# Stay Awhile and Listen to 3Buddy, a Co-creative Level Design Support Tool

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### Abstract

There is untapped potential in having a computer work as a *colleague* with the video game level designer as a source of creative stimuli, instead of simply working as his slave. This paper presents 3Buddy, a co-creative level design tool exploring this digital peer paradigm, aimed at fostering creativity by allowing human and computer to work together in the context of level design, and describes a case study of the approach to produce content using the Legend of Grimrock 2 level editor. Suggestions are generated and iteratively evolved by multiple inter-communicating genetic algorithms guiding three different domains: innovation (exploring new directions), guidelines (respecting specific design goals) and convergence (focusing on current co-proposal). The interface allows the designer to orient the tool behaviour in the space defined by these dimensions. This paper details the inner workings of the system and presents an exploratory study showing, on the one hand, how the tool was used differently by professional and amateur level designers, and on the other hand, how the nuances of the co-creative interaction through an intention-oriented interface may be a source of positive influence for the creative level design process.

## Introduction

Creativity is of paramount importance in our current day and age, and more rewarded than technical prowess in certain domains, in particular in the games software industry (Murphy-Hill, Zimmermann, and Naggapan 2014). While no consensus exists regarding the definition of creativity, there is an overall agreement that *creativity* can be seen as the "interaction among aptitude, process and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context" (Plucker, Beghetto, and Dow 2004). This work explores how a computer could foster creativity in an important componentent of digital game development: Level Design.

### Computational Co-creativity

Most people face computers as facilitating tools, and disregard their potentially valuable contribution to any creative process, as if something impossible for a computer to help with. The fact that creativity is often considered to be a mental process occurring within an *individual*'s head strengthen this belief when, in fact, creativity is an ability that can be stimulated in a distributed way within a *group* (Sawyer and DeZutter 2009).

Lubart (2005) identifies four ways a computer can support human creativity: management of creative work, in which the computer takes the role of a "nanny"; communication between individuals collaborating on creative projects, in which the computer takes the role of a "pen-pal"; the use of creativity enhancement techniques, in which the computer acts as a "coach", and; the creative act through integrated human-computer cooperation during idea production, in which the computer acts as a "colleague" and co-creator. Lubart (2005) classifies the last category as the most ambitious way that computers can support human creativity, but also one of the most interesting to explore, mainly because of the inherent potential of an interaction between computers, that excel at exhausting a search-space, and humans, that excel at transforming rough concepts into coherent ideas. Our work shares this point of view and explores the digital *colleague* paradigm.

### Content Creation for Digital Games

*Procedural Content Generation* or PCG (Togelius et al. 2011), is a growing trend in digital game development, a set of techniques able to quickly generate "correct" content within a set of constraints, and support a more cost-efficient process for content-heavy digital games. Although this technique excels at generating "filler" content, the digital game development process lacks tools to support the design of critical and crucial moments for the game experience, moments that are able to surprise the player and make a game stand out from others on the market (possibly using the same PCG toolbox). To complement the content *generation* tools, we need content *creation* support tools.

We believe *Level Design*, "the thoughtful execution of gameplay into gamespace for players to dwell in" (Totten 2014), is a good example of an activity which would benefit from a computer-assisted co-creative tool. Several modern games are released with content editors and modding tools, facilitating the creation of custom content, although such tools are generally the ones that supported the creation of the base game itself and offer little to help the user create genuinely interesting and novel content that could be classified as "creative" and have a value on its own. We need tools to help achieve that goal.

## Co-creative Level Design Support Tools

Our research builds on previous work in mixed-initiative co-creative support tools such as the Sentient Sketchbook (Liapis, Yannakakis, and Togelius 2013) and Tanagra (Smith, Whitehead, and Mateas 2011), and takes the research one step further in terms of the digital *peer* paradigm. Our design is guided by the seminal work on *Lateral Thinking* by DeBono (De Bono 1977) and the experiments by Yannakakis et al. with *mixed-initiative co-creativity* (Yannakakis, Liapis, and Alexopoulos 2014) merging both Lateral Thinking, which use the interaction should facilitate but not enforce, and *Diagrammatic Reasoning* (Vile and Polovina 1998), i.e. reasoning via the use of visual representations, a cognitive process inherently present in level design.

