5 Sources of Uncertainty

We're now equipped to examine the sources of uncertainty in games more closely.

Performative Uncertainty

I've restricted the term "performative uncertainty" to mean the uncertainty of physical performance. In today's conventional videogame market, games of performative uncertainty rule: first-person shooters, action/adventure games, driving games, and the like. Indeed, many videogamers view challenges of hand-eye coordination as inseparable from the very idea of "the videogame," though of course there are in fact many digital games for which this is not true: turn-based strategy games, adventure games, and so on.

One school of thought holds that games of performative uncertainty, or player-skill games, are inherently superior to character-skill games, or to games of analytic complexity, which are often derided as "animated spreadsheets." The notion is that "real gamers" should develop l33t skillz, and anything else is an inferior experience.

The problem with depending on player skill, however, is that, by nature, players are not evenly matched. A new FPS player, signing onto a multiplayer server, will die over and over, at the hands of more experienced players—not a positive player experience. It's no fun to feel as if you have no chance; any uncertainty departs.

Of course, there are ways of redressing this problem—having a scheme to match players by experience, for example. But designing any such system is tricky, and none is perfect.

Equally tricky is the problem of tuning performative challenge in a soloplay game. Almost whatever you do, some players will find the game too easy, and others too hard; those who find it too hard will abandon it, and feel that the money they paid for the game was not well spent, while those who find it too easy will be similarly dissatisfied. Moreover, developers tend to listen to their most ardent fans, who are by nature hard-core and more skilled than the general audience, and therefore tend to develop games that satisfy the hard core, at the potential expense of reaching a wider audience; indeed, over time, particular genres become harder and less newbie friendly, the phenomenon of grognard capture. Anyone could play *Doom*; only someone who grew up playing FPSs can master more recent titles, particularly at the highest difficulty setting.

Developers try to deal with this problem using variable difficulty settings, or dynamically adjusted difficulty, but even the "easy" setting in many games is beyond the capabilities of some players. For my part, there are bosses in, say, the *Zelda* games I cannot beat, my strategy typically being to hand the controller to a teenage daughter and tell her "five bucks to beat this boss."

While it is possible to construct a player-skill game that is fairly casual in nature—*Tetris* (Pajitnov, 1984) and *Snood*

(Dobson, 1996) are examples—games of physical challenge tend to be "lean forward" rather than "lean backward" in nature. That is, they typically require continuous attention from the player and excellent timing for success; they are tense, not relaxing. Lean backward games, by contrast, are less tense, do not require continuous attention, and are played more for relaxation—match-three games such as *Bejeweled* (Kapalka, 2001) for example. Consequently, games of performative skill are less likely to be successful in more "casual" markets.

Games of performative skill tend also to be "blue" rather than "pink"; I don't wish to make broad assertions about what sorts of games women and men prefer, because people are different, and almost any such assertion is falsifiable. But observably, the most hard-core of player-skill games attract a largely male audience, and the sorts of games that appeal most strongly to a female demographic—casual and social games—are either devoid of performative challenge or tuned very low in terms of difficulty.

Some gamers find performative challenge to be undesirable in games, rather than essential. Abstract strategy gamers find games that rely on anything other than a clean mental contest unappealing; strategy simulation gamers are interested in simulation verisimilitude and not in mastering a set of reflex actions; casual gamers often find player-skill games frustratingly hard. Thus, as in so many things, whether or not performative challenge is appropriate and useful in a game is almost entirely a matter of aesthetics.

Solver's Uncertainty

Solver's uncertainty was rare in games before the digital era, although present in some: in *Cluedo* (Pratt, 1948; published as

Clue in the United States), determining the murderer, room, and weapon is a kind of logic puzzle.

Most tabletop games are algorithmic, rather than instantial, meaning that the game's "content" is algorithmically generated by the nature of its system, and not a set of predesigned elements that are less interesting on second exposure.

By contrast, most digital games are designed to be played once, with no compelling reason to want to play a second time. Puzzles, each of which have one or a handful of solutions, are therefore eminently suited to digital games of this sort.

While there are games, like *The 7th Guest* (Devine and Landeros, 1993), that incorporate classic puzzles, the puzzles in most digital games derive from the game's own rules of interaction. For instance, in *The Incredible Machine* (Ryan and Tunnell, 1993), the player is given a series of objects, each of which has a strictly defined set of behaviors—ropes and pulleys, for instance—and must combine them to accomplish a particular task. Or, as another example, in the excellent *Deadly Rooms of Death*, you control a single character with a sword, and each turn you may take one action—with all enemies taking an action immediately afterward. Enemy actions are always predictable, and each "room" has at least one solution, a sequence of actions you may take to traverse the room and clear it of enemies.

In other words, most puzzle-based games are composed of elements created for the specific purpose of enabling the development of interesting puzzles. The problem with this, however, is an inevitable sense of artificiality; while there may be a metaphorical connection between the puzzle elements and real-world entities, their behavior is explicitly defined by the game, and only the rules of the system determine permissible behaviors. In puzzle games, there is, typically, scant possibility for a player to devise inventive and creative solutions to a problem; instead, he must, in essence, try to read the game designer's mind, try to imagine what solution the designer envisioned. This is particularly true of graphic adventures, with their reliance on inventory puzzles and the combination of inventory items; the solution to a puzzle in a graphic adventure does not, as with most puzzle games, depend on an understanding of the behaviors of game elements, but instead on an often arbitrary, designer-established, specific combination.

