinions of a transformation procedure. The *PopconSort* thinkLet allows the organize collaboration pattern to flourish, by providing a set of rules for quickly organizing a large set of ideas into categories.

3. METHODOLOGY

In collaborative games players work together as part of a team. When collaboration is defined as directing joint effort towards a goal, then goal achievement logically is a success factor of collaboration [26]. Collaboration is thus not a goal by itself; it is a process, instrumental to a goal. Achieving successful collaborations has the objective of increasing the quality of collaboration itself [26]. We can describe the goal as an output factor of this process, which makes joint effort made by collaborative players an input factor. In this research we analyse collaborative processes, where players work as a team, and try to describe them by using tools from CE such as the collaboration patterns and thinkLets. The approach we took in this research has many similarities with work breakdown structure approaches, workflow management and Business Process Reengineering/Change [19]. Each of these approaches offers methods to plan, decompose and sequence collaborative activities. However, these approaches do not offer tools to prescribe the exact method a group can employ to execute these activities and how activities can be supported with collaboration technology [4].

To apply CE principles and design patterns to collaborative games, we conducted a three-stage study. (1) *Sampling and collection of collaborative games*: We listed the collaborative games we gathered over time and searched on Google with keywords such as "collaborative game" or "cooperative game" for collaborative games. The purpose of this collection was to get an overview of the types of collaborative games that have been created from which we could take a sample for a more detailed investigation. We came up with a database of 62 games. This is by no means the entire collection of collaborative games, but a sufficiently large enough sample to continue to our second stage. For example, in this search we focused on digital games only. In the future we will consider board games too.

(2) *Reviewing and analysing the games*: In this stage we looked at the processes that take place in the collected collaborative games and tried to unpack them by identifying their collaborative activities. The purpose of this effort was to get a general idea of how collaboration takes place in games and how CE could be of help in analysing them. Once we identified the collaborative activities we aimed for describing them according to the six main patterns of collaboration described in CE. This method is similar to the Collaboration Design Approach in CE [29]. This approach is used to design step-by-step collaborative processes by looking into collaborations and translating them into the form of activities and patterns of collaboration. Based on our analysis we identified three main groups of collaborative games:

i. *Instinctual collaboration*: Games in which collaboration happens based on players' instinct. In such games achieving agreement and consensus building among team members happens intuitively and needs to occur swiftly. No time exists for discussion at the conscious cognitive level (e.g., *LittleBigPlanet*). With the conscious cognitive level we refer to a deliberate exchange of thoughts between team members about dealing with the challenges imposed by the game. Many games fit in this group.
ii. *Supportive collaboration*: Games where team members are given opportunity to discuss, plan and make strategies at the conscious cognitive level but it all happens before playing (e.g., *FIFA* soccer game series) or at predetermined intermittent points (e.g., safe rooms in *Left4 Dead*). Although any game could qualify for this when considering the ability to pause the game or discuss strategies in advance of playing, games are only considered to be part of this group if the game supports these collaborative activities. Some games fit in this group.
iii. *Integrative collaboration*: Games that provide opportunity for the players to experience collaborative decision making and consensus building at the conscious cognitive level. The game mechanics in such games are supportive towards collaboration throughout the entire game (e.g., *TeamUP*). Very few digital games fit this group. The ones that do are not the well-known entertainment games but lesser known educational games and Alternate Reality Games (ARGs).

(3) *Selection of two distinctive games for further analysis*: The second stage of reviewing and analyzing the games gave us two important insights. First, CE is about having an "atomic view" towards designing steps that direct teams in decision-making processes that happen at a conscious cognitive level. Any CE tools used for collaboration would only be applicable in a situation where a conscious deliberation takes place. Therefore, in this research we decided to focus on the third group of games that we identified, the ones that have an integrative collaboration.

