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Cognitive Flow: The Psychology of Great Game Design

By Sean Baron

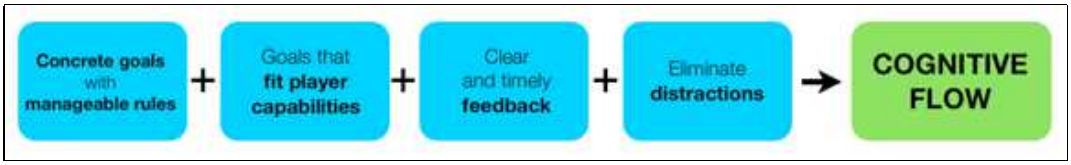
[*Microsoft Studios user experience researcher Sean Baron takes a look into the often discussed, but rarely concisely defined, concept of Flow, and offers a succinct definition and suggestions for implementing conditions to help players get into the zone*.]

You sit down, ready to get in a few minutes of gaming. Hours pass and you suddenly become aware that you're making ridiculous faces and moving like a contortionist while trying to reach that new high score. You ask yourself: Where did the time go? When did I sprain my ankle?

Maybe you didn't sprain your ankle, but if you consider yourself a gamer, you've probably ended up in similar situations. They happen because you've reached a critical level of engagement with whatever game you're playing.

More often than not, these types of gaming sessions occur when you're playing a great game. If game developers were able to characterize and add design considerations that facilitate these engaged states they'd create more enjoyable and better selling games.

Luckily, these heightened levels of engagement have been studied by psychologists. They even have a name for it: **Cognitive Flow**. In what follows, I will introduce Flow and the four characteristics of tasks that promote it. For each characteristic, I will provide some basic psychological perspectives and relevant recommendations for game developers.



Introduction

In the 1970s a psychologist named Mihaly Csikszentmihalyi experimentally evaluated Flow. He found that a person's skill and the difficulty of a task interact to result in different cognitive and emotional states. When skill is too low and the task too hard, people become anxious. Alternatively, if the task is too easy and skill too high, people become bored. However, when skill and difficulty are roughly proportional, people enter Flow states (see Figure 1).

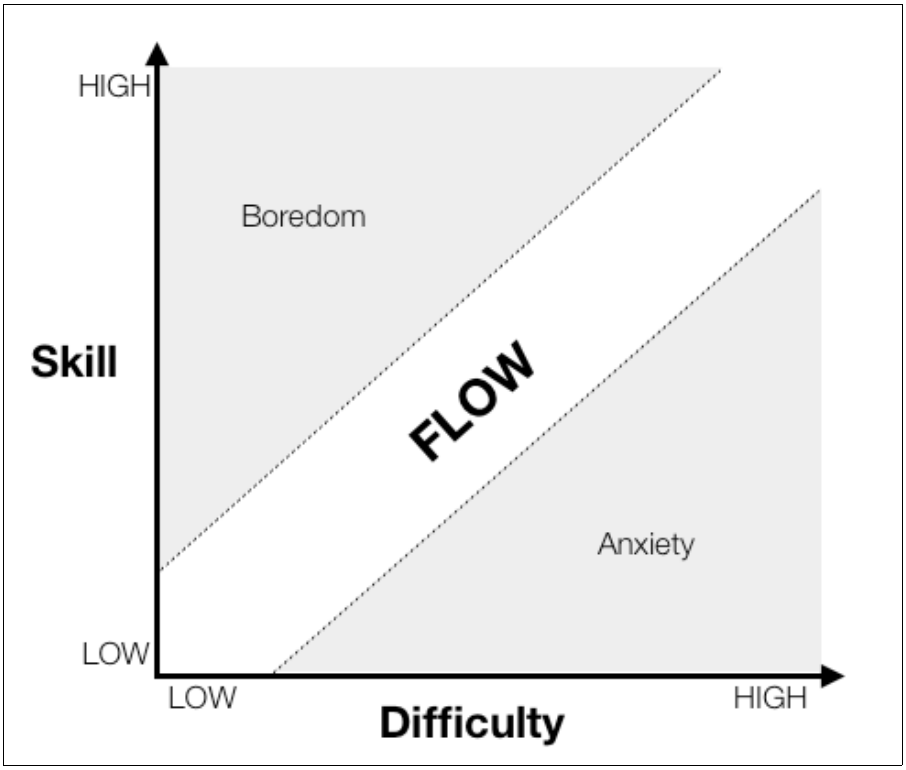


Figure 1: Flow, boredom, and anxiety as they relate to task difficulty and user skill level. Adapted from Csikszentmihalyi, 1990.

