
SUPER STAR
BASKETBALL
OFFICIAL SIZE & WEIGHT
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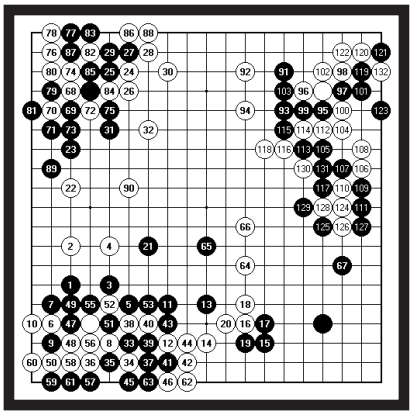
OFFICIAL SIZE & WEIGHT

SYSTEMS



objects
attributes
internal relationships
environment
open systems
closed systems

5

*The system is partly a memory of its past, just as in origami, the essence of a bird or a horse is both in the nature and order of the folds made. The question that must be answered when faced with a problem of planning or design of a system, is what exactly is the system? It is therefore necessary to know the nature of the inner structure before plans can be made.—**Wolfgang Jonas,** "On the Foundations of a 'Science of the Artificial'"*

Introducing Systems

Games are intrinsically systemic: all games can be understood as systems. What do we mean by this? Let's begin our investigations of games and systems by looking at some common understandings of the word "system."

> System
>
> 1. A group of interacting, interrelated, or interdependent elements forming a complex whole.
>
> 2. A functionally related group of elements, especially:
>
> a. The human body regarded as a functional physiological unit.
>
> b. An organism as a whole, especially with regard to its vital processes or functions.
>
> c. A group of physiologically or anatomically complementary organs or parts: the nervous system; the skeletal system.
>
> d. A group of interacting mechanical or electrical components.
>
> e. A network of structures and channels, as for communication, travel, or distribution.
>
> 3. An organized set of interrelated ideas or principles.
>
> 4. A social, economic, or political organizational form.
>
> 5. A naturally occurring group of objects or phenomena: the solar system.
>
> 6. A set of objects or phenomena grouped together for classification or analysis.
>
> 7. A condition of harmonious, orderly interaction.
>
> 8. An organized and coordinated method; a procedure.[1]

Some of these definitions focus on the biological or natural idea of the word "system" (2a, 2b, 2c, 5). Others reference mechanical systems (2d) or systems of transportation and communication (2e). Still others focus on the social meanings of the word (4, 7) or on ideas and knowledge (3, 6, 8). Despite differences in emphasis, there is something that all of these definitions of "system" share. Look for it in the very first definition on the list, which describes systems as "a group of interacting, interrelated, or interdependent elements forming a complex whole." This understanding of a system as a set of parts that relate to form a whole contains all of the other special cases of this same concept. When understood in this way—as a set of parts that together form a complex whole—it is clear that games are systems.

In a game of Soccer, for example, the players, the ball, the goal nets, the playing field, are all individual elements. When a game of Soccer begins these elements gain specific relationships to each other within the larger system of the game. Each player, for example, plays in a certain position on one of two teams. Different player positions have roles that interrelate, both within the system that constitutes a single team (goalie vs. forward vs. halfback), and within the system that constitutes the relationship between teams (the goalie guarding the goal while an opposing forward attempts to score). The complex whole formed by all of these relationships within a system comprises the game of Soccer.

As systems, games provide contexts for interaction, which can be spaces, objects, and behaviors that players explore, manipulate, and inhabit. Systems come to us in many forms, from mechanical and mathematical systems to conceptual and cultural ones. One of the challenges of our current discussion is to recognize the many ways that a game can be framed as a system. Chess, for example, could be thought of as a strategic mathematical system. It could also be thought of as a system of social interaction between two players, or a system that abstractly simulates war.

The Elements of a System

A *system* is a set of things that affect one another within an environment to form a larger pattern that is different from any of the individual parts. In his textbook *Theories of Human Communication,* Stephen W. Littlejohn identifies four elements that constitute a system:

- The first is *objects*—the parts, elements, or variables within the system. These may be physical or abstract or both, depending on the nature of the system.
- Second, a system consists of *attributes*—the qualities or properties of the system and its objects.
- Third a system has *internal relationships* among its objects. This characteristic is a crucial aspect [of systems].
- Fourth, systems also possess an *environment*. They do not exist in a vacuum but are affected by their surroundings.[2]

Let us take a detailed look at a particular game, Chess. We will first think about Chess as a strictly strategic and mathematical system. This means considering Chess as a purely formal system of rules. Framed in this way, the four elements of the system of Chess are as follows:

- *Objects:* The objects in Chess are the pieces on the board and the board itself.
- *Attributes:* These are the characteristics the rules give these objects, such as the starting positions of each piece and the specific ways each piece can move and capture.
- *Internal Relationships:* Although the attributes determine the possible movements of the pieces, the internal relationships are the actual positions of the pieces on the board. These spatial relationships on the grid determine strategic relationships: one piece might be threatening another one, or protecting an empty square. Some of the pieces might not even be on the board.
- *Environment:* If we are looking just at the formal system of Chess, then the environment for the interaction of the objects is the play of the game itself. Play provides the context for the formal elements of a game.