As an example, in the original *Zork: The Great Underground Empire* (Blank, Lebling, et al., 1980), I was stymied for a long time by a puzzle I needed to solve to open a particular doorway called "the gates of Hell." I had a bell, a book, and a candle, knew that these are elements used in real-world exorcisms, and surmised that they could be used to open the door. In this, I was correct. I also knew that the phrase is "bell, book, and candle," and therefore attempted to ring the bell, then read the book, then light the candle. This did not work, nor did any number of other possibilities I tried. It was only when I tried using these three elements in all possible combinations that I uncovered the solution; you must light the candle before reading the book, and then ring the bell—the reverse of the order I had assumed was required.

Now doubtless the game's designer had reasoned that you need light to read by, and thus the candle must be lit before the book is read, and that you ring bells to open doors and therefore this element should be last; but there is no a priori reason to value this line of reasoning over my own, that the items should be used in the order defined by the common English phrase. In an ideal world, either the failure message from my attempt should have given me a clue as to why I had failed, or perhaps the designers should have permitted both approaches to work. But the result of this was considerable player frustration, which is rarely a desirable outcome in a game. In short, the solution to the puzzle was both arbitrary and artificial, requiring, as previously said, an attempt to read the designer's intentions.

This kind of artificiality is inevitable with any game in which puzzles are one-offs and do not emerge naturally from puzzle elements. The contrast is with games in which each game element has a predictable behavior, which are arranged in particular combinations to create puzzles. An excellent example is *Lemmings*; in each level of *Lemmings*, you must guide your little creatures (the eponymous lemmings) safely across the level and out the other side. You can create some special lemmings with defined behaviors, such as ones that build ramps, ones that explode and destroy nearby obstacles, and so on. The geography of each level is designed in such a way that some combination of lemming powers can be used to traverse the level; there is none of the sort of arbitrary reference to real-world entities that complicates and often confuses the issue in graphic adventures.

Lemmings is a complicated enough system that there are often less efficient and more efficient ways to solve a particular level (efficiency based on the number of lemmings that die in the process—fewer being better). However, there is a maximum number of permitted deaths in a level, and the puzzle elements permitted to the player within a level are highly constrained; thus, the player needs to be close to maximally efficient. And while this kind of game avoids the sort of artificiality that requires reading the game designer's mind, it has another sort of artificiality: the rules of the system are arbitrary. In the real world, there are no exploding lemmings, nor ones that build ramps; there is no connection to real-world phenomena. There is no opportunity for "creative" solutions; typically, there is only one solution to a level, and the only variation is in how quickly and efficiently you find and implement it. It is a finely structured game for those who enjoy mental challenges, and the lemmings themselves are cute; but for those who enjoy rich narrative, systems that permit a degree of creativity and self-expression, the kind of spectacle that many videogames offer, or a sense of skill-based mastery, it has little to offer, since it is so tightly focused on puzzles. By this I do not mean to criticize the game; *Lemmings* is an excellent game of its type. Rather, I mean to point out some of the difficulties involved in incorporating solver's uncertainty in games.

That being said, if you look for solver's uncertainty, you'll find that it turns up as an embedded element in many games that are not primarily concerned with puzzles. For instance, in a turn-based strategy game, a player must, each turn, try to solve the puzzle of how to make the most effective attack with the limited resources available to him at that point in time, given the opposing disposition of forces and the terrain on which combat occurs. In an action/adventure game, a player must often try to deduce the precise sequence of events that will bring down a boss, given the boss's visible and repetitive behaviors, the layout of the level in which the confrontation takes place, and the tools and verbs available to the player. And in a hand of *Poker*, figuring out whether to check, raise, or fold is a puzzle that involves considering what you know about the other players' hands, what cards remain in the deck, and the likelihood that your hand will improve given your own cards.

To put it another way, almost any multivariable strategy game creates puzzles, but these puzzles, unlike those of explicit puzzle games, emerge from the complexity of the mechanics of the game itself; one way to improve a strategy game is to consider whether the puzzles it creates are sufficiently interesting in themselves, and if not, what change in mechanics might make them so.

Player Unpredictability

In principle, any multiplayer game can harness player uncertainty, but as we saw in the case of *Monopoly*, not all do. In general, it's hard to see why multiplayer games *shouldn't* exploit it in some fashion, except perhaps in the case of games designed for players of very divergent skill, such as games played by adults with children. In such games, allowing one player to gain an advantage by adversely affecting others skews it too much toward better-skilled players.

The simplest way to enable player unpredictability is to allow players to "attack" each other, by which I do not literally mean in a military fashion, but to affect each other in either a zero-sum (your loss is my gain) or a negative-sum (your loss is either a lesser gain to me, or also some loss to me) way. An example of a negative-sum interaction, in fact, is a military attack: if I attack you, I am likely to suffer some loss of manpower or units, even if I am victorious.

If attacks are feasible, players must always work to increase their offensive and defensive powers, and they must try to determine the likelihood of attack and the effectiveness of an opponent's potential attacks. If, as is often the case, increasing offensive and defensive power involves trade-offs against achieving other goals, players have a tasty set of uncertainties to grapple with. And if, as in *Diplomacy*, players can effectively ally and/or backstab, the need to negotiate with and try to model the behaviors of others becomes important as well.

Player uncertainty can also play a role, albeit a less tense one, even in games that permit only positive-sum (we both gain) interactions. For example, in many Eurogames, such as *The Settlers of Catan* (Teuber, 1995) trading is a critical element, and few players can advance far without engaging in trade with others. The game is designed so that all players are likely to have a surplus of some trade goods and a deficit in others, encouraging them to trade. And yet *Settlers* permits only a single winner, so players must also consider whether a proposed trade benefits themselves more than their opponent, and also where they stand relative to that opponent—a player far in the lead might well agree to a trade that advances the trade partner more than himself, so long as this increases his own lead over other players.