Second, it became clear what kind of analyses are possible and under what circumstances. We identified three types of analyses that could be made with CE: process, activity, and pattern analysis. With a *process analysis* the purpose is to identify the activities within a game and then determine issues where CE can be of help. Such an analysis can be done based on a detailed description of the design. However, for an *activity analysis* the actual dynamics [22] of the game have to be experienced and analysed. Its purpose is different: it is to get an understanding of how collaboration takes place in the game. The CE collaboration patterns will help in achieving this understanding. Finally, a pattern analysis is possible. This can be used to determine what techniques have been used to establish a collaboration pattern in a game or where thinkLets can be of help. This requires a fine-grained analysis that entirely deconstructs the experience into its atomic pieces. A complete overview of the approach towards the analysis of games using CE is presented in Table 1.

Table 1. The approach towards the analysis of games using CE

	Process Analysis	Activity Analysis	Pattern Analysis
Purpose	Identify collaboration activities and how CE tools can be of help	Get an understanding of how collaboration takes place with CE tools	Retrieve existing or a new set of rules to reproduce collaboration patterns
Level of analysis	Macro	Meso	Micro
Relevant CE tools	Collaboration Design Approach	Collaboration patterns	thinkLets
Required	Design description	Playing game	Deconstruction
Effort	Low	Medium	High
This paper	*Tower of Babel*	*TeamUP*	Future work

The purpose of the third stage was to identify the next steps that we should take to see to what extent CE can be applied to analyzing collaborative processes in games. Based on the insights from the second stage, we decided that we should first illustrate the process and activity analysis in more detail and conclude what we can learn from this before advancing further. We sampled a game for which we only had access to a detailed design description (*Tower of Babel*) and another that we were able to play (*TeamUP*).

4. CASE STUDIES

In this section we examine the two distinctive games we selected: *Tower of Babel* and *TeamUP*. In order to be clearer about the application of CE into game design processes, we decided to analyze each game at a different level. The *Tower of Babel* is analyzed at a higher level of abstraction where collaborative processes are the main target of analysis (i.e., process analysis), while *TeamUP* is analyzed at a more in-depth level where we considered how the collaboration patterns could help us understand how collaboration takes place in that game (i.e., activity analysis).

4.1 *Tower of Babel*

Connolly et al. [12] investigated the use of an Alternate Reality Game (ARG) in motivating secondary school students to learn modern foreign language. ARGs, sometimes referred to as "immersive gaming", are a form of online interactive narrative and puzzle-solving [12] often involving multiple media, collaborative technologies and game elements to tell a story that may be affected by the actions and/or ideas of the players. The ARG for Language Learning, *Tower of Babel* [12], is developed in a way that allows groups of students from across Europe to work collaboratively in undertaking quests that could be puzzles, assignments and quizzes. The quests involved answering multiple-choice questions, translating languages, uploading files and sharing the content on the Internet. Collaboration among players in *Tower of Babel* forms a key role, as players must work together in solving puzzles and successfully completing the game [12]. The language learning focus of *Tower of Babel* game was provided through the situation that students had to communicate collaboratively in the language they were learning in undertaking the quests. The role of the teachers was as puppet masters, dynamically intervening to scaffold the experience and challenge students. The collaborative nature of a number of processes that happen within *Tower of Babel* and also the objective of collaborative learning make it an appropriate case for analysis using the CE principles.

ARGs need to be motivating. Based on the work of Malone and Lepper [42] on intrinsic motivation, Davies et al. [13] suggest several guidelines for ARGs in order to promote challenge, fantasy and curiosity. CE principles can support intrinsic motivation in ARGs. We discuss examples of *Tower of Babel* below where CE provides an useful approach for addressing on how such aims are accommodated within the design of the ARG.

Process analysis 1: Routes towards success. According to the guidelines provided by Davis et al. [13] players must be able to tangibly affect the outcome of the ARG. Also, there must be an overriding goal/challenge as well as sub-goals and sub-challenges with positive and negative outcomes based on player actions. This objective is supported by the use of CE principles: CE suggests procedural design process [35], which highlights the requirement for the support of team collaborations through the use of predictable step-by-step collaborative process that directs the team towards the goal. The collaborative process consists of activities, which are explained according to the six main patterns of collaboration described in CE. For each collaborative goal to be achieved there are alternative step-by-step processes, which support the collaboration. Therefore the CE approach supports alternative routes towards goal achievement, which are taken based on players' actions or decisions. Such quality of the CE discipline supports the argument that ARGs need to offer multiple routes to success [13].