But framing the game as a formal system is only one way to think about the system of Chess. We can extend our focus and think of Chess as a system with experiential dimensions as well. This means thinking of Chess not just as a mathematical and logical system, but also as a system of interaction between the players and the game. Changing the way that we frame the game affects how we would define the four components of a system. Framed as an experiential system, the elements of the system of Chess are as follows:

- *Objects:* Because we are looking at Chess as the interaction between players, the objects of the system are actually the two players themselves.
- *Attributes:* The attributes of each player are the pieces he or she controls, as well as the current state of the game.
- *Internal Relationships:* Because the players are the objects, their interaction constitutes the internal relationships of the system. These relationships would include not just their strategic interaction, but their social, psychological, and emotional communication as well.
- *Environment:* Considering Chess as an experiential system, the total environment would have to include not just the board and pieces of the game, but the immediate environment that contained the two players as well. We might term this the *context of play.* Any part of the environment that facilitated play would be included in this context. For example, if it were a play-by-email game of Chess, the context of play would have to include the software environment in which the players send and receive moves. Any context of play would also include players' preconceptions of Chess, such as the fact that they think it is cool or nerdy to play. This web of physical, psychological, and cultural associations delineate—not the experience of the game—but rather the context that surrounds the game, the environment within which the experience of play occurs.

Lastly, we can expand our focus and think about Chess as a cultural system. Here the concern is with how the game fits into culture at large. There are many ways to conceive of games as culture. For example, say that we wanted to look at the game of

Chess as a representation of ideological values associated with a particular time and place. We would want to make connections between the design of the game and larger structures of culture. We would be looking, for example, to identify cultural references made in the design of the game pieces (What is the gendered power relationship between King and Queen implied in their visual design?); references made in the structure and rituals of game play (Was playing Chess polite and gentlemanly or vulgar and cutthroat?); and references made to the people who play (Who are they—intellectuals, military types, or computer geeks?). Framed as a cultural system, the four elements of the system of Chess are as follows:

- *Objects:* The object is the game of Chess itself, considered in its broadest cultural sense.
- *Attributes:* The attributes of the game would be the designed elements of the game, as well as information about how, when, and why the game was made and used.
- *Internal Relationships:* The relationships would be the linkages between the game and culture. We might find, for example, a relationship between the "black and white" sides of the game and the way that race is referenced when the game pieces are represented figuratively.
- *Environment:* The environment of the system extends beyond any individual game of Chess, or even the context of play. The total environment for this cultural framing of Chess is culture itself, in all of its forms.

Note that there are innumerable ways of framing Chess as a cultural system. We could examine the complex historical evolution of the game. Or we could investigate the amateur and professional subcultures (books, websites, competitions, etc.) that surround the game. We could study the culture of Chess variants, in which Chess is redesigned by player-fans, or how Chess is referenced within popular culture, such as the Chess-like game Spock played on the television show *Star Trek*. The list goes on.

Framing Systems

Even though we were talking about the same game each time, as we proceeded from a formal to an experiential to a cultural analysis, our sense of what we considered as part of the system grew. In fact, each analysis integrated the previous system into itself. The hierarchical nature of complex systems makes this integration possible.

> Because of the hierarchical nature of the critical or complex system, with interactions over all scales, we can arbitrarily define what we mean by a unit: In a biological system, one can choose either a single cell, a single individual, such as an ant, the ant's nest, or the ant as a species, as the adaptive unit. In a human social system, one might choose an individual, a family, a company, or a country as the unit. No unit at any level has the right to claim priority status.[3]

In a game system, as in a human social system or biological system, hierarchies and interactions are scalable and embedded, as complexity theorist Per Bak points out in the quote above. Although no single framing has an inherent priority, there are specific relationships among the kinds of framings given here. The formal system constituting the rules of a game are embedded in its system of play. Likewise, the system of play is embedded in the cultural framing of the game. For example, understanding the cultural connotations of the visual design of a game piece still should take into account the game's rules and play: the relative importance of the pieces and how they are actually used in a game. For example, answering a cultural question regarding the politics of racial representation would have to include an understanding of the formal way the core rules of the game reference color. What does it mean that white always moves first?

Similarly, when you are designing a game you are not designing just a set of rules, but a set of rules that will always be experienced as play within a cultural context. As a result, you never have the luxury of completely forgetting about context when you are focusing on experience, or on experience and culture when you're focusing on the game's formal structure. It can be

useful at times to limit the number of ways you are framing the game, but it is important to remember that a game's formal, experiential, and cultural qualities always exist as integrated phenomena.

The History of Systems

The formal use of systems as a methodology for study has a rich history, which we can only quickly outline here. Many of the ideas surrounding systems and systems theory come from Ludwig von Bertalanffy's 1928 graduate thesis, in which he describes organisms as living systems. By 1969, von Bertalanffy had formalized his approach in the book *General Systems Theory: Foundations, Development, Applications.* Von Bertalanffy proposed a systems-based approach to looking at radically different kinds of phenomena, from the movement of particles to the cellular structures of organisms to the organization of a society. Von Bertalanffy's book called for a single integrated science of systems that acknowledged the linkages between the way systems operate across radically varying scales. Bertalanffy's systems-based approach contributed to the development of the fields of information theory, game theory, and cybernetics; each of these fields, in turn, contributed to contemporary concepts of computer science.