Player unpredictability of this kind can play a role, strangely enough, even in games in which the standing of one player is basically irrelevant to that of another. In the social game *Empires & Allies* (uncredited, 2011), for instance, a player may "attack" another, eliminating some of the opponent's units and occupying some of the opponent's territory. However, unlike a conventional wargame, "occupying territory" just makes it a little harder for the opponent to collect resources from the area, until the attack is "repelled," either by the target player or another player who happens to visit. The attacked player is injured; the attacker gains some (fairly small) benefit; but since there is no overall winner or loser, and as with most social games this is mostly a soloplay builder with player communication at the periphery, it does not, in the long term, really matter. Moreover, since social games seek to retain players for as long as possible, and since seeing your position destroyed by attackers is not likely to keep you playing, the game strictly limits how much damage a particular attacker can do; attacks are an annoyance, cannot destroy anything you have built (other than a few units), and only modestly reduce your resource collection capabilities. And yet these attacks have value for the game, because they make its universe feel more alive, as if you are actively playing with others who are unpredictable and who can either help (via gifts) or injure you; *Empires & Allies* feels more like a genuinely multiplayer game than most social games, despite the fact that it is at its core, the same kind of soloplay builder as so many others. There is also, of course, a business objective here; games that support player versus player (PvP) behavior tend to monetize more effectively (produce higher average revenues per daily active user [ARPDAU]) than those that do not, at the expense of excluding more casual players who do not like this kind of mechanic.

Player unpredictability does not depend solely on actions that directly injure or assist others; it can also exist in games that permit one player to take actions that either close off or open up opportunities for others, without affecting them directly. For example, in *Puerto Rico* (Seyfarth, 2002) each player chooses an action, which all players may then perform, but with some additional benefit for the selecting player; at the end of a turn, some actions remain unchosen, because there are always more available actions than players. By selecting a particular action, you deny other players the special benefit conferred on the player who chooses it, but you also allow them to take the action, which benefits them; of course, you try to select the action that benefits you most and others least. But you are not directly engaging with other players; you are opening up or closing off options to them.

Eurostyle boardgames are sometimes accused (by those more comfortable with directly competitive games) of being "solitaire games played together," the conceit being that since players cannot injure each other directly, the only real conflict between them arises through endgame scoring. This is, in fact, an unfair claim; rather, Eurostyle games tend to avoid direct attacks because games that permit this are viewed by those who enjoy the genre as being "too nasty." There is still competition among the players, and a player's actions are contingent not merely on what benefits them most, but also on how an action will benefit or deny benefits to others. It is true that interactions, and competition, are not as direct as in a more "Ameritrash"[1]-style boardgame, but this merely means that the conflict among the players is indirect, and that players must be more clever about how they work to injure their opponents.

Because player interactions are so rich a source of uncertainty, many soloplay games try to provide a sense of it with AI opponents. These can vary from enemy soldiers engaged in flocking behavior in a mass-scale combat game like *Rome: Total War* (Smith, Brunton, et al., 2004), to individual AI opponents in a soloplay FPS responding to notional aural or visual cues, to an entire civilization opposing yours as in *Civilization*. The problem, of course, is that real humans are inevitably sneakier and less predictable than AI routines, and "the AI sucks" is a common refrain from gamers. If you look more closely at AI code, you'll find that it, like all code, is procedural and predictable, except to the degree that it contains some random element to reduce the predictability; of course, if sufficiently complex, the algorithmic complexity of the system may make its behavior more unpredictable to the player, if wholly predictable from a systems point of view. Still, you can parse this and perhaps say that the source of uncertainty here is not truly "player unpredictability": there's a degree of hidden information, since the source code is not available; if the AI algorithms are complicated, there's a degree of analytic complexity; and if there's a random element involved, that also provides uncertainty. So in a sense, AI opponents harness different kinds of uncertainty to provide players with the illusion of player unpredictability.

Randomness

Many gamers dislike, or think they dislike, randomness in games. That's true of many different kinds of gamers: abstract strategy gamers eschew games that depend on anything other than a mental contest, and skill-and-action videogamers want to feel that they win through l33t skillz, not luck. For that matter, Eurogamers prefer games that allow them to feel that (a) winning is accomplished through superior strategy and (b) any random elements are peripheral and unlikely to affect outcomes strongly.

And yet games with strong random elements are among the most ancient, common in every human culture. In a series of books for the Smithsonian at the turn of the last century, Stewart Culin documented the games of dozens of neolithic cultures.[2] Almost all cultures have what Dave Parlett calls "race games,"[3] games in which players use a random number generator—dice, or binary lots such as knucklebones or cowrie shells—advancing a token along a track (sometimes just a set of lines drawn in the dirt) on the basis of the random cast, with the winner being the player to reach the end of the track first.

Of course, randomness has, for ancient cultures, an aspect that is less resonant to most modern people; as a civilization based on scientific rationalism, we know that randomness is just randomness. For most other cultures, "luck" is a seemingly real, not illusory, phenomenon, and randomness may be a way of testing your favor with the divine. Lots are often cast for divinatory purposes, as with the *I Ching*, and indeed, some race games may have been originally devised as a mechanism for recording the outcome of divinatory lots.

Some games, such as *Roulette*, depend almost wholly on chance; however, such games are, for the most part, used only in a gambling context. Risking real money stakes produces a sense of tension that concentrates the mind on the outcome; without such stakes, these games are, for most players, dull, precisely because the player has no ability to affect the outcome in any fashion.