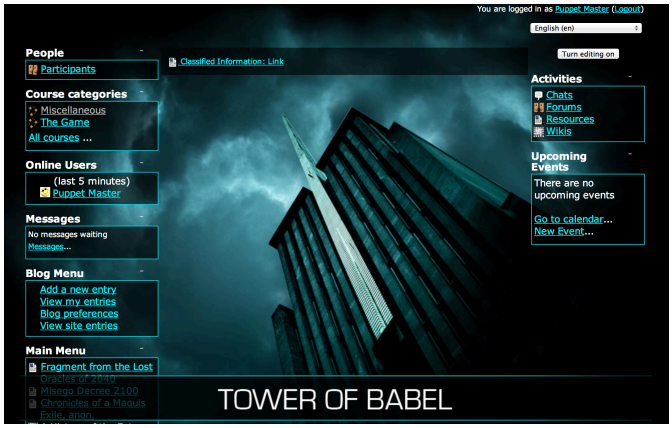

Figure 1. Main menu of *Tower of Babel*.

The CE approach is very practical when it comes to analysing and comparing different potential game scenarios. Other than providing support for intrinsic motivation promoting challenge, fantasy and curiosity in ARGs, CE addresses a number of design challenges the project team has to face when developing the ARG. The following outcomes discuss these.

Process analysis 2: Cognitive complexity and differences in roles. According to Connolly et al. [12], it was a challenge to investigate the design of an integrated set of multilingual, multimedia problems that require collective effort to be solved or to create an interface to facilitate communication of individuals who possess different roles within a collaborative structure. CE supports collective intelligence through the application of a pattern based pre-designed collaborative

process into team collaborations. ThinkLets help to address the problem of cognitive complexity that would normally arise because of the difference in the role of team members and their understanding about the task they have in hand. A thinkLet describes the interaction protocol, mainly in the form of facilitation scripts, between group members and the tools they interact with to achieve collaboration [23], therefore it is supportive to use thinkLets in designing ARGs in which collective effort is mandatory for goal achievement by team player with different roles. It is also beneficial to use thinkLets in designing such ARGs since thinkLets describe rules on how team members should make contributions to achieve overall consensus at the group level, at each stage of the game.

Process analysis 3: Recurring problems and replicable solutions. More importantly, Connolly et al. [12] argue that a main challenge they faced while designing the ARG was to understand the possibility to produce a replicable solution that could be used by modern foreign language teachers across Europe. Obviously such challenge is addressed through the use of design patterns. As discussed before, design patterns aim to describe solutions to recurring problems. The design solutions provided through the use of patterns of collaboration described in CE are "replicable" in nature. A combination of design patterns, possibly supported by thinkLets, can form a collaborative process that could provide a solution to these recurring problems.

Process analysis 4: Facilitation of learning processes. Within the structure of *Tower of Babel*, a central role is played by the puppet master who steers players in different directions as the game's story unfolds. The puppet master can adopt the role of an adversary to the players in placing obstacles in their path to solving a quest, or an ally in providing deliberate clues that enable players to find resources to overcoming obstacles [12]. The role of the puppet master in the ARG is equal to the role of the facilitator as it is defined in CE, which in the case of this study contributes to the effective accomplishment of the learning outcome. Whether the facilitator decides to smooth the collaboration process or to make it a more challenging experience for the players, the library of thinkLets would provide appropriate options for both purposes. As an example, within the initial group formation process, the puppet master can use the ice-breaking thinkLets [44] to evoke a sense of community belonging among the learners. Moreover, to make the learning process more challenging, the puppet master can use a flexible, quick and on the fly interventions using Modifiers [23]. Modifiers add a number of rules to a thinkLet used by the facilitator to make a predictable change or variation to group processes. An example of the use of a modifier is anonymity. In the case of *Tower of Babel*, the puppet master can make players' roles anonymous. This would result in more open discussions and hence more ideas. It would also increase the cognitive load to process all of the ideas and thus for a more challenging learning process.