Although formal systems theory is no longer in common use today, systems-based approaches have given rise to a variety of interdisciplinary fields, including studies of complexity, chaos, and artificial life. Scholars come to these fields from a wide array of disciplines, including mathematics, genetics, physics, biology, sociology, and economics. We will be only be touching on their work here, but if these systems-based investigations interest you, additional references can be found in the suggested readings for chapter 14, ***Games as Emergent Systems.***

Open and Closed Systems

There are two types of systems, *open* and *closed.* In fact, the concept of open and closed systems forms the basis of much of our discussion concerning the formal properties of games and their social and cultural dimensions. This concept speaks not only to games themselves, but also to the relationships games have to players and their contexts. What distinguishes the two types of systems? Littlejohn writes, "One of the most common distinctions [in systems theory] is between closed and open systems. A *closed system* has no interchange with its environment. An *open system* receives matter and energy from its environment and passes matter and energy to its environment."[4]

What makes a system open or closed is the relationship between the system and the context, or environment, that surrounds it. The "matter and energy" that passes between a system and its environment can take a number of forms, from pure data (a thermometer measuring temperature and passing the information to the system of a computer program that tries to predict the weather), to human interaction (a person operating and interacting with the system of a car in order to drive down a highway). In both examples the system is open because there is some kind of transfer between the system and its environment. The software system passes temperature information from the outside climate. The car system exchanges input and output with the driver in a variety of ways (speedometer, gas pedal, steering wheel, etc.).

When we frame a game as a system it is useful to recognize whether it is being treated as an open or closed system. If we look at our three framings of Chess, which framings were open and which were closed?

- *Formal system:* As a formal system of rules, Chess is a closed, self-contained system.
- *Cultural system:* As a cultural system, Chess is clearly an open system, as we are essentially considering the way that the game intersects with other contexts such as society, language, history, etc.

- *Experiential system:* As an experiential system of play, things get tricky. Framing Chess as an experiential system could lead to understanding the game as either open or closed. If we only consider the players and their strategic game actions, we could say that once the game starts, the only relevant events are internal to the game. In this sense, the game is a closed system. On the other hand, we could emphasize the emotional and social baggage that players bring into the game, the distractions of the environment, the reputations that are gained or lost after the game is over. In this sense, the play of Chess would be an open system. Framed as play, games can be either open or closed.

In defining and understanding key concepts like design and systems, our aim is to better understand the particular challenges of game design and meaningful play. Game designers do practice design, and they do so by creating *systems.* But other kinds of designers create systems as well—so what is so special about games? The systems that game designers create have many peculiar qualities, but one of the most prominent is that they are interactive, that they require direct participation in the form of play. In the next chapter, we build directly on our understanding of systems and design to tackle this confounding but crucial concept: the enigmatic *interactivity.*

Notes

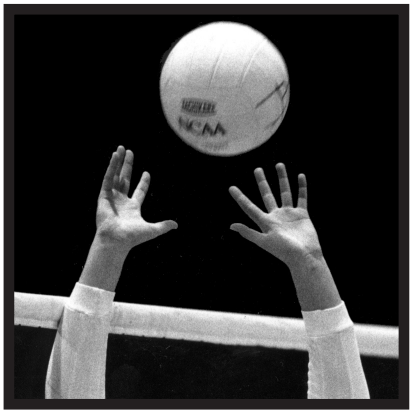
1. <dictionary.com>.
2. Stephen W. Littlejohn, *Theories of Human Communication,* 3rd edition (Belmont, CA: Wadsworth Publishing Company, 1989), p. 41.
3. Per Bak, "Self-Organized Criticality: A Holistic View of Nature." In *Complexity: Metaphors, Models and Reality,* edited by George A. Cowan, David Pine, and David Meltzer (Cambridge: Perseus Books, 1994), p. 492.
4. Littlejohn, *Theories of Human Communication,* p. 41.

Systems SUMMARY

- A **system** is a set of parts that interrelate to form a complex whole. There are many ways to frame a game as a system: a mathematical system, a social system, a representational system, etc.
- There are four elements that all systems share:
    - **Objects** are the parts, elements, or variables within the system.
    - **Attributes** are the qualities or properties of the system and its objects.
    - **Internal relationships** are the relations among the objects.
    - **Environment** is the context that surrounds the system.

  The way these elements are identified in any individual game depends on the way it is framed as a system. The four elements would be different, for example, if a game were framed as a formal, mathematical system, an experiential system of play, or as a cultural system.
- These three framings of a game as a system, **formal, experiential,** and **cultural,** are embedded in each other. A game as a formal system is always embedded within an experiential system, and a game as a cultural system contains formal and experiential systems.
- Although all three levels (formal, experiential, and cultural) exist simultaneously, it can be useful to focus on just one of them when making an analysis or solving a design problem. It is crucial when designing a game to understand how these three levels interact and interrelate to each other.
- Systems can be **open** or **closed.** An open system has an exchange of some kind with its environment. A closed system is isolated from its environment. Whether or not you consider a game as a closed or open system depends on the way you frame it:
    - **Formal** systems are closed systems.
    - **Experiential** systems can be open or closed systems.
    - **Cultural** systems are open systems.

INTERACTIVITY



action > outcome
four modes of interactivity
anatomy of a choice
internal event
external event
space of possibility

6

The word "interactivity" isn't just about giving players choices; it pretty much completely defines the game medium.—***Warren Spector,*** *RE:PLAY: Game Design + Game Culture*

Hotrod joystick | | Volleyball

Introducing Interactivity

Play implies interactivity: to play with a game, a toy, a person, an idea, is to interact with it. More specifically, playing a game means making choices within a game system designed to support actions and outcomes in meaningful ways. Every action results in a change affecting the overall system. This process of action and outcome comes about because players interact with the designed system of the game. Interaction takes place across all levels, from the formal interaction of the game's objects and pieces, to the social interaction of players, to the cultural interaction of the game with contexts beyond its space of play.