The other class of games that depend wholly on luck are those that are designed for adults to play with children, such as *Candy Land* (Abbott, 1949). Even here, however, the luck-dependent nature of the game is partially hidden from the naïve player, for whom the tasks of drawing cards, advancing tokens correctly, and taking turns provide a sense of "game-ness" even though no real decisions are being made and no real test of skill is involved.

Some games that are highly dependent on luck for uncertainty are, despite this, very much skill-based games. *Poker* is the classic example; card distribution is random, but the statistics of the system are algorithmically complicated because it is a nonstochastic system. In a stochastic system, each event is unrelated to the previous one—die rolls are an example. In a nonstochastic system, the previous state of the system does have an effect on its evolution; once one card is known, the odds of drawing other cards, or of obtaining a card that will improve your hand, shift. It is beyond most players' abilities to accurately recalculate odds with each revealed card. Thus, the randomness of the system itself fosters, rather than diminishes, strategic play. There are certainly other ways in which skill plays a role in *Poker*—bluffing, reading others, and choosing a betting strategy—but the way in which strategy emerges from, rather than is diminished by, the randomness of the game is part of the game's fascination.

Many games harness randomness as a means of creating moment-to-moment uncertainty, but reduce the overall effectiveness of randomness by performing many random tests, each of small weight. The idea here is that, with many random tests, the system regresses to the mean; if a game is dependent on a single die roll, it is highly random, but if there are dozens or hundreds of die rolls, each of modest impact, the likelihood is that the overall results will be within a narrow range of the bell curve, not at one extreme or another. Thus, in a board wargame, a player is never certain of the outcome of any individual attack, but over the course of the game, it is unlikely that his luck with the dice will dictate the outcome; rather, it is more likely that his ability to figure out how to arrange his forces for maximum impact will be the determining factor. In games like this, randomness has a positive aspect beyond creating a degree of uncertainty; it provides simulation value, because in reality, a military commander can never control everything that happens on the battlefield, so "random factors" stand in for all the myriad issues that create uncertainty in a chaotic struggle.

Another common use of randomness is to break symmetry. That is, many games begin symmetrically, with all players in equal and equivalent positions, in order to ensure game balance; the problem with this is that unless symmetry is broken, all players are likely to value resources equivalently, adopt very similar strategies, and be able to judge quite easily where they stand relative to one another as the game progresses. It is desirable to break this symmetry, in order to provide uncertainty among the players about the other players' objectives, goals, and standing;

and one simple way to do this, without unbalancing the game, is with some random distribution of assets, either at the start of the game or as the game progresses. Thus, for instance, in *Ticket to Ride* (Moon, 2004) the initial distribution of route cards means players will seek to build tracks in different regions of the board. Similarly, in *Empires & Allies*, each player is able to produce one, and only one, type of metal (iron, copper, aluminum, and uranium); this encourages players to trade with one another, provide gifts in the hope of receiving gifts from others, and visit friends to obtain some of the kind of metal they produce. The distribution of resource types is random, but it fosters behavior the game operators find desirable: gifting, player visits, and trade, all mechanisms to encourage the use of social network virals, and thereby foster player retention and acquisition.

Another common use of randomness is to provide variety of encounter, that is, to ensure that players are uncertain about what obstacles they will face next in the game. This can be seen in a wide diversity of games. In *Magic: The Gathering*, the next card draw is uncertain not only because of the nature of card randomization, but also because of the wide variety of *Magic* cards in existence, and the fact that the cards owned by your opponent, and selected for their deck, is hidden information. In *NetHack* and other Rogue-likes, the level layout and the monsters and treasure to be found therein are generated at random, and thus each new game will be different from the last. Using randomness in this way ensures a high degree of replayability, which is advantageous from most, if not all, perspectives.

As a source of uncertainty in games, randomness provides one thing it is not normally credited for: a sense of drama. There is a moment of tension when the dice are rolled, or the player otherwise commits himself to a course of action the outcome of which is luck dependent. When an underpowered character in a tabletop role-playing game succeeds in overcoming a fearsome foe by, say, rolling a critical hit, the player of the character is likely to experience a moment of fiero, of real triumph over adversity—in a way that would be impossible with a system lacking random elements.

Randomness thus has strengths: it adds drama, it breaks symmetry, it provides simulation value, and it can be used to foster strategy through statistical analysis. It has countervailing weaknesses: in excess, it imbalances games, it can foster a sense that success is a consequence of luck rather than excellent play, and it can produce frustration when a streak of bad luck affects a player. But given the ease with which it fosters uncertainty, it has a useful role to play in many games. As always, whether or not to harness randomness in a design is as much a matter of aesthetics as anything else; it has no place in a game of abstract strategy, but it is almost essential in a simulation.

Analytic Complexity

Reiner Knizia, one of the finest and most prolific designers of Eurogames, creates games that offer players only a handful of choices, but difficult ones. Similarly, Sid Meier, a designer of digital strategy games, says: "A game is a series of interesting choices." Though the games they create are very different, they're both talking about analytic complexity; they want games in which players need to think about what to do, have to parse a complicated decision tree, and perhaps are uncertain, even as they make a decision, that it is necessarily the correct decision to make.

This is, needless to say, a cerebral kind of game, and perhaps alien to those who play mainly digital action games. As such, analytic complexity is not an appropriate source of uncertainty for all styles of games and all audiences. *Super Mario Bros.*, for instance, as fine a game as it is, does not involve any degree of analytic complexity, and there are those who, like Patrick Curry, consider it the ne plus ultra of game design.

I said previously that *Chess* is the game of analytic complexity par excellence, and so it is. However, this truth has limited applicability for designers or students of games. *Chess* is a game that has been iteratively refined over more than a millennium of play by many minds; it would take a genius of unparalleled talent to create so deep a game alone. Even so, occasionally a game like *Blokus* (Tavitian, 2000) appears that comes close. While trying to play in this arena is an interesting design challenge, we're mostly better off humbly accepting that a thousand years of folk refinement is always going to produce a deeper game than we can create in our mayfly lifetimes.