While in these states, people experience:

1. Extreme focus on a task.
2. A sense of active control.
3. Merging of action and awareness.
4. Loss of self-awareness.
5. Distortion of the experience of time.
6. The experience of the task being the only necessary justification for continuing it.

Csikszentmihalyi also outlined four characteristics found in tasks that drive an equilibrium between skill and difficulty, thus increasing the probability of Flow states. Specifically, these are tasks that:

1. Have concrete goals with manageable rules.
2. Demand actions to achieve goals that fit within the person's capabilities.
3. Have clear and timely feedback on performance and goal accomplishment.
4. Diminish extraneous distraction, thus facilitating concentration.

It is these four task characteristics that game developers should consider if they want to increase the likelihood of causing Flow states in gamers playing their games. I will now go into more detail about each characteristic.

Characteristic 1: Games should have concrete goals with manageable rules.

> *I'm lost. An NPC just told me what I was supposed to do, but I was distracted by the loot in the middle of the room and the Giant Spiders coming at me from all directions. It doesn't help that that I can't access the NPC anymore, or that all of the rooms in this dungeon are the same shape and color. Lost. I have no idea where to go or how I'm supposed to get there. Fifteen minutes pass before I find the puzzle I need to complete. But now I have no idea which of the 20 quest items in my inventory I should use to solve it. After a while, I give up in frustration.*

Flow breaks down when a player doesn't know what their goals are, how they're expected to accomplish them, or which new game techniques they're supposed to use to solve a puzzle. When this happens, gamers disengage and are more likely to stop playing.

Why do people need concrete goals and manageable rules?

We have limits on our information processing and attentional capabilities. Not all of the information coming from the screen or out of the speakers gets processed. While we are capable of handling a lot of visual and auditory information at one time, we do have limitations.

Critical processing restrictions occur when our attention is divided. This can happen when task-relevant information is

presented too quickly or when multiple sources of stimulation are competing for our attention. In either case, task performance can drop dramatically. When this happens, people become anxious about accomplishing their goals, thus inhibiting Flow.

Another aspect of information processing that can be overlooked is the congruency between directions and task. People are best able to understand and apply relevant information to a task when there is congruency between the task and the information/instructions.

Our ability to problem solve and make decisions is directly affected by information processing and attentional issues. When there are breakdowns in information processing, comprehension of task goals and rules also suffers. If people do not understand the nature of a problem, they can become frustrated attempting to solve it. These peaks in frustration decrease Flow and also affect problem-solving techniques.

When overwhelmed with too much stimulation, people will often revert to methods of problem solving that have worked in the past. These reversions may or may not be what the developers had in mind.

Concrete goals with manageable rules are achievable. The act of achieving goals is rewarding and reinforces actions that allow individuals to continue completing goals. Whether it's leveling your character or earning points for head-shots, the very act of accomplishing something reinforces your desire to keep accomplishing. This goal-achievement-reward cycle can keep gamers glued to a game and facilitates Flow states.

How can game designers fix problems with goals and rules?

If designers are able to take into account the psychological factors mentioned above, they can easily address issues with rules and goals.

- Everything from the user interface to the play screen should clearly direct or cue the gamer to their task. Situational cues, HUD information, NPCs, etc. should make goals plainly comprehensible.
- Because divided attention hurts comprehension, goals and directions should not be given to a player during high-stimulation times (e.g., while a player is fighting an infestation of the Flood in *Halo 2* or fending off hordes of Draugr in *Skyrim*).
- Care must be taken to provide important information so that congruency between the information and the task/goal is achieved. The directional cues used in *Dead Space* are a wonderful example of this. By overlaying an illuminating path to the next objective on the player's immediate surroundings, the developers left no ambiguity regarding where to navigate.
- Regarding rules, the gamer may be expected to try new variations of gameplay techniques developed throughout the game.