In games, it is the explicit interaction of the player that allows the game to advance. From the interactivity of choosing a path to selecting a target for destruction to collecting magic stars, the player has agency to initiate and perform a whole range of explicit actions. In some sense, it is these moments of explicit action that define the tone and texture of a specific game experience. To understand this particular quality of games—the element of interaction—we must more completely grasp the slippery terms "interactive," "interaction," and "interactivity."

Defining Interactivity

Perhaps even more than "design" and "systems," debates over the term "interactivity" have run rampant. Interactivity is one of those words that can mean everything and nothing at once. If everything can indeed be considered interactive, then the concept loses its ability to help us solve design problems. In corralling this runaway word, our aim is to try and understand it in its most general sense, but also to identify those very particular aspects of interactivity that are relevant to games. To this end, we look at several definitions of interactivity. We begin with a general question: What is *"interaction?"* Here are some basic dictionary definitions:

- *interaction:* 1. intermediate action; 2. mutual or reciprocal action or influence;
- *interact:* to act on each other; act reciprocally;
- *interactive:* reciprocally active; acting upon or influencing each other; allowing a two-way flow of information between a device and a user, responding to the user's input.[1]

In the most general terms, interactivity simply describes an active relationship between two things. For our purposes, however, we require a slightly more rigorous definition, one that takes into account the particular nature of games. Instead of asking about interactivity in the abstract, what does it mean to say that something is "interactive?" More specifically, how does interactivity emerge from within a *system?*

Communications theorist Stephen W. Littlejohn defines interactivity this way: "Part and parcel of a system is the notion of 'relationship'…. Interactional systems then, shall be two or more communicants in the process of, or at the level of, defining the nature of their relationship."[2] In other words, something is interactive when there is a reciprocal relationship of some kind between two elements in a system. Conversations, databases, games, and social relationships are all interactive in this sense. Furthermore, relationships between elements in a system are defined through interaction.

Following this definition, digital media theorist and entrepreneur Brenda Laurel brings the concept of *representation* to an understanding of the term: "…something is interactive when people can participate as agents within a representational context. (An agent is 'one who initiates actions.')"[3] Laurel's model emphasizes the interpretive component of interactive experiences, framing an interactive system as a representational space.

In an alternative definition of interactivity, theorist Andy Cameron builds on this interpretive dimension by stressing the idea of *direct intervention.* In his essay "Dissimulations," Cameron writes that

> Interactivity means the ability to intervene in a meaningful way *within the representation itself,* not to *read* it differently. Thus interac-

> tivity in music would mean the ability to change the sound, interactivity in painting to change colors, or make marks, interactivity in film…the ability to change the way the movie comes out."[4]

Cameron suggests a connection between interactivity and *explicit action,* a key feature of games and meaningful play. In some sense, it is these moments of explicit action that define the tone and texture of a specific game experience.

A final definition comes from game designer Chris Crawford, who metaphorically defines interactivity in terms of a conversation: "Interactivity: a cyclical process in which two actors alternately listen, think, and speak. The quality of interaction depends on the quality of each of the subtasks (listening, thinking, and speaking)."[5]

While his definition hearkens back to Littlejohn's relational model, Crawford's definition stresses the *iterative quality* of interactivity. He uses the following example for emphasis:

> A conversation, in its simplest form, starts out with two people, Joe and Fred. Joe says something to Fred. At this point, the ball is in Fred's court. He performs three steps in order to hold up his end of the conversation:
>
> *Step One:* Fred listens to what Joe has to say. He expends the energy to pay attention to Joe's words. He gathers in all of Joe's words and assembles them into a coherent whole. This requires an active effort on Fred's part.
>
> *Step Two:* Fred thinks about what Joe said. He considers, contemplates, and cogitates. The wheels turn in his mind as Fred develops his response to Joe's statement.
>
> *Step Three:* Fred expresses his response back to Joe. He forms his thoughts into words and speaks them.
>
> Now the tables are turned; the ball is in Joe's court. Joe must listen to what Fred says; Joe must think about it and develop a reaction; then he must express his reaction to Fred. This process cycles back and forth. Thus, a conversation is an iterative process in which each participant in turn listens, thinks, and speaks.[6]

Each of these definitions provides its own critical way of understanding interactivity: it takes place within a system, it is relational, it allows for direct intervention within a representational context, and it is iterative. Yet none of the definitions describes how and where interactivity can take place, and none of them address the relationship between structure and context, two key elements in the construction of meaning. These questions of the "how," "where," and "by whom" are critical to anyone faced with the challenge of designing interactivity.

In other words, none of these definitions resolve the question of whether or not all media, or even all experiences, are interactive. If interactivity is really so ubiquitous, can it possibly be a useful term for understanding games?

A Multivalent Model of Interactivity

Each of the previous definitions foreground a particular aspect of interaction; in our view, they are all are useful ways of defining interactivity. Rather than try and distill them into a composite definition, we have elected instead to offer a model of interactivity that accommodates each of these definitions. The model presents four modes of interactivity, or four different levels of engagement, that a person might have with an interactive system. Most "interactive" activities incorporate some or all of them simultaneously.