How, then, can we create games of analytic complexity? Brute force is one approach—creating a game with such complex rules that players find them hard to master completely. Many games do precisely this; Paradox, a Swedish developer of grand strategy games, does so routinely. Their best-known title is *Europa Universalis* (Anderssen, Berndal, et al., 2000) a game that spans the era from the fall of Constantinople to the rise of Napoleon, with systems governing economics, warfare, diplomacy, exploration, and colonization. At any given time, it is quite difficult, as a player, to determine whether your time and resources should best be spent on diplomacy with your neighbors, building up your military, improving your technology, or expanding colonially. And indeed, the optimal path is likely to change over the course of history; external events, such as a declaration of war, the emergence of a new power nearby, or one of the game's many planned historical events, can throw a sudden monkey wrench into your plans.

Perhaps the most extreme example of brute force complexity is *The Campaign for North Africa* (Berg, 1979), a ludicrously detailed game of the North African front in World War II that does such things as track individual pilots and aircraft, with rules governing minutiae like water consumption (Italians consume more because they need to boil pasta, apparently) and the siting of prisoner of war camps (you may not place them in wadis because of the danger of flash floods). It typically takes 1,500 hours to play a complete game, the rules are 90 pages long and printed in 8-point type, and the amount of bookkeeping involved is staggering.[4]

In other words, simply layering on many systems and mechanics that interact with each other in complex ways makes it harder for players to grasp the system as a whole. This does, however, have obvious deleterious effects: so complex a system will ensure that the game appeals only to the small minority of players who are attracted to very complex games. And the very complexity of the system will also mean that it is hard for the designer to tune and balance.

Yet there are games that do this, and successfully: *Slaves to Armok: God of Blood, Chapter II: Dwarf Fortress* (Adams and Adams, 2002), more commonly known as *Dwarf Fortress*, is an example. The game simulates a fantasy world at a truly amazing level of depth, down to weather patterns and mineral deposits at arbitrary levels below the surface. It is largely an exploration and crafting game, in which you play a band of dwarves trying to build an underground civilization, mining for resources to expand and sometimes coming under attack by rival fantasy races. The developers have managed to keep the game in some kind of balance by layering on new systems gradually; they're helped by an enthusiastic community of fans, who assist in tuning systems. This is, however, a rare and somewhat amazing accomplishment, particularly given that it is an indie game created by a two-man team.

Another approach to fostering analytic uncertainty is asymmetry. In a perfectly symmetrical game like *Hex* (Hein, 1942), all players strive for identical goals, with identical starting capabilities, and it is therefore typically straightforward to determine the degree to which an action benefits yourself and/or injures other players; the symmetrical nature of the game means that, all things being equal, players' analytical paths tend to follow the same line. The moment a degree of asymmetry is introduced, players come to value the actions available to them differently, and analyzing play requires them to try to understand what and why the other players are doing what they are doing.

An example of this in action is *Medici* (Knizia, 1995). Players are Renaissance merchants, bidding on lots of commodities. Each commodity marker is printed with a numerical value and is of a particular type—leather, silk, spices, and so on. Each round of the game, you may purchase up to five items, and at the end of the round, players score the printed commodity values, with bonuses for those with the highest total value. So far, this is perfectly symmetrical; a commodity with a value of five is worth five to every player.

However, at the end of each round, each player records how many units of each type of commodity they shipped; for this purpose, leather with a value of zero still counts as a unit of leather, and so does leather with a value of five. At the end of the game, players score additional victory points if they shipped the most of a particular commodity during play. Thus if, say, I shipped three units of leather in the first round, I have a strong incentive to ship more units of leather; leather is now worth more to me than it is to another player, and I must ponder whether a commodity's type or numerical value is more important to me at any particular juncture—and also whether it is worthwhile to prevent one of my opponents from getting a commodity that, while not inherently all that valuable to me, is sufficiently valuable to them that it can push them into the lead.

Medici is, in rules terms, quite a simple game, on the low end of the Eurogame scale; but the way in which it breaks symmetry produces considerable analytical uncertainty.

Digital games do this less than nondigital ones, but some do purposefully break symmetry in similar ways; *StarCraft* (Phinney and Metzen, 1998) has three different races (Terrans, Zerg, and Protoss), each with different units and different capabilities. In a multiplayer game, you have to plan optimally for your own race but also consider what actions others are likely to take on the basis of the capabilities they possess. This makes it a much deeper game, from a strategic point of view, than *WarCraft: Orcs and Humans* (uncredited, 1994), its precursor; in that game, the different races had the same capabilities, with racial differences affecting only appearance—mere window dressing, in other words.

In general, analytic complexity is the product of a system that allows a player several options but forces trade-offs. In *Chess*, you may make only one move each turn, and therefore must ponder which of the options available to you is best. In an action selection game such as *Puerto Rico* or *Agricola* (Rosenberg, 2007), you have a choice of actions each turn, but may select only one, and must determine which is best for you and which is suboptimal for others. In *Civilization*, a city may construct only one thing at a time, so when selecting what to build next, you need to consider whether making your population happier, larger, or more productive is most essential at present—and whether it would be advantageous to forego these options in order to create a Wonder of the World. These games are very different from each other, but all require the player to contemplate trade-offs.