  However, introducing new mechanics mid-level or mid-game may inhibit Flow. Sometimes this is necessary and leads to increasingly fun and dynamic game-play (e.g., when Gordon Freeman is first given the Zero-point energy field manipulator in *Half-Life 2*).

  When this happens care should be taken to train the player on new skills (e.g., when Gordon used the Zero-point energy field manipulator to play catch with Dog).
- The completion of small goals (e.g., clearing a field of boars) links to larger goals (e.g., getting enough XP to level up), which in turn link to even larger goals (e.g., getting access to level-specific gear). This linkage creates a series of rewarding experiences that can hook gamers to a game and create the goal-achievement-reward cycle.

If players are readily able to accomplish goals, they are more likely to continue playing. Though, as previously mentioned, there must be a balance between the player's skill and the difficulty of task.

Characteristic 2: Games should only demand actions that fit within a player's capabilities.

> *I know I'm supposed to swipe in the opposite direction of the Fiend's attack. This should parry his attack, opening him up for my own counter. But I just can't do it. Whether it is lack of reflexes, or the fact that I just started playing the game, I'm hopelessly inept. I'm also seriously frustrated.*

Understanding the limits of player ability and cultivating player skill is of critical importance. If players are unable to accomplish goals -- even if goals and rules are clear -- then they will find their gaming experience dissatisfying.

Why should games only demand actions that fit within a player's capabilities?

Even beyond the obvious answer -- "Because players will stop playing!" -- there exist many psychologically based considerations worth enumerating. Here are a couple of them:

Stress and performance affect Flow. If a player isn't skilled or capable enough to accomplish game-based goals, they may experience stress-provoking drops in performance. This kills Flow states and drives down the overall enjoyment of the gaming experience.

Goal difficulty and player perseverance. As goals become increasingly difficult to accomplish (in relation to player skill), commitment to accomplishing these goals diminishes. If this happens, a gamer is very likely to simply stop playing.