> ***Mode 1:*** *Cognitive interactivity; or interpretive participation*
> This is the psychological, emotional, and intellectual participation between a person and a system. Example: the complex imaginative interaction between a single player and a graphic adventure game.
>
> ***Mode 2:*** *Functional interactivity; or utilitarian participation*
> Included here: functional, structural interactions with the material components of the system (whether real or virtual). For example, that graphic adventure you played: how was the interface? How "sticky" were the buttons? What was the response time? How legible was the text on your high-resolution monitor? All of these elements are part of the total experience of interaction.

Mode 3: *Explicit interactivity; or participation with designed choices and procedures*

This is "interaction" in the obvious sense of the word: overt participation like clicking the non-linear links of a hypertext novel, following the rules of a board game, rearranging the clothing on a set of paper dolls, using the joystick to maneuver Ms. Pac-Man. Included here: choices, random events, dynamic simulations, and other procedures programmed into the interactive experience.

Mode 4: *Beyond-the-object-interactivity; or participation within the culture of the object*

This is interaction outside the experience of a single designed system. The clearest examples come from fan culture, in which participants co-construct communal realities, using designed systems as the raw material. Will Superman come back to life? Does Kirk love Spock?

Some of these modes occur universally in human experience, such as Mode 1, cognitive interactivity. Yet not all of them do. For our purposes, Mode 3, explicit interactivity, comes closest to defining what we mean when we say that games are "interactive." An experience becomes truly interactive in the sense of Cameron's "direct intervention" only when the participant makes choices that have been designed into the actual structure of the experience.

The rest of this chapter focuses primarily on explicit interactivity and how game designers can create the kinds of choices that result in meaningful play. However, even though we will be focusing on Mode 3, it is important to remember that the other three modes of interactivity are also present as players make explicit choices. For example, choosing whether to fold or not in Poker represents a moment of explicit interactivity. But at the same time, the material quality and size of the cards affect the functional interactivity; the fanciful images on the face cards might engender cognitive interactivity; and notions about what it means to be a suave card shark—or perhaps resentment at being trounced at the Poker table last week—represent forms of cultural participation that lie outside the bounds of the particular game being played.

Interaction, even the explicit interaction of a seemingly straightforward game choice, is never as simple as it appears at first glance. But before we dissect the components of explicit interactive choices, let's pause to consider the role of design itself in creating interactivity.

But Is it "Designed" Interaction?

Interaction comes in many forms. But for the purposes of designing interactivity, it is important to be able to recognize what forms of interactivity designers create. As an example, compare the following two actions: someone dropping an apple on the ground and someone rolling dice on a craps table. Although both are examples of interaction proper, only the second act, the rolling of the dice, is a form of designed interaction.

What about this action has been designed? First, the dice, unlike the apple, are part of a system (a game) in which the interaction between the player and the dice is made meaningful by a set of rules describing their relationship. This relationship, as defined by the rules of Craps, describes the connection between action and outcome—for example, "When the dice are rolled a player counts the number of dots appearing on the face-up sides of the dice." Even this extremely simple rule demonstrates how the act of rolling has meaning within the designed interactive system of the game. Secondly, the interaction is situated within a specific context: a game. Remember that meaningful play is tied not only to the concept of player action and system outcome, but also to a particular context in which the action occurs.

The description of "someone dropping an apple on the ground," on the other hand, does not contain a designed structure or context. What conditions would have to be present to evolve this simple interaction into a designed interaction? The

dropping of the apple does meet baseline criteria for interaction: there is a reciprocal relationship between the elements of the system (such as the person's hand, the apple, and the ground). But is it a designed interaction? Is the interactivity situated within a specific context? Do we have any ideas about what dropping an apple might "mean" as a form of interaction between a person and an apple? Do we have a sense of the connection between action and outcome?

No. All we know is that an apple has been dropped. What is missing from this description is an explicitly stated context within which the dropping of the apple occurs. If we change the scenario a little by adding a second player and asking the two participants to toss the apple back and forth, we move toward a situation of designed interaction. If we ask the two apple-tossers to count the number of times in a row they caught the apple before dropping it, we add an even fuller context for the interaction. The simple addition of a rule designating that the players quantify their interaction locates the single act of toss-catch within an overall system. Each element in the system is assigned a meaning: the toss, the catch, and the dropped toss. Even in the simplest of contexts, design creates meaning.

Interaction and Choice

The careful crafting of player experience through a system of interaction is critical to the design of meaningful play. Yet, just what makes an interactive experience "meaningful"? We have argued that in order to create instances of meaningful play, experience has to incorporate not just explicit interactivity, but meaningful *choice*. When a player makes a choice in a game, the system responds in some way. The relationship between the player's choice and the system's response is one way to characterize the depth and quality of interaction. Such a perspective on interactivity supports the descriptive definition of meaningful play presented in chapter 3.

In considering the way that choices are embedded in game activity, we look at the design of choice on two levels: micro and macro. The *micro* level represents the small, moment-to-moment choices a player is confronted with during a game. The *macro* level of choice represents the way these micro-choices join together like a chain to form a larger trajectory of experience. For example, this distinction marks the difference between tactics and strategy in a game such as Go. The *tactics* of Go concern the tooth-and-nail battles for individual sectors of the board, as individual pieces and small groups expand across territory, bumping up against each other in conflict and capture. The *strategy* of the game is the larger picture, the overall shape of the board that will ultimately determine the winner. The elegance of the design of Go lies in its ability to effortlessly link the micro and the macro, so that every move a player makes works simultaneously on both levels. Micro-interaction and macro-interaction are usually intertwined and there are, of course, numerous shades of gray in-between.