This work aims at conceiving a support tool that will *proactively* take part in a dialogue with a designer during the level design process that will (1) benefit the *creative process* per se, (2) allow to reach more *creative outcomes* as an output of this process, and; (3) have a lasting effect on the participants own *creative abilities*. Yannakakis et al. (Yannakakis, Liapis, and Alexopoulos 2014) point there are two types of evaluation when a computational creator is involved: the evaluation of the intermediate and final outcomes and the evaluation of the co-creative process. We believe the impact of the interaction on the *participants*' (both human and digital) creative capabilities to be of importance when evaluating creativity support tools.

This work is framed within the field of computational creativity, a key issue being to understand how the interaction with our level design tool could help support a more creative process, outcome, and impact the abilities of both participants. Our work contributes towards the enhancement of human creativity with the aid of computer programs, framing it as a Creativity Support Tool (CST) (Shneiderman 2007).

In this paper, we present an *exploratory study* probing how different participants, with different game and level design backgrounds, interact with our creative support tool in the context of a specific level design task for a commercial video game, and how it impacts their approach to the task. The remaining of the paper is organized as follows. We start by describing the commercial game level design tool used in this work, as well as the metaphor for interacting and communicating with our CST and detail its implementation. Then, we present our user exploratory studies and discuss the results of this evaluation. We conclude with our final remarks and directions for future work.

# Legend of Grimrock 2 Editor

The game Legend of Grimrock 2 (Almost Human Ltd. 2014), henceforth designated by the acronym LoG2, is a computer game of the dungeon crawler genre which includes an in-game level editor. The LoG2 editor (Figure 1) provides the designer with a 2D canvas, as well as a series of tools to edit the layout of the level as well as its content. It is also possible to test, in real-time, the impact of the changes performed on the level by running the game in one of LoG2 editor viewports. In this paper, the LoG2 editor serves as the primary editing tool for the level designer, whereas our companion tool will propose suggestions related to the content being created inside the LoG2 editor. We also focus on the co-creation of the dungeon layout, which in LoG2 is represented by a grid and is available as a plain text Lua script file, that serves as the communication point between the editor and our companion tool.

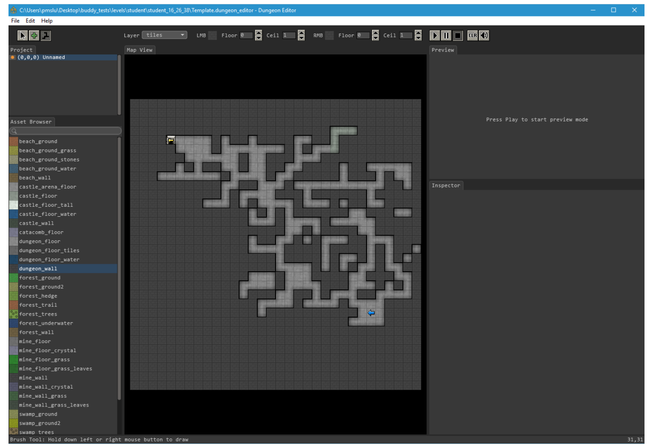

Figure 1: Legend of Grimrock 2 editor

# Editor Buddy (3Buddy)

*Editor Buddy*, henceforth designated *3Buddy*, is a C# application that runs independently but alongside the LoG2 in-game editor. Its primary goal is to foster creativity during a level design activity by presenting visual hints and suggestions iteratively, while the designer works inside the game editor. Following a dialogue metaphor, its interface provides the level designer with visual information as a way to stimulate creativity, and guides the application behaviour to adapt to the moment-to-moment needs of the creative process.

## 3Buddy Interface

The interface of 3Buddy is inspired by the control knobs found on analogue synthesizers, that shape the sound produced by these musical instruments. In our case, the control sliders (sliders were found to be preferred to control knobs during early prototyping) shape the direction of the dialogue with the level designer during interaction. 3Buddy user interface (Figure 2) essentially consists of three control sliders and an interactive canvas. The control sliders are:

- a slider controlling the amount of innovation expected in the current moment of the creative process (*innovation*);
- a second slider controlling the importance of complying to specific design goals (a pane allows the selection of currently active guidelines) (*guidelines*);
- a third slider controlling how much the current solution being edited by the level designer should be taken into consideration when making suggestions (*convergence*).