4.2 *TeamUP*

TeamUP is a multiplayer serious game about teamwork [6]. A team of four players control each an avatar and has to work together to overcome a number of challenges within the game. Each challenge is designed to emphasize a specific element of effective teamwork. For example, one of the challenges is about leadership and another about communication. The game was originally conceived during the Game Design Project course taught by Igor Mayer from the TU Delft and was later redesigned by Arne Bezuijen during his Master Thesis under supervision of Igor Mayer. After finishing his thesis, Arne started his own company The Barn, which now licenses the game to whomever is interested in using the game. The game is supposed to be used in a workshop setting with a trainer, where players sit in close vicinity from each other, each with their own laptop. The trainer will reflect on the experiences with help of detailed reports on all of the players and a debriefing tool that allows to go back to specific moments of gameplay to discuss a team's thought process at that time.

We chose this game as our second case because it illustrates clearly how games can work *against* players in collaborative play – what we have coined negative collaboration activities. The challenge resulting from these negative activities enables team building as well as forms an experience to reflect on how to work together. So inhibiting collaboration eventually also results in increased collaboration. The difference is that with negative activities teams have to come up with their own procedures and tools to make collaboration work, whereas with positive activities this is provided for them. Despite that the game inhibits collaboration at most times, it does have occurrences in which positive collaboration activities can be distilled. These insights were found by performing an activity analysis, which dissects the activities using the CE collaboration patterns, and here we present three of our insights of how collaboration happens in this game. For each activity we present the predominant collaboration pattern that plays a role in that activity. Readers should keep in mind that in many of these activities more than one pattern can be identified.

Figure 2. The Tile Maze in *TeamUP*.

Activity analysis 1: Shared vision obfuscation (based on negative generate pattern). Communication is crucial in teamwork. In *TeamUP* players can freely communicate with each other. However, the laptops are positioned in such a way that players cannot look on each other's screens. Players are also asked not do this. Therefore, players cannot see what other players are seeing or doing. In one of the first challenges of the game, players have to navigate a tile maze (see Fig. 2).

Only one player can enter the maze at a time. This maze consists of a grid of tiles and one path of tiles is correct. If players step on a tile that is not part of the path, they are catapulted out of the maze and they can try the maze again or let another player go in to find the correct path. The challenge is resolved when all players have been able to navigate the maze. The crux of this challenge is being able to communicate to others the correct tiles, which is made into a challenge by inhibiting a shared vision and thereby a shared understanding of the problem. This is a clear example of a negative collaboration activity, because in CE tools are used to foster a shared vision. In terms of the original six collaboration patterns, what is inhibited is in particular the *generate* pattern. Collecting and sharing ideas has been made difficult.

Activity analysis 2: Divide and conquer (based on negative clarify pattern). The concept of "divide and conquer" refers to a strategy of breaking up existing power structures and of preventing smaller groups from linking up. The power of collaboration concerns the team and by breaking up this team it will be harder to collaborate. Games do this by forcing players to take each a particular route. Along this route they cannot enjoy the support from one another. This is what happens in another challenge in *TeamUP*. When players arrive at this challenge in the game, they first have to figure out that each player needs to stand on top of a switch. Once all four players stand on top

of a switch, three players are placed at different points in another maze. The fourth player is lifted into the sky and has an overview of the maze. The idea is that this fourth player illustrates his or her leadership by navigating the other players through the maze. At last, the leader needs to walk through the maze as well. This is again a negative activity because it challenges collaboration instead of that it fosters it. In this particular case the *clarify* pattern is especially challenged. It becomes difficult achieving a shared understanding of the situation as team members are dispersed and view the problem situation differently. In this challenge only one person, the assigned leader can propose explanations.

Activity analysis 3: Cueing for team roles and goals (based on positive reduce pattern). *TeamUP* does not entirely consist of negative collaboration activities. In another challenge, which is centered on the concept of delegation or task division, each player has to stand on a switch. Part of the challenge is to find the switches. The other part is to figure out the meaning of the switches. For this latter part players receive assistance. Once a players stands on top of a switch, a path of fire lights up going to an obstacle that prevents the players from proceeding.