Keep in mind that "choice" does not necessarily imply *obvious* or *rational* choice, as in the selection of an action from a menu. Choice can take many forms, from an intuitive physical action (such as the "twitch" firing of a Time Crisis pistol) to the random throw of a die. Following are a few more examples of designed choices in games.

The choice of whether or not to take a hit in Blackjack. A Blackjack player always has a clear set of choices: the micro-choice of taking or not taking a hit will have the eventual outcome of a win or a loss against the house. On the macro-level, each round affects the total amount of money the player gains or loses over the course of the game. Playing each hand separately, according to its probability of beating the house is like tactics in Go. Counting cards, which links all of a players' hands between rounds, is a more long-term, strategic kind of choice-making.

The choice of what to type into the flashing cursor of a text adventure. This is a more open-ended choice context than the simple hit or pass of Blackjack. The micro-choice of typing in a command gives the player feedback about

how the player moves through or changes the world. The choice to type the words "Move North" takes the player to another location in the game where different actions are possible—perhaps actions that will eventually solve the multi-part puzzles that exist on the macro-level of game play. Even when a player tries to take an action that the program cannot parse (such as typing "grab rock" instead of "get rock"), it is meaningful: the outcome of bumping up against the limits of the program's parsing ability serves to further delineate the boundaries of play.

The choice of what play to call in a Football game. This moment of game-choice is often produced collaboratively among a coaching staff, a quarterback, and the rest of the offensive players. There are a large number of possible plays to call, each with variations, and the choice is always made against the backdrop of the larger game: the score, the clock, the field position, the down, the strengths and weaknesses of both teams. The most macro-level of choices address the long-term movement of the ball across the field and the two teams' overall scores. The most micro-level of choices occur once the play is called and the ball is hiked: every offensive player has the moment-to-moment challenge of executing the play as the defensive team does its best to put a stop to it.

As these examples demonstrate, choice-making is a complex, multi-layered process. There is a smooth transition between the micro- and macro-levels of choice-making, which play out in an integrated way for the player. When the outcome of every action is discernable and integrated, choice-making leads to meaningful play. Game designer Doug Church, in his influential online essay "Formal Abstract Design Tools," outlines the way that these levels of choice transition into a complete game experience.

> In a fighting game, every controller action is completely consistent and visually represented by the character on-screen. In Tekken, when Eddy Gordo does a cartwheel kick, you know what you're going to get. As the player learns moves, this consistency allows planning—intention—and the reliability of the world's reactions makes for perceived consequence. If I watch someone play, I can see how and why he or she is better than I am, but all players begin the game on equal footing.[7]

As Church points out, the macro-levels of choice-making include not only what to do over the course of a game, but also whether or not you want to play a game, and against whom. If you are beaten in a fighting game that doesn't contain clear and meaningful play, you will never know why you lost and you will most likely not play again. On the other hand, if you know why your opponent is better than you are, your loss is meaningful, as it helps you assess your own abilities, gives you ideas for improvement, and spurs on your overall interaction with the game.

Choice Molecules

> *[The designers of Spacewar!, the first computer game] identified action as the key ingredient and conceived Spacewar! as a game that could provide a good balance between thinking and doing for its players. They regarded the computer as a machine naturally suited for representing things that you could see, control, and play with. Its interesting potential lay not in its ability to perform calculations but in its capacity to represent action in which humans could participate.—**Brenda Laurel,** Computers as Theater*

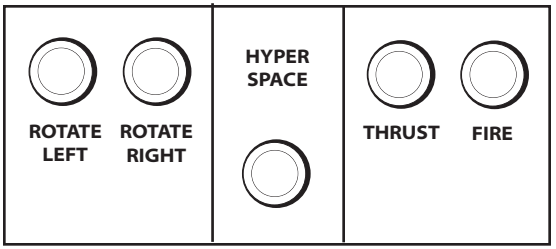
The capacity for games to "represent action in which players participate" forms the basis of our concept of "choice." If we consider that every choice has an outcome, then it follows that this action > outcome unit is the vehicle through which meaning in a game emerges. Although games can generate meaning in

many ways (such as through image, text, sound, etc.), to understand the interactive nature of meaningful play, we focus on the kinds of meaning that grow from player interaction. At the heart of interactive meaning is the action > outcome unit, the molecule out of which larger interactive structures are built.

In order to examine this concept more closely we look at the classic arcade game Asteroids, a direct descendent of Spacewar!. In Asteroids, a player uses buttons to maneuver a tiny spaceship on the screen, avoiding moving asteroids and UFOs and destroying them by shooting projectiles. The action > outcome interactive units of Asteroids are manipulated through a series of five player commands, each one of them a button on the arcade game's control panel: rotate left, rotate right, thrust, fire, and hyperspace. Within the scope of an individual game, possible player actions map to the five buttons:

- **Press rotate right button:** spaceship rotates right
- **Press rotate left button:** spaceship rotates left
- **Press thrust button:** spaceship accelerates in the direction it is facing
- **Press fire button:** spaceship fires projectile (up to four on the screen at a time)
- **Press hyperspace button:** spaceship disappears and reappears in a different location (and occasionally perishes as a result)

Action on the screen is affected through the subtle (and not so subtle!) orchestration of these five controls. As the game progresses, each new moment of choice is a response to the situation onscreen, which is the result of a previous string of action > outcome units. The seamless flow that emerges is one of the reasons why Asteroids is so much fun to play. Rarely are players aware of the hundreds of choices they make each minute as they dodge space rocks and do battle with enemy ships—they perceive only their excitement and participation inside the game.