A simpler version of the interface that transforms all sliders into switches that can simply be turned on or off (Figure 2 middle) is also available to the level designer. Usability

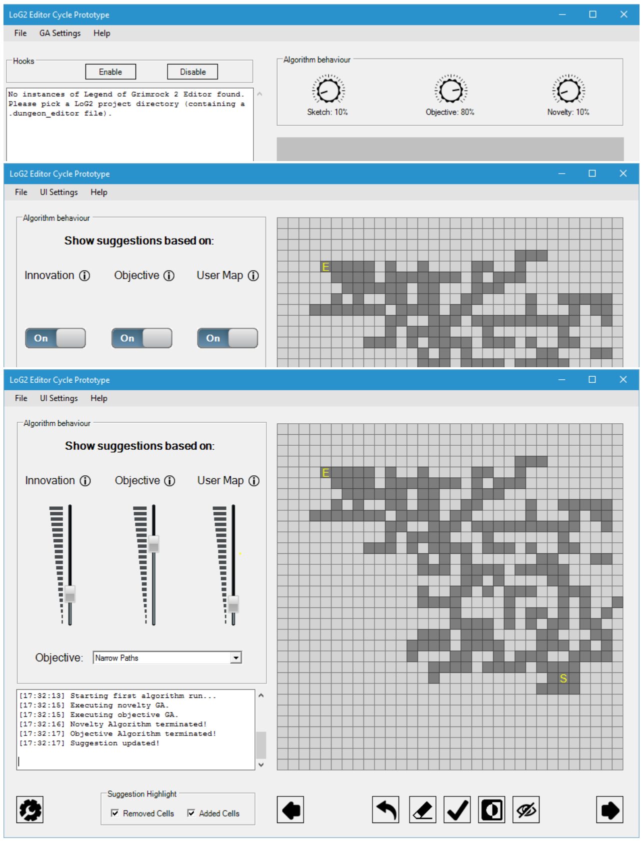


Figure 2: 3Buddy interface at different stages: (top:) early prototyping with knobs (cut) (middle:) standard mode with switches (cut), and (bottom:) expert mode with sliders (full).

testing encouraged us to include this option as it is useful on the first interactions to get a feel for the individual impact of each control slider on the overall co-creation process.

The interactive canvas supports the *dialogue* between 3Buddy and the level designer. On the one hand, the designer can select sections of the idea to import into the editor or define the focus in terms of the interaction with the creative companion. A set of editing tools similar to the ones provided in LoG2 editor are available to the designer to allow for the precise selection of specific parts of the dungeon layout. On the other hand, 3Buddy presents its suggestions in terms of colour-coded differences to the current version of the level layout present in the LoG2 editor, i.e. additions and removals are presented in different colours. The colour coding can be turned on and off, which is useful when a commitment is reached. Although 3Buddy always works in a complete solution, it only shows changes in the part of the dungeon that is the current focus. The designer, however, can ask 3Buddy to reveal “hidden” parts of the layout at any time. Finally it is possible to revisit past suggestions. Overall, the interactive canvas allows to intuitively and visually communicate both focus and suggestions to support diagrammatic reasoning, a cognitive process inherently present in level design.

## 3Buddy Behaviour

3Buddy’s behaviour is triggered each time the dungeon layout is saved by the level designer in LoG2 editor or after an inactivity time-out. As a response to this trigger, a suggestion is computed and presented on the interactive canvas of 3Buddy. The suggestion can be ignored by the designer or part (or the whole) of it integrated in the current level layout. The designer can also select parts of the canvas to specify the section on which both the designer and 3Buddy are working at the moment. This quick interaction cycle guided by the three sliders is what distinguishes our approach from previous ones. By allowing the designer to consider and evaluate intermediate steps in a less rigid structure, we expect to tap into a process with a greater creative potential.

**Computational Approach.** To compute a suggestion and present it to the level designer, 3Buddy conceptually uses three different base sets of suggestions (Figure 3):

- a set of suggestions that are computationally evolved to be close to the current dungeon layout the designer is working on in LoG2 editor (*convergence* pool).
- a set of suggestions that are computationally evolved to be radically different from what the designer is currently working in the LoG2 editor (*innovation* pool).
- a set of suggestions that are computationally evolved to comply to the currently active design goals and guidelines (*guidelines* pool).

The innovation and guidelines pool are initialized with random individuals and evolved according to their respective purpose, while the convergence pool is initialized with copies of the current dungeon layout that will typically undergo small changes through mutation.

A new population (*suggestion* pool, see Figure 3) is then created by randomly selecting individuals from each one of the three base sets, according to the proportions defined by each one of the control sliders (convergence, innovation and guidelines). The sliders metaphorically control the flow of ideas from each base set to the suggestion pool that will give birth to 3Buddy’s suggestion.