Analytic uncertainty inherently produces a cerebral style of play, which is both its advantage and its weakness. Many gamers do not particularly want mental challenges from the games they play. Hard-core videogamers typically prize spectacle and the mastery of the physical skills needed to beat opponents and bosses; they're accustomed to the kind of uncertainty that depends on player skill. While they will tolerate some degree of puzzle solving, they want to be swept up in the moment of play, to be, for the most part, in a flow state, and not be halted to think deeply about the next thing they must accomplish. Similarly, casual gamers prize lean back games that allow them to while away some time in an interesting way, with a degree of visual spectacle and a continuing dopamine drip of nicely timed rewards; they don't mind a modest cerebral challenge, such as recognizing potential match-threes, but they're playing to relax, and a deeper mental challenge is not what they're after.

Another issue is that analytic uncertainty often leads to analysis paralysis, the phenomenon whereby one player agonizes over his choices and delays the game for others. And of course, action games can support only modest levels of analytical complexity, because, by nature, a game that requires quick responses by players cannot also pose difficult mental challenges for them.

Yet games of this style do have their devoted partisans; as with all things, whether or not to make analytic uncertainty central to a design depends on your objectives and ambitions.

Hidden Information

Hidden information is a source of uncertainty in a wide variety of games. In many games, its main role is to foster a desire for exploration; in *Sid Meier's Civilization*, known simply as *Civilization*, you can see only the area immediately around your two units at the start of the game, and the vast remainder of the world is dark. There's a thrilling sense of a world to explore. Similarly, most modern videogames are 3D environments that you explore, controlling a single character; much of the enjoyment of the game comes from finding out what amazing sights and challenges the developers have scattered about their world. Contrast this with boardgames, in which the extent of the system is known and visible before play.

Donald Rumsfeld famously spoke of "known unknowns and unknown unknowns." In these kinds of games, the world is an unknown unknown; you know certain things about it, such as the theme and fantasy of the game you are playing, but the rest is to be discovered. In many other game styles, however, hidden information is a form of "known unknown"; in a game of *Poker*, you may not know what cards the other players hold, but you know the range of possibility. A player will not surprise you by playing the thirteen of hearts, for there is no such card in the deck.

Hidden information of this kind is common in board and card games; indeed, the primary use of cards is to allow players to have information hidden from others. These known unknowns create strategic concerns for the players; in *Poker*, you are always trying to divine what cards your opponents may hold. The uncertainty is partial, because some information is revealed—the "up cards"—but in many other games, players do not have even that much information. In *Memoir '44*, for instance, there are no up cards to give you a hint as to your opponent's cards; since you are ignorant of them, you must try to plan for all possible eventualities, which increases the bushiness of the decision tree.

The same kind of phenomenon is seen in multiplayer digital games as well. Real-time strategy games such as *StarCraft* have "fog of war" systems, meaning that areas of the game world distant from your units are not visible to you. This increases uncertainty to a tension-inducing level; in the early stages of a multiplayer RTS game, you know that your opponents are working feverishly to build up their base and military strength, but can't see how they are progressing, which motivates you to work even more feverishly; and when battle is joined, you may be surprised by an enemy attack before you are ready, or conversely launch an attack on an enemy to find that he has already been laid to waste by a third player.

Hidden information often fosters experimentation. In a text adventure, you experiment with different formulations of words, testing the limits of the text parser (and the designer's cleverness at anticipating things players may want to say). In many games with crafting systems, such as *Harvest Moon: Tree of Tranquility* (Ishikawa, 2008), you are not provided recipes and instead must discover what you can craft by experimentally combining different resources (or Googling for a guide, of course). In *NetHack*, you may know what range of potions exists in the game, but you don't know what a "plaid" potion does until you experiment with it. In a sense, this is exploration—but of the parameters of the system rather than of physical space.

In general, hidden information increases variety of encounter; in a game with a designed world, everything is a surprise when first encountered; in a game with algorithmically generated challenges (such as *Poker* or a Rogue-like), hidden information ensures that no two sessions are the same.

The potential flaw of hidden information is that, as with randomness, players may feel that what they encounter is arbitrary, or be unable to make reasonable decisions because they lack enough information to do so intelligently. In *Minesweeper* (Donner and Johnson, 1990), your initial click is purely arbitrary and may result in a loss no matter how clever you are, and indeed it may not be for several clicks before you have enough information to play effectively—a flaw of the game, redressed by the fact that you have invested little time at this stage, so restarting is not onerous.

Hidden information is such a powerful source of uncertainty that simply adding an element of it can transform an otherwise flat design into one that is quite compelling. *Agricola* is a good example; it is a game of perfect information and symmetrical strategy except for the cards that are passed to the players at the inception of play, which offer each of them advantages and opportunities different from the others, and are not revealed until used in play. The rules provide for a "family" version of the game that excludes these cards (which add considerable complexity), but the family version—while useful in introducing new players to the game—is quite dull. The cards make *Agricola* a far more interesting game.

Narrative Anticipation

Stories, like games, require a degree of uncertainty. What keeps us reading a novel is a desire to see what comes next. In general, if what comes next is wholly predictable, we will think the novel dull. Even in genres where overall story arcs are predictable—in a romance, you know that the female lead will find love, and it's rare for there to be much uncertainty about with whom after the first chapter or two—there is still great uncertainty on a moment-to-moment basis, and the twists and turns and surprises of the story keep us interested.

Much the same is true when it comes to games. It is true, most obviously, of games with strong story elements, like graphic adventures and modern action-adventure games like *Elder Scrolls V: Skyrim* (Nesmith, 2011); but it's true of other game styles as well. It's true of games with a quest structure, such as *World of Warcraft* or *CityVille*, where the story moments are discrete and finished over the course of a small quest chain, rather than over the game as a whole. It's true of platformers, in which the narrative may be very slight—defeat all the castles to rescue the princess—but in which we anticipate that each new level will have new and interesting challenges, as well as a new visual appearance, and look forward to that experience.