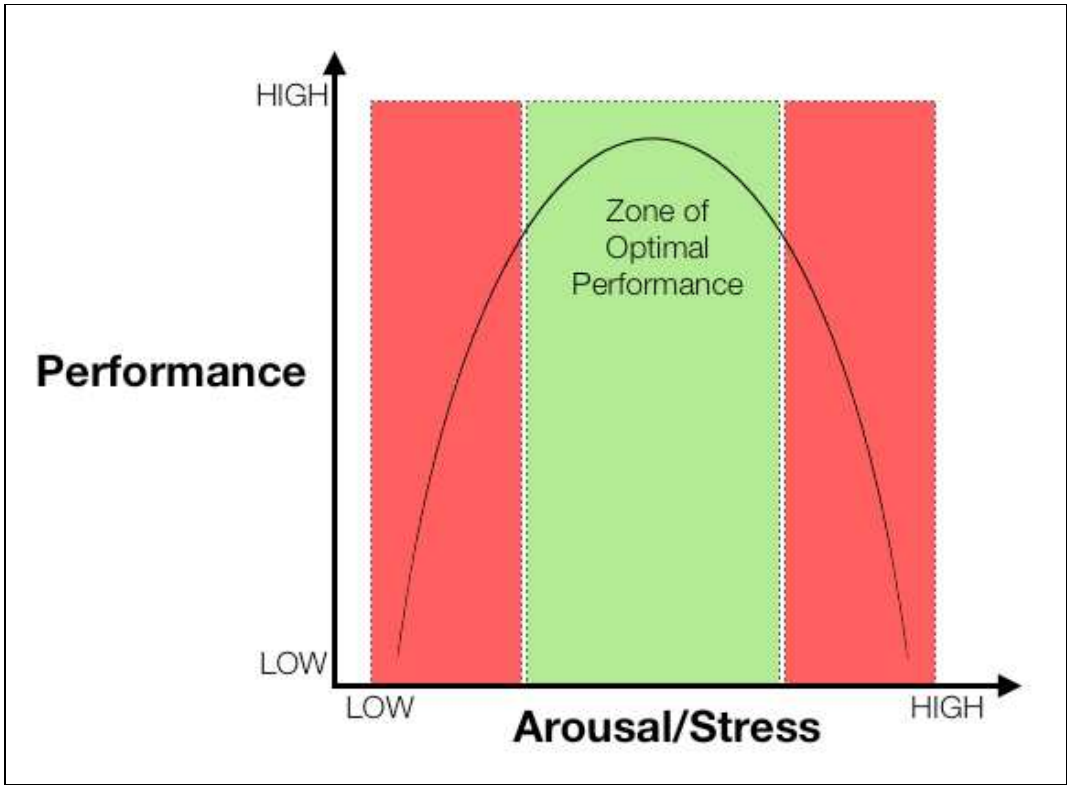


Figure 2: Performance as a function of Arousal/Stress. Adapted from Yerkes & Dodson, 1908, and Hanin, 2007.

How can game designers fix problems related to skill and difficulty?

Each gamer has a unique performance-stress curve (see Figure 2). This means that for some people +7 stress (an arbitrary value) causes them to operate at their highest level of performance, but for a different person +7 stress results in them failing spectacularly.

This also means that coarse gradations of game difficulty (e.g., Easy, Normal, Hard) may not lead to an optimal experience for many gamers.

Game developers could include AI that are able to dynamically adjust the in-game conditions affecting difficulty, thus positively affecting player performance (e.g., the AI Director in the *Left4Dead* series).

One critical consideration for such an AI is the relationship between performance and enjoyment. Some players may perform extremely well when dynamic difficulty is increased; however, they may not enjoy being under such high levels of challenge. In this case, they may feel anxiety (e.g., Fig. 1). Game developers could identify this by marking players who have high performance and high quit-rates (i.e. the player quits in response to changes in difficulty, but their performance remains steady).

Another consideration is how these AI handle difficulty for multiplayer teams (e.g., four players in a *Left4Dead 2* campaign). In these cases it is important to recognize that dynamic changes to difficulty may affect players of varying ability in different ways. Thus, it is crucial to determine how to optimally change difficulty without ruining the game for very good or very bad players on the same team.

Certain game-specific skills must be slowly taught to players. If a game does not leverage skills commonly used in gaming (e.g., typical FPS controls and aiming), players must be gradually taught the new game-specific skills. Because of previously mentioned information processing restrictions, this sort of in-game training should occur in a relatively subdued environment.

Characteristic 3: Games should give clear and timely feedback on player performance.

I did that right, right? Is the axe I just made actually in my inventory? Is this action adding to my enchantment

abilities?

Whether the feedback is in the form of sound coming off of a virtual golf club, the omnipresent experience bar in an RPG, or the flash of red simulated blood in the vision of a FPS avatar, players need to know how they're doing.

Why do gamers need *timely* feedback?

Our innate learning and conditioning mechanisms. Feedback that occurs directly after (200 to 400 millseconds) or midway through the completion of an action leads to the formation of the strongest associations between action and outcome.

Interestingly, simultaneous timing of feedback with the onset of an action does a poor job of facilitating associations. (See Figure 3).

Back to goals... For medium and long-term goals (completing a level, or the game) feedback on progress can drive further engagement and eventual accomplishment.

This means that players who get feedback will want to play more.