This new population now constitutes the guidelines pool and a new cycle begins: the convergence pool is updated with new individuals representing the current dungeon layout in LoG2 editor and evolved to create proposals that are small variations from it; the innovation pool is evolved to create individuals moving away from the current proposal, and; the guidelines pool, a mix of the previous three base suggestion sets, is evolved to find a new dungeon layout to suggest to the designer guided by the active design goals. Once selected, the new suggestion is presented on the interactive canvas, highlighting the differences to the current layout and hiding all details that are not in the area currently under focus. 3Buddy then waits for the next trigger before starting a new cycle.

**Implementation.** The behaviour of 3Buddy is guided by genetic algorithms (GA) associated with each set, which themselves are tied to the dungeon section on which both 3Buddy and the designer are working at the moment.

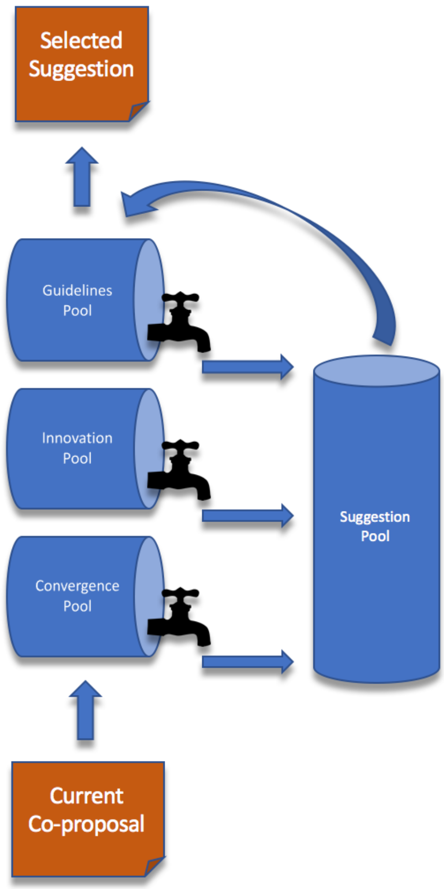


Figure 3: 3Buddy computational approach

The GA implementation is based on the Genetic Algorithm Framework by Newcombe (2015) which was adapted to account for the bi-dimensional grid layout of the dungeon. Each dungeon layout suggestion (a 32x32 square grid) is represented as an unidimensional line-major chromosome (Figure 4, middle), in which each gene records whether it is crossable or not. For this exploratory evaluation, each GA population was composed of 30 individuals, that are initially randomly generated, with approximately 50% of crossable tiles, and 80 generations were computed each time 3Buddy's behaviour triggers the evolution of a suggestion set.

The parents for the next generation are selected using roulette wheel selection, i.e. the probability of being selected is proportional to the fitness of the individual. Crossover occurs with a 80% probability. The standard crossover operator was redefined to take into account the bi-dimensional nature of such space: conceptually, a square (in this specific implementation we used a 3x3 square, mapped to the one-dimensional chromosome space) is randomly chosen in the dungeon layout to define the crossover boundary combining the genetic material from two offsprings (see Figure 4, top and bottom).

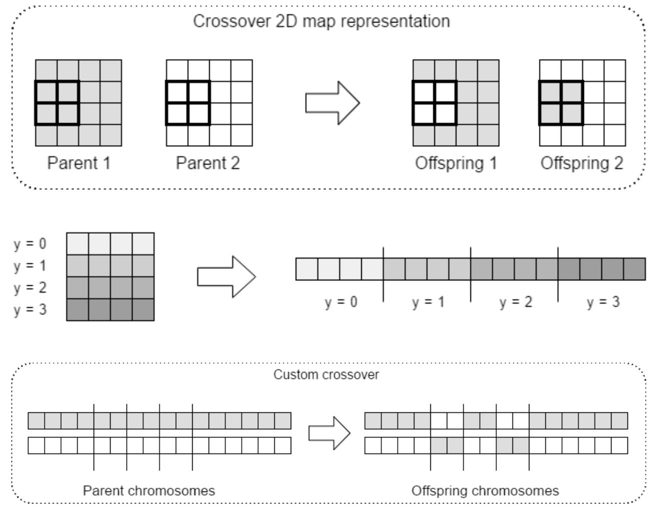


Figure 4: (top:) Example of our crossover approach using a 2x2 square and in a 4x4 grid, (middle:) Example mapping of a 4x4 space to a 16-gene chromosome, and (bottom:) Example mapping of a 2x2 square crossover to a 16-gene chromosome.