If players get off the switch, the path of fire disappears. This path of fire is a cue that players need to stay on top of a switch. In other words, their role is to stay put on the switch until enough paths of fire are lit to remove the obstacle. The path of fire is also cue that standing on the switch is related to the obstacle, as the path connect the switch with the obstacle. In other words, the path cues players into what the goal of the challenge is and what each of their roles are as part of dealing with this challenge. Unlike the first two analyses, this cueing helps the collaborative decision-making process by enabling team role definitions and task delegations. This makes it a positive activity, and the best way to describe it is as a reduce pattern. The game provides a focus through these cues on what the team needs to pay attention to.

5. DISCUSSION

The purpose of this paper was to describe the usefulness of Collaboration Engineering (CE) for investigating what kind of collaborative processes and activities could be analysed in games. Exceptions exist, but existing practices in game design patterns has dominantly been from the ground up by studying games in isolation from theories and disciplines outside of the domain of games. As many games involve collaboration and decision-making, it seems a logical step to consider what, if any, can be learned from CE, a field that has resulted in the establishment of patterns for enabling collaboration. Those patterns could potentially be harnessed in the design and analysis of games, to see how collaboration is and can be supported in games.

In applying CE to games, it became clear that a conceptual difference between game design and CE exists when it comes to analysing collaborative processes and activities. CE is at all times used to support collaboration. With game design, on the other hand, collaboration is sometimes supported and at other times worked against. This has to do with the nature of games, which is to *challenge* players. With the game mechanics collaboration is inhibited and made difficult in various ways, from separating players (e.g., Divide and conquer) to making communication difficult (e.g., Shared vision obfuscation). This conceptual difference has nothing to do with dark patterns and anti-patterns [42], but is more analogous to the difference between Usability Engineering (UE) [36] and game design. With UE interfaces are made as efficient as possible, ensuring that people can get the task done in the easiest and fastest way possible (e.g., getting cash from an ATM). With games efficiency is not at stake. In fact, games actually challenge players to accomplish their goal. Players might get so frustrated that they never achieve the goal or they simply lose interest in achieving it, which is an absolute sine qua non for UE. To make a distinction in how games handle collaboration we coined the term "positive collaboration activity" for activities supporting collaboration (e.g., Safe room) and the term "negative collaboration activity" for activities challenging collaboration.

Table 2. Outcomes process analysis of *Tower of Babel* and activity analysis of *TeamUP*

Process Analysis Outcomes: identification of obstacles and issues in game activities where CE can be used.	**Activity Analysis** Outcomes: understanding of how collaboration takes place in game activities using CE patterns.
1) Routes towards success: CE helps to identify goals and sub-goals that exist in game play and to distinguish processes that lead to success in goal achievement or vice versa.	**1) Shared vision obfuscation:** To negatively enhance gathering and creating information among group members by not letting members see the same situation
2) Cognitive complexity and differences in roles: CE helps to improve the level of communication among t*eam members* and help them *understand* the meaning behind *each other's* words and actions.	**2) Divide and conquer:** To negatively enhance formulation of a shared concept by breaking up the team members into smaller groups.
3) Recurring problems and replicable solutions: Using the design patterns, CE helps to apply replicable solutions to the same or similar design problems.	**3) Cueing for team roles and goals:** To improve and positively enhance abstracting, summarizing or selecting among concepts by cueing team members into what they need to do to accomplish their goal
4) Facilitation of learning processes: CE helps to regulate collaborative learning processes by introducing the concept of facilitation and scripts used by the facilitator that can also be applied by novice facilitators, leaders or instructors in teams.	

CE is used to facilitate the collaborative decision-making process. Its scope consists of the moment a problem arises over which collaborative decision-making is needed until the final decision made. This scope is of importance because it allows us to understand for what type of games CE could be of use. We made a distinction between instinctual, supportive, and integrative collaboration games. It is the latter category for which CE is most promising and applicable. With fast-paced, twitch-speed co-op games not much time for deliberation is possible. In those types of games teams need to rely on intuition, routine, and agreements on the strategy made earlier. With supportive collaboration, where collaborative decision-making is limited to before the start of playing or at intermittent points, CE can be of use, by helping players to make up a strategy. However, this is a limited application of CE and therefore we focused on games for which collaborative decision-making is a core element of the gameplay. These are games that involve multiple players that need to consciously deliberate and discuss what action to take before taking one. We call such games "Collaborative Decision-Making Games". In the current state of affairs in the world of games, with still much emphasis on fast and primitive action and responses [29], this means that CE is applicable to only a limited set of games. Most games that fit this label are of a serious nature and are used for business, public policy, and urban planning [21].