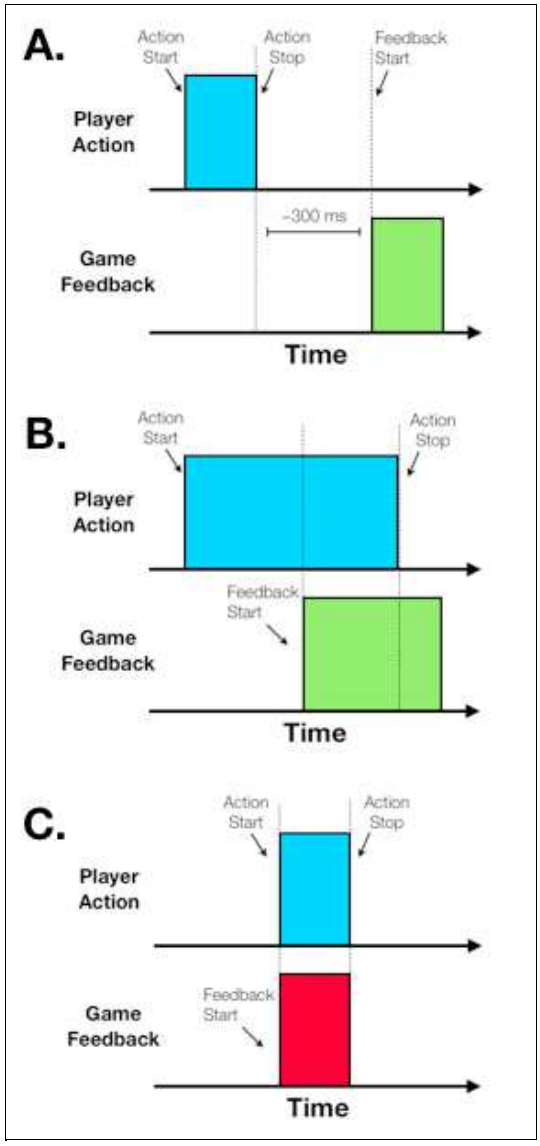


Figure 3: Examples of good (A and B) and bad (C) timing between player action and game feedback.

How can game designers address feedback concerns?

- If designers want to create lasting connections between a gamer's actions and the outcomes within the game, they must be sensitive to the timing issues mentioned above (and in Fig. 3).
- If there is a critical disconnect between an action and an outcome the gamer will fail to understand how their action affected their in-game performance.
- Establish mechanisms and displays of both long-term and short-term goal accomplishment early on, and then maintain these throughout the game.

Characteristic 4: Games should remove any extraneous

information that inhibits concentration.

> *These animated spell and item icons across the bottom and top of my screen sure look cool! See the particle effects on my Ice Storm spell... Wait -- is someone attacking me?*

As sensory and informational clutter increases, the gamer's ability to find and evaluate important stimuli diminishes greatly. This means that designers should strive to maintain a level of simplicity across all aspects of their games (from UI to HUDs).

Why do gamers need extraneous information to be removed?

Again, there are inherent limitations on how much information we can parse at any moment: As detailed in the discussion about the first characteristics of tasks that invoke Flow, we are limited in how much information we can process. Cluttered visual fields disrupt information processing. These disruptions can then negatively affect goal comprehension and rule learning, which ultimately affects Flow.

How can game designers address extraneous information? HUDs and in-game menus should be as simple as possible (e.g., *Dead Space* or *Fallout*).

Game skills or options should only be included if they are relevant to the story of the game or are purposefully being used by the developer to push artistic and technical boundaries.

Conclusion

Tasks that induce Flow states tend to have concrete goals with manageable rules, goals that fit player capabilities, clear and timely feedback on performance, and are good at eliminating distractions. If game developers are able to include design considerations that take these characteristics into account they will drastically improve player engagement (and likely game sales).

The example design considerations that I provided for each characteristic are just that: examples. The same can be said for the psychologically-based rationales I provided. Depending on the type of game a developer is making, and whether it is high- or low-concept, different ways of addressing these characteristics are eminently possible -- just as there are many more psychological factors driving how each characteristic contributes to Flow.

It's also worth noting that, for the most part, good game designers and good game companies are already explicitly (or implicitly) taking these Flow characteristics into account.

In the end, I only hope to provide developers and designers with some food for thought on improving player engagement. It is up to those involved in creating games to decide how best to apply this information.

Reading List

Flow: The Psychology of Optimal Experience (2008), by Mihaly Csikszentmihalyi, published by Harper Perennial Modern Classics.

Working memory (1992), by Alan Baddeley, published in *Science*.

Cognitive fit: An empirical study of information acquisition (1991), by Vessey & Galletta, published in *Information Systems Research*.

Effect of goal acceptance on the relationship of goal difficulty to performance (1984), by Erez & Zidon, published in *Journal of Applied Psychology*.

Emotions and athletic performance: Individual zones of optimal functioning (1997), by Yuri Hanin, published in *European Yearbook of Sports Psychology*.

Conditioning as a function of the time between conditioned and unconditioned stimuli (1947), by Gregory Kimble, published in *Journal of Experimental Psychology*.

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