Replacement policy uses generational replacement, where the best offspring replaces its least fit parent. Mutation has a 15% chance of occurring and consists in swapping two genes within the chromosome. Finally, an elitism policy was used: the top 5% individuals from a population are copied to the next generation without being modified.

To account for their different purposes, each GA used a different fitness function:

- The "convergence" GA uses the number of equal genes between two chromosomes as the fitness function.
- The "innovation" GA uses the number of different genes between two chromosomes as a measure of fitness.
- The "guideline" GA and "final suggestion" GA use a linear combination of fitness functions specific to each active design goal.

The design goals implemented in 3Buddy for the evaluation task were: "a path exists between an entry tile and an exit tile"; "the dungeon has narrow halls"; "the dungeon has ample rooms". Each design goals has a specific fitness function related to that goal. Changing the active design goals resets the "guidelines" suggestion pool with a new random set of chromosomes that are evolved according to the combination of the new active design goals.

## User Study with 3Buddy

To evaluate the perceived utility and efficiency of 3Buddy in the context of level design, we conducted a user study performed on a small group of participants for short periods of time, inspired on a realistic task for a game development studio. By *utility*, we refer to the ability to contribute, direct or indirectly, with useful content – the definition of usefulness remaining at the designer's discretion. By *efficiency*, we refer to the possibility of configuring 3Buddy in such a way as to produce coherent and useful content according to the needs and intentions of the designer at a given time during the co-creative process.

The study included two tasks designed to explore different contexts of use for 3Buddy in level design: the first task targeted content creation from scratch while the second task focused on modifying content previously created.

**Sample:** 6 participants were selected for this study, with ages ranging from 21 to 35 years old ($M = 27.3$, $SD = 5.16$, 6 male). We used a purposeful sampling method and selected participants according to two different profiles based on background and expertise: 3 professionals or expert individuals, game or level designers, and 3 amateur or inexperienced individuals, Computer Science MSc students from a Games course. All the participants expressed having a clear interest in Level Design.

**Procedure:** Participants would arrive individually at the laboratory where the study would take place and be introduced to the most important features of the game Legend of Grimrock 2, its editor and 3Buddy, through a 5 minute video tutorial. They would then experiment with these tools and freely ask questions regarding their usage to the researcher supervising the study. The whole introduction / tutorial took around 30 minutes.

After this initial contact, participants would be asked to design a new playable dungeon floor between two existing floors (fictitious and not provided) with certain constraints: they would be using the LoG2 editor while interacting with 3Buddy to support them during the level creation process; they would have to design a solution with a valid path between the (unmovable) entry and exit points of the level that represent the access to contiguous levels (Figure 5), and; the solution should be as interesting as possible for the player.

This first task had an additional constraint:

> The level layout should be maze-like and contain narrow paths, as monsters with a charge attack, that will be placed later in the development, should be able to take full advantage of their ability in this level.

The participants were then told they would have all the time needed until they would feel totally satisfied with their solution. However, after 20 minutes (the average duration of this task, as measured during pre-test with 5 other participants), we would ask him to interrupt his current work and start working on a second task. If the task was completed before that time, we would interrupt the participant as he would stand up to inform the researcher. This new task is in all similar to the first except for an additional constraint:

> The level layout needs to accommodate for challenging big monsters that will be placed on this level but are too big to fit the standard narrow halls.

This second task had no time limit, but took around 20 minutes to complete. After the level layout is finished, we asked the participant to fill a questionnaire (circa 10-15 minutes) and undergo a semi-structured interview (circa 20-30 minutes). The last stage of the study consisted in looking at the solution provided by the participant, congratulating him for his accomplishment, thanking him for his participation and saying goodbye. The full experiment had an average duration of 2h per participant.