To illustrate and study how CE could be of use, we selected two cases: *Tower of Babel* and *TeamUP*. Both cases were selected because they represent the types of games for which CE could be relevant. On each case we performed a different analysis, out of necessity but also to illustrate specifically how CE can be of use. The outcomes of this early work are presented in Table 2.

Tower of Babel drives like most ARGs on the collaboration among players. Closer investigation reveals that this collaboration is enabled

with fairly traditional web tools, such as a discussion forum and chat system. These tools allow for communication between players, but do not necessarily facilitate the decision-making process. The only system that could be qualified as such is the rating system that allows players to rate the responses by players on the discussion forum. As with most ARGs, collaboration is instigated by design by dispersing information among players and requiring players to work together as some have skills that others do not have to deal with a challenge. With the *Tower of Babel* this concerns language skills. Another design strategy has been to request players to get information from each other and create a sense of community among players. These forced ways of working together are in our eyes a symptom of a natural inclination of c*ollaboration lethargy*: players will not collaborate spontaneously, especially in distributed environments, and so design strategies are employed to foster collaboration. This lethargy might very well exist because the environment does not offer any collaboration tools. If the environment were to have more advanced abilities to generate, reduce, clarify, organize, and evaluate ideas and build consensus, players might engage with the topics in a more intense, in-depth manner. This is where CE could be of help. Of course, this does require that challenges should not have relatively simple answers to them. Quests that can be solved with a quick Google search, as some of the quests in *Tower of Babel* (e.g., When was the European Union founded?), do actually increase collaboration lethargy. If there is no need to work together, why bother?

TeamUP is likewise about collaboration, but does this by making it intentionally difficult to collaborate. If *Tower of Babel* represents various types of ARGs, then *TeamUP* represents various serious games that have been created to train effective teamwork (e.g., *Novicraft*, *Infiniteams*, and *Moonbase Alpha*). Like most of these games, this game throws various challenges at the players and the only way to deal with them is to somehow find a way to collaborate. Throughout the process players learn about collaboration and start collaborating. This is what we consider the *collaboration paradox*: the game actively tries to hinder collaboration and by doing so fosters collaboration. We identified a number of negative collaboration activities that constitute this paradox in *TeamUP*. Others could be designed by *reverse engineering* the CE patterns. Instead of supporting collaboration, the patterns will be used to challenge collaboration. Nevertheless, as *TeamUP* also highlights, and what is true with almost any type of game, designers will need to balance challenging and supporting players. Too much challenge will result in frustration and that will cause players to quit the game. Therefore, the collaboration paradox should actually be: the game actively tries to hinder collaboration, but does provide the necessary scaffolds for players to succeed, and by doing so fosters collaboration.

This paper does not provide a definitive answer on the applicability of CE for creating a patterns approach to collaborative games. This would require a more extensive and systematic study than what has is discussed here. Yet, approaching the topic of collaborative games from the perspective of CE has resulted in various valuable insights and opportunities for game design and analysis. In addition, this paper has made clear in what contexts CE is relevant and what kind of role it can play. This depends very much on whether the game mechanics are working for or against the players.

6. CONCLUSION

Collaborative games seem on the rise, most notably as ARGs and serious games, and designing effective collaborative games is of importance for the success of entertainment as well as serious games. In this paper our aim was to examine how collaborative games support collaboration through their mechanics. Instead of considering a variety of games, distilling their patterns, and then possibly testing their effectiveness, we decided to first consider the applicability of CE, a mature field that has a significant body of knowledge on methods and techniques for enabling collaboration. So in addition to exploring collaboration patterns, our purpose was to consider the usefulness of CE as theoretical lens for determining a patterns approach to collaborative games.

Our findings highlight that CE can be of use of analysing collaborative processes and activities, but that it differs from game design in that games are not always supportive of enabling collaboration. However, with reverse engineering CE could still be of use there. We also find that CE is only applicable to a limited set of games.

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