Anatomy of a Choice

Although the concept of choice may appear basic upon first glance, the way that a choice is actually constructed is surprisingly complex. To dissect our action > outcome molecule, we need to ask the following five questions. Together, they outline the *anatomy of a choice:*

1. What happened before the player was given the choice? What is the current state of the pieces on a game board, for example, or the level of a player's health? What set of moves just finished playing out? What is the game status of the other players? This question relates to the both the micro and macro events of a game, and addresses the context in which a choice is made.

2. How is the possibility of choice conveyed to the player? On a game board, the presence of empty squares or a "draw pile" might indicate the possibility of choice, whereas choices in a digital game are often conveyed through the game's controls. In Asteroids, for example, the five buttons on the control panel communicate the opportunity for choice-making to the player.

3. How did the player make the choice? Did the player make a choice by playing a card, pressing a button, moving a mouse, running in the opposite direction, or passing on a turn? The mechanisms a player uses to make a choice vary greatly, but all are forms through which players are given the opportunity to take action.

4. What is the result of the choice? How will it affect future choices? A player taking action within a system will affect the relationships present in that system. This element of the anatomy of a choice speaks to the outcome of a player action, identifying how a single choice impacts larger events within the game world. The outcome of taking a "hit" in Blackjack impacts whether or not the player wants to take another hit, as well as the outcome of the game.

5. How is the result of the choice conveyed to the player? The means by which the results of a choice are represented to a player can assume many guises, and forms of representation are often related to the materiality of the game itself. In a game of Twister, for example, the physical positioning of bodies in space conveys the results of choices; in Missile Command, the result of the choice to "fire" is conveyed by a slowly moving line of pixels, ending in an explosion; in Mousetrap, the mechanical workings (or non-workings) of the mousetrap convey the results of moving a mouse into the trap space. Note that step 5 leads seamlessly back to step 1, because the result of the choice provides the context for the next choice.

These are the five stages of a choice, the five events that transpire every time an action and outcome occur in a game. Each stage is an event that occurs internal or external to the game. *Internal events* are related to the systemic processing of the choice; *external events* are related to the representation of the choice to the player. These two categories make a distinction between the moment of action as handled by the internal game state and the manifestation of that action to the player.

The idea that a game can have an internal event represented externally implies that games are systems that store information. Jesper Juul, in a lecture titled "Play Time, Event Time, Themability," describes this idea by thinking of a game as a state machine:

> A game is actually what computer science describes as a state machine. It is a system that can be in different states. It contains input and output functions, as well as definitions of what state and what input will lead to what following state. When you play a game, you are interacting with the state machine that is the game. In a board game, this state is stored in the position of the pieces on the board, in computer games the state is stored as variables, and then represented on the screen.[8]

In Juul's example of a board game, the "internal" state of the game is immediately evident to the players in the way that the pieces are arranged on the board. In the case of a computer game, as Juul points out, the internal variables have to be translated into a representation for the player. The distinction between internal and external events helps us to identify and distinguish the components of a choice. Within the action > outcome molecule, stages 1, 3, and 4 are internal events, and

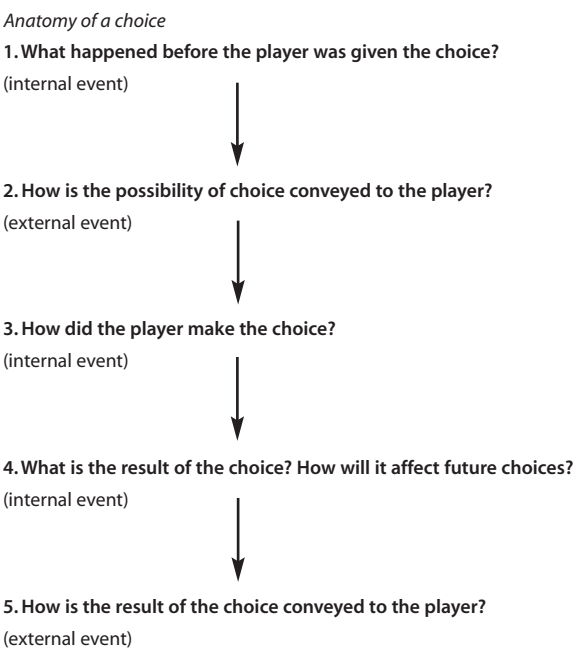


Figure 1

Anatomy of a Choice	Asteroids	Chess
1. What happened before the player was given the choice? (internal event)	Represented by the current positions and trajectories of the game elements.	Represented by the current state of the pieces on the board.
2. How is the possibility of choice conveyed to the player? (external event)	The possible actions are conveyed through the persistent button controls as well as the state of the screen, as it displays the relationships of the game elements.	The possible actions are conveyed through the arrangement of pieces on the board, including the empty squares where they can move.
3. How did the player make the choice? (internal event)	The player makes a choice by pressing one of the 5 buttons.	The players makes a choice by moving a piece.
4. What is the result of the choice? How will it affect future choices? (internal event)	Each button press affects the system in a different way, such as the position or orientation of the player's ship.	Each move affects the overall system, such as capturing a piece or shifting the strategic possibilities of the game.
5. How is the result of the choice conveyed to the player? (external event)	The result of the choice is then represented to player via screen graphics and audio.	The result of the choice is then represented to the player via the new arrangement of pieces on the board.