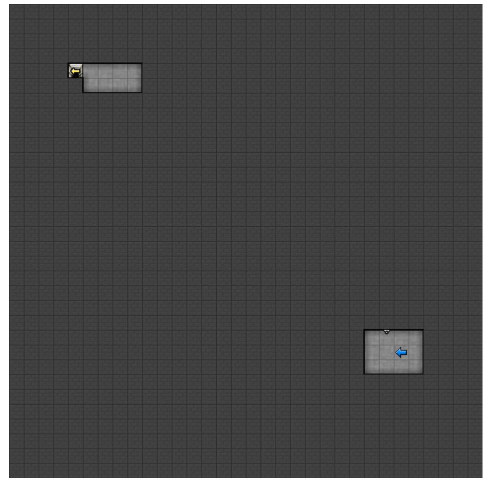

Figure 5: Starting level layout for evaluation

**Data collection:** To evaluate 3Buddy, we used qualitative data gathered through participant observation, a questionnaire, and a semi-structured interview.

While a researcher was always present in the back of the room, taking notes and answering technical questions when requested to by the participants, observation was complemented by screen recording during the entire process: we were interested in the participants' actions during level design activities including their interaction with both the ingame editor and 3Buddy.

We used a linear scale questionnaire to get a measure of usability for the LoG2 editor and the 3Buddy interfaces. The questionnaire also measured the discrepancy between the participant expectation when tuning the control sliders in a certain configuration when compared to the associated suggested content by 3Buddy. Finally, the questions incentivised the participant to think about certain issues that would be explored during the following interview.

After participants were finished with the questionnaire, a semi-structured interview was conducted. The goal for the interview was to draw out patterns from common concepts and insights regarding the personal experience of each participant while interacting with 3Buddy.

# Results

## Questionnaire

The following agreement statements (5-point Likert scale) evaluated the usability of LoG2 editor and 3Buddy: (U1:) it was easy to edit the layout of my level using the LoG2 editor; (U2:) it was easy to configure 3Buddy's behaviour using the available interface controls; (U3:) it was easy to make and edit a section of the map suggestion made by 3Buddy; (U4:) there were no issues regarding the communication between the LoG2 editor and 3Buddy.

Participants reported 3Buddy to be easy to use and its integration with LoG2 editor intuitive and satisfying. This was reinforced by observation and interviews. Table 1 shows the results from the usability section of the questionnaire.

| 5-point Likert | U1 | U2 | U3 | U4 |
|---|---|---|---|---|
| Totally disagree | 0 | 0 | 0 | 0 |
| Somewhat disagree | 0 | 0 | 0 | 0 |
| Neither agree nor disagree | 0 | 0 | 1 | 1 |
| Somewhat agree | 2 | 2 | 1 | 2 |
| Totally agree | 4 | 4 | 4 | 3 |

Table 1: Frequency of answers to usability questionnaire

Regarding the evaluation of 3Buddy's behaviour, Figure 6 shows how 3Buddy's suggestions, when using the *innovation* control slider, were as expected and how useful they were perceived by the participants. Figures 7 and 8 do the same for the *guidelines* and *convergence* control sliders.

The experiment confirmed what we had learned during pre-test: suggesting the participant to start with standard mode before moving to expert mode is key to the creation of adequate expectations regarding the interaction.

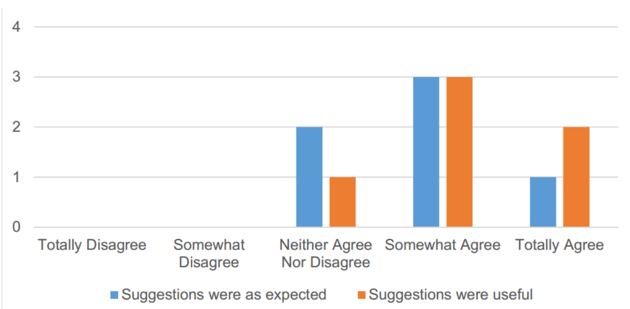


Figure 6: Frequency of answers to (B1:) suggestions using "innovation" were in line with my expectations (B2:) suggestions using "innovation" were useful.

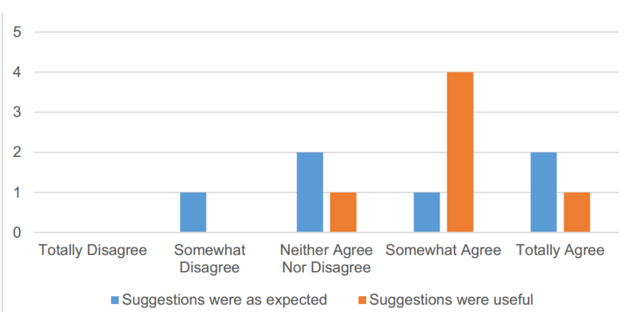


Figure 7: Frequency of answers to (B3:) suggestions using "guidelines" were in line with my expectations (B4:) suggestions using "guidelines" were useful.