And it's even true of games as abstract as *Chess*; playing, we want to see how our opponent will react, how forces will ebb and flow over the course of play. There's a sort of narrative arc at work here, even if there is no direct connection to story.

In terms of narrative, anticipation is the key; this means keeping the player uncertain as to how the story, or play arc, of the game will evolve. Many games fail on this score, at least after a time; *Chess* is an example. At some point, it is fairly obvious who is going to win a *Chess* game; the endgame is dull. The game does not conform to the classic narrative arc of increasing tension followed by release. Rather, tension builds to a point, and then slowly declines, as the board is cleared and the stronger player emerges, with a whimper of a coda as, often, the king is chased about the board until the inevitable checkmate.

In general, games that have positive reinforcement cycles, in which success begets greater strength, suffer from endgames lacking narrative tension. In *Risk* (Lamorisse, 1957), for instance, a player who quickly gains, and is able to defend, control of two continents is in a very strong position *vis-à-vis* his opponents—a problem that classic *Risk* counterbalances with its card system. Even a player in a weak position can cash in a trio of cards for a large number of additional armies—which may not be sufficient to outweigh another player's growth over time through control of continents, but which does give the player the opportunity to take many areas and alter the shape of the game for a time. Consequently, you can never count a player out until his last army is destroyed. This is, in fact, why *Risk: Factions* (uncredited, 2012), the social variant of the game, is less satisfying; absent this card system, weaker powers decay and stronger powers grow, and the endgame is predictable and dull.

One way of addressing the problem is by incorporating negative reinforcement loops, whereby strength is redressed in other ways. In *Kingsburg* (Chiarvesio and Iennaco, 2007), for instance, the first mover in each turn has a strong advantage, and the game determines player order in inverse power order. Thus, the weakest player gains an advantage that may help him to overcome the stronger ones.

Another is by ensuring that even very weak players still have some chance of affecting the outcome, or even of victory; in *Diplomacy*, a player reduced to a single supply center may still participate in a draw, if his last remaining unit is critical in the formation of a stalemate line.

Similarly, many digital games have some system of dynamic difficulty adjustment to ensure that even a strong player remains challenged by the system; many racing games, for instance, speed up NPC vehicles if the player is performing very well and slow them down if the player is performing poorly. The objective isn't to reward failure or penalize success, but to sustain narrative tension by ensuring that the player always feels challenged.

In general, designers should always work to shape a game's play arc into a pleasing experience; it is helpful to think of this by direct analogy to the narrative arc. You want to hook players quickly, without exposing them to too much detail and complexity at the start, ramp up tension over time, and sustain tension into the endgame.

Whether to incorporate an explicit narrative is, however, a more difficult issue. Most videogame players expect their games to deliver story, but there are many successful game styles that do not: arcade games, real-time strategy (RTS) and FPS games in multiplayer mode, and many (though not all) casual games. In general, incorporating story has strong advantages, in terms of player engagement and narrative anticipation, but also countervailing problems. In particular, games require a degree of player agency but stories require a degree of linearity, and these two factors are in direct conflict.[5]

The use of story in games neverending—games like massively multiplayer online (MMOs) and social games, which never come to an explicit end—is particularly problematic. Stories, by nature, have arcs and reach conclusions; games neverending cannot.

Some games, such as *Asheron's Call* (Ragaini, 1999), have tried to impose a narrative arc, with the world changing and the story advancing each month; players, however, don't typically feel involved in these stories and simply view updates as the introduction of new monsters to slay, areas to explore, and so on—new content, but not in a meaningful narrative sense.

Most games neverending try to incorporate a sense of narrative with the use of quests or missions, and these can be viewed as small narrative loops embedded in a larger game system;

players tend to tune out the narrative elements in these missions, however, simply scanning to find out what they need to do to complete it and receive the offered reward; take box X to location Y, thanks, never mind the hugger mugger about the evil orcs. Unless you're telling me that I need to prepare to kill some orcs along the way.

Surprisingly, social games, in particular, have not experimented with stories that *do* reach a conclusion; a social game player typically sticks with the game for a mere handful of months before drifting away. In principle, there's no reason you can't design a game to last for, say, six months; such a game might well retain its players longer than ones that are open-ended. And while some players would doubtless take the end of one game to mean that it's time to move on, those who enjoyed it most might well sign up for a second play-through. This would be harder to accomplish with MMOs, which involve a more intense time commitment, but, notably, one indie MMO does precisely this; *A Tale in the Desert* (Tepper, 2003) runs for a year and change, ends in a definitive conclusion, and restarts—with Pharoah (Andrew Tepper, its creator) making changes to the game with each new play-through.

Sustaining narrative tension is an issue with games of all sorts; the use of a literal narrative is essential for some kinds of games, of benefit to others, and irrelevant to many others.

Development Anticipation

Until the rise of online gaming, games were largely fixed on release. That is, the game itself was a single, unchanging entity, fixed in a tangible medium, whether a set of components in a box or data on a cart or disc. This is no longer true; it is obviously untrue of games that live largely online, such as social games and MMOs, but untrue even of more conventional titles, which are often patched over the network after release and, increasingly, for which developers create postrelease content, sometimes offered for free and sometimes as paid downloadable additions.

Some gamers decry this, feeling that they ought to get "the full game" when they plunk down their money; but for games neverending, at least, it's actually a draw for the players. Conventional digital games are usually designed for a one-time playthrough, like a novel or film; games never-ending also have content that a player consumes over time, but since the game is expected to go on ad infinitum, when a player comes to the end of the available content, rather than placing the game on a shelf, he pesters the developers for more.