The exploration of the negative marks showed that the "guideline related suggestion not as expected" (Figure 7)

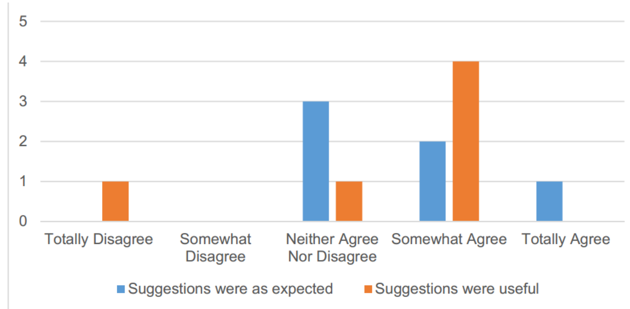


Figure 8: Frequency of answers to (B5:) suggestions using "convergence" were in line with my expectations (B6:) suggestions using "convergence" were useful.

was actually perceived as a good thing, "a pleasant surprise", and the 1-rating in convergence control (Figure 8) was related to the inability of 3Buddy to understand what the level designer was "thinking and trying to do rather than doing". This particular participant also reported "not needing the help of a tool to be able to perform his work". This never happened with the amateur level designers who were thrilled with the help provided. This is a factor that clearly needs further study, as a tool aimed at helping in the creative process could be perceived as a competitor in a domain where creativity is more valuable than technical skills such as the digital games industry.

## Observation

Through direct observation and screen recording, we were able to identify key-events and key-issues during participant interaction with 3Buddy, as well as important processes which occurred over time. Identified *key-events* were:

- Increase in interaction with the behaviour control sliders, immediately after the user changed to expert mode;
- Increase in interaction with 3Buddy canvas and suggestion selection in all cases after moving to expert mode;
- Exporting suggestion selections almost always meant a consequent refinement of that content in the designer's working level layout;
- When asked to work towards a different objective with 3Buddy, the vast majority immediately changed 3Buddy guidelines as a response.

*Key-issues* detected through observations:

- When facing participants with poor suggestions from 3Buddy that rarely translated into an attempt to reconfigure its behaviour using the standard mode;
- When trying to preview the entire suggestion, the majority of participants would perform a selection of the whole canvas instead of using the dedicated visibility button;
- Participants almost never interacted with the history buttons to revisit previous suggestions;
- After changing to expert mode, participants never changed back to the standard mode.

*Important processes* such as decision making or control interaction were essentially different for each participant, but here are the more frequent patterns detected:

- Professionals had a predetermined idea for the level and only interacted with 3Buddy after they were finished with a first version of the layout;
- Non-professionals started interacting with 3Buddy early on and effectively performed selections, exported and improved these changes frequently during the interaction;
- The interaction with the behaviour switches (standard mode) and/or sliders (expert modes) increased over time;
- Participants would perform selections over the canvas regularly, as part of their creation process, even if the result was not exported;
- No participant felt the need to use the revert button to go back to a previously layout suggestion;
- Although there was no time limit, the duration of each task was very even amongst all participant professional and amateur alike, averaging 20 minutes.

Finally, and as a *heuristic* approach to validate the adequacy of the interaction with 3Buddy in a creative context, observation allowed us to verify that some techniques presented by Debono in his seminal work on Lateral Thinking (De Bono 1977) did occur during the interaction with 3Buddy. Specifically, we identified the following techniques in the recorded interactions: to explore simultaneously different alternatives, to change focus during the interaction, to break free from the requirements and limits imposed by the design process, to allow for the connection of unrelated and random and provocative input to open new lines of thinking, and to harvest the best ideas and reshape them into a practical solution. This suggests the interaction with 3Buddy does not limit the use of such techniques in the creative process.

### Semi-structured Interview

The interview was guided by the following script, while exploring aspects raised by the participants:

1. Overall, did you find 3Buddy useful?
2. In which case did it work best: on the first task where you had to start from scratch, or on the second task where you had to rework your current level?
3. If you moved to expert mode, what made you change? If you have not, why did you not change?
4. What combination(s) of behaviour switches/sliders would you recommend a friend using this tool for the first time?
5. What would be the combination(s) you would not recommend?
6. Was there a right time to use a particular switch or slider all the way up or down?
7. If you could make any change to the interface, what would it be? Why?
8. If you could make any change to the behaviour, what would it be? Why?
9. If you could have a mode where 3Buddy suggestions would be directly applied to your work without the need for your approval, how would you feel about that?
10. Any other comment that would help us improving 3Buddy?