Back in the 1980s, I did some work for Prodigy, a commercial online subscription service that predated the Internet.[6] Prodigy conducted a survey of its subscribers to determine what kept them coming back to the service: Shopping? News? Games? The number one reason subscribers gave was the desire to see how the service evolved.

They were, of course, early adopters of a then new technology, so the answer is not all that surprising. But the same element is true for many digital games today. Players of *CityVille* are delighted when new features and buildings are released. Players of *World of Warcraft* retain their subscriptions even when they've hit the level cap, knowing that Blizzard will release a new expansion at some future time. And indie developers are increasingly selling their games even while in beta, often long before they are complete, at a lower price, getting players excited about the game and harnessing their input to polish and improve it over the course of development; *Minecraft* (Persson, 2010) sold more than four million units before leaving beta.[7]

Schedule Uncertainty

Social games are typically designed for short play sessions but engagement over months or years. In part, this dynamic is historical; social games evolved from earlier web games that were offered for free (supported by ads). In order to minimize costs—reducing server loads and bandwidth usage by players—these games limited the amount of time a player could spend in a single session with energy limits or similar mechanics. Social games simply borrowed these mechanics, even though their per-customer revenues are far higher, and both server and bandwidth costs have declined over time.

In part, however, the mechanic is also designed to cater to the largely casual audience for social games; older casual-downloadable games were also designed for short play times—a few minutes for a complete but replayable game—because casual players do not want the lengthy, multihour experiences of more hardcore games.

The main reason the mechanic persists, however, is that it reengages players. At the end of a session, players typically have more things they wish to accomplish than their available resources permit; they are encouraged to return later, when their energy recharges, their crops grow, or whatever. In social games, this is called a "timed reengagement mechanic," its purpose to induce players to return (and, hopefully, monetize; they can always buy their way out of these limits).

To my mind, this is a crude and fairly unaesthetic form of uncertainty—the uncertainty caused by your own erratic schedule; gating gameplay in this way strikes me as often frustrating. Yet it is a proven financial success for social game developers, and money does, alas, trump aesthetics.

Uncertainty of Perception

The last type of uncertainty we discussed is uncertainty of perception, the difficulty of perceiving what's going on in the game space. The classic example is the hidden object game, which requires a player to visually identify items on the screen, but other games harness this same issue to some degree. In a bullet-hell shmup such as *Geometry Wars: Retro Evolved* (Cakebread, 2005), the screen is typically so busy that a major part of the game's challenge is parsing the view, focusing on the visuals representing bullets or enemies while screening out all the visual noise of the screen. In *Tetris*, the challenge is to recognize the shape of the new dropping piece quickly, and scan those already at screen bottom, finding the optimal placement for your piece, in whatever rotational state, as quickly as possible; there's a puzzle-solving aspect to this, in addition to a skill-and-action component, but the need to perceive quickly plays a role as well.

And in rhythm games such as *Guitar Hero* (Kay, 2005), much of the player's uncertainty lies in perception: in listening attentively to the rhythm of the music, watching carefully advancing notes along the visual musical path, and timing fret-button presses to match. That is, there is a skill-and-action component—mastering color-coordinated button presses—but also a matching perceptual challenge—knowing precisely when to trigger a button press or chord.

In general, designers rarely think about the tuning of perceptual challenges, but perhaps they should; one way to make any game more difficult, after all, is to make it harder for the player to perceive precisely what action they must take at any given time.

Malaby's Semiotic Contingency

Malaby describes semiotic contingency as "the unpredictability of meaning that always accompanies attempts to interpret the game's outcomes."[8] He gives as an example his experience learning to play *Backgammon* in Greece; Greeks consider it something of a national game, and as his game improved, his opponents would say things like "You're a Greek now." In other words, they were ascribing a cultural meaning to the game external to the game itself.

At first thought, one might say that semiotic uncertainty, which is external to the formal structure of the game, is not relevant to our exploration of uncertainty in games; it's not a source of moment-to-moment uncertainty in play.

But on reflection, there *are* games, albeit not many, that consciously work to create cultural meaning, and in some cases, the ways in which they do so do contribute to a form of uncertainty. One example is *Train* (Brathwaite, 2009). *Train* is an art boardgame in which players load little yellow "meeples" into rail boxcars, then move the trains about a track. Only when a train reaches its destination is the nature of that destination revealed; all are named for Nazi extermination camps, and by implication, you are delivering Jews to their deaths. This epiphany totally changes the meaning of the game for the players, creating a real and unsettling emotional impact.

Or as a less arty example, *Syobon Action* (z_gundam_tenosii, 2007) is a masocore platformer that uses the tropes of *Super*

Mario Bros. to play with the player's head. For example, when you reach the end of a level, there is a flagpole; in *Super Mario Bros.*, there are likewise flagpoles at the end of each level and, in that game, you must leap on the flagpole to free someone imprisoned in the nearby castle. In *Syobon*, when you leap on a flagpole, the flagpole kills you.

This is a form of ludic self-referentiality, of course; it's a game commenting on a game, but it's the cultural meaning of *Mario*'s tropes that make *Syobon* interesting (and infuriating, and hilarious) to experienced platformer players. In this context, we're talking about game culture rather than national culture, but that doesn't change the fact that this is a form of semiotic uncertainty. Once you've jumped on a flagpole, you question the meaning of everything else you encounter in the game, rightfully, and are uncertain what the consequences of an action might be.

Semiotic uncertainty is not a characteristic of many designed games, but as these examples show, it can be effective, and perhaps designers should consider how to foster it more often in their work.