Results collected from the semi-structured interviews were more subjective and, thus, harder to convey in their entirety. Some interesting patterns, however, emerged during this process, and specific improvements were suggested.

Generally, non-professionals preferred to use 3Buddy during the first task where they were asked to create content from a minimal template. In opposition, professionals, preferred to use 3Buddy during the second task where they were asked to modify their work towards a different design goal instead of creating content from scratch.

Regarding control configurations, although innovation and convergence switches and sliders were the controls which had most disparity in terms of usage and preference over time, we found there was a relation to both the task and the stage of the design participants were focusing at the time. Generally, participants recommended alternating between innovation and convergence on the full map in the early stages to quickly generate a large quantity of content, and doing the same thing on small portions of the map at later stages of the level design, to explore detailed changes on parts of the map they were unhappy with.

Regarding configurations of controls to avoid, most comments were in line with our expectations: "do not use innovation if you just want to slightly modify your work" and "do not use convergence if you want to explore different alternatives". These comments strengthened that the function provided by 3Buddy as a result of interface interaction was in line with user expectations.

Suggested interface improvements included:

- Parametrization of the colour coding scheme and small refinements at the interface level to optimize intuitiveness;
- Highlight of viable paths from start to finish, and visual feedback based on compliance to the active guidelines;
- Visual differentiation between older and recent suggestions, e.g. more vibrant colours for newest suggestions;
- An initial procedure to help setting up an optimal configuration according to the type of user.

Suggestions to improve 3Buddy behaviour included:

- A way to ask for an immediate new suggestion without having to make any change in the current dungeon layout;
- Add continuous sliders to allow for greater control on map complexity, rather than using statements for guidelines;
- Add a slider to set up the trade-off between the quality of the suggestions and the response time;
- Add a slider defining how much the suggestions presented could fall outside the region selected by the user, rather than strictly adhering to it;
- 3Buddy should identify patterns in the current layout and be able to replicate this style in the following suggestions.

At first sight, most comments seem to point to a need participants had to be more in control. A closer look, however, revealed that participants actually felt the need to clearly communicate their *intentions* at different moments in the creative process to 3Buddy. And that was exactly what the designers were able to intuitively express through the three sliders provided by the interface.

## Conclusions

In this paper, we presented 3Buddy, a co-creative support tool exploring the digital *colleague* paradigm to foster creativity in the context of video game level design. We described 3Buddy's simple and innovative interface composed of: (1) an interactive 2D canvas, allowing to intuitively and visually communicate both focus and suggestions to support diagrammatic reasoning, a cognitive process inherently present in level design, and; (2) three control sliders defining what is important at a certain moment in the creative process, expressed as a combination of three dimensions: innovation, wanting to explore new directions; guidelines, following specific design goals, and; convergence, focusing on the current co-proposal. We explained how 3Buddy was connected to the flow of level creation in the commercial game Legend of Grimrock 2, and how its implementation based on multiple and inter-communicating genetic algorithms supported this approach. Finally, we presented an exploratory qualitative study with both professional and inexperienced designers in the context of two level design tasks: one based on the creation of new content and another based on the modification of existing material. The study supported that, although 3Buddy was perceived as intuitive and useful and that standard lateral thinking techniques were observed during the interaction, professionals and inexperienced participants had very distinct patterns of interaction with the three sliders with which they expressed their intent during the creative process. Such patterns need to be taken into account when creating creativity support tools such as 3Buddy.

**Future directions:** As a result of the encouraging results obtained from this exploratory study, we are currently exploring several directions to improve 3Buddy. We are exploring how the same (but refined) interface could be used to support other level design specific tasks and are looking at puzzle creation as well as enemy and loot placement within a LoG2 level, as well as how these different dimensions could be integrated into one single CST. We are researching how the interface could be personalized for each user while exploiting patterns learned from the interaction and, as such, be more proactive while warmly accepted by all designer typologies. We are also exploring how different search algorithms colour the type of suggestions provided by 3Buddy. Finally, we want to test the impact of the co-creative process on the final player experience as well as on the impact on the creative posture of the designers themselves.

### Acknowledgements

This work was supported by national funds through Fundação para a Ciência e a Tecnologia (FCT) with reference UID/CEC/50021/2013.

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