stages 2 and 5 are external events. These two layers of events form the framework within which the anatomy of a choice must be considered. To see how this all fits together, let us take an even closer look at the way choice is constructed in two of our example games, Asteroids and Chess. *(Figure 1)*

Although all five stages of the action > outcome choice event occurred in both games, there are some significant differences. In Asteroids, the available choices and the taking of an action both involve static physical controls. In Chess, the pieces on the board serve this function, even as they convey the current state of the game. The internal and external states of Chess are identical, but in Asteroids, what appears on the screen is only an outward extension of the internal state of the software. The "anatomy of a choice" structure occurs in every game, although each game will manifest choice in its own way.

This way of understanding choice in a game can be extremely useful in diagnosing game design problems. If your game is failing to deliver meaningful play, it is probably because there is a breakdown somewhere in the action > outcome chain. Here is a sample list of common "failure states" that can often be found in games and the way that they relate to the stages of a choice.

- *Feeling as if decisions are arbitrary.* If you need to play a card from your hand and it always feels like it doesn't matter which card you select, the game probably suffers in stage 4, the effect of the player's choice on the system of the game. The solution is to make sure that player actions have meaningful outcomes in the internal system of the game.

- *Not knowing what to do next.* This can be a common problem in large digital adventure games, where it is not clear how a player can take action to advance the game. The problem is in stage 2, representing choices to the player. These kinds of problems are often solved with additional information display, such as highlights on a map, or an arrow or indicator that helps direct the player.
- *Losing a game without knowing why.* You think that you're about to reach the top of the mountain, when your character dies unexpectedly from overexposure. This frustrating experience can come about because a player has not sufficiently been informed about the current state of the game. The problem might be in stage 5, where the new state of the game resulting from a choice is not represented clearly enough to the player.
- *Not knowing if an action had an outcome.* Although this sounds like something that would never happen, there are many examples of experimental interactivity (such as a gallery-based game with motion sensor inputs) in which the player never receives clear feedback on whether or not an action was taken. In this case, there is a breakdown at stages 3 and 4, when a player is taking an action and receiving feedback on the results.

These examples represent only a small sampling of the kinds of problems that a game's design can have. The anatomy of a choice is not a universal tool for fixing problems, but it can be especially useful in cases where the game is breaking down because of a glitch in the player's choice-making process.

Space of Possibility

We conclude this chapter with an excerpt from David Sudnow's book, *Pilgrim in a Microworld,* a wonderfully detailed personal account of one man's very real obsession with the video game Breakout. Sudnow brings readers into the space of designed interactivity through detailed descriptions of what he experienced—physically, psychologically, emotionally—as he played. There are remarkably few documents that offer such a sensitive and insightful analysis of designed interaction.

> I'd catch myself turning my chair into a more en face position vis-à-vis the TV. An obvious delusion. Maybe I could rest one elbow on the set to help feel the angle of my look and deepen a sense for the scale of things. See it from this side and that, see the invisible backside of things through an imaginary bodily tour of the object. Nonsense. If only I could feel the impact of the ball on the paddle, that would certainly help, would give me a tactile marker, stamping the gesture's places into a palpable little signature so I'd feel each destination being achieved and not just witness the consequences of a correct shot. Nonsense.
>
> Non-sense, just your eyes way up top, to be somehow fixed on things in ways that can't feel them fixing, then this silent smooth little plastic knob down there, neither near nor far away but in an untouchable world without dimensions. And in between all three nodes of the interface there's nothing but a theory of electricity. So fluid, to have to write your signature with precise consistency in size within the strict bounds of a two and three-sevenths of an inch of space, say, while the pen somehow never makes contact with the paper. There's nothing much to hold on to, not enough heft in this knob so your hands can feel the extent of very minor movements, no depth to things you can use to anchor a sense of your own solidity.[9]

As game designers, what can we glean from Sudnow's observations? His analysis suggests that there is a wealth of information to be gained about a game's interactivity by looking at it from the player's point of view. One of our disappointments with current writing on games and interactivity is that much analysis occurs not from the point of view of the player, but from the point of view of an outside spectator. This style of over-the-shoulder journalism fails to recognize that interac-

tivity is something to be experienced, rather than observed. In writing a player-centric account of his encounter with the game, Sudnow calls attention to key concepts for designed interaction. Concepts such as directed choice, player control, amplification of input, system representation, and direct, visible feedback emerge in his poetic meditation on perception, attention, cognition, and the body.

Creating a game means designing a structure that will play out in complex and unpredictable ways, a space of possible action that players explore as they take part in your game. What possible actions might players take in the course of a game of Musical Chairs? They might push, shove, tickle, poke, or fight for their seat once the music stops and the mad scramble for chairs begins. The game designer must carefully craft a system of play in which these actions have meaning in support of the play of the game, and do not distract or interrupt its play.

But game designers do not directly design play. They only design the structures and contexts in which play takes place, indirectly shaping the actions of the players. We call the space of future action implied by a game design the *space of possibility.* It is the space of all possible actions that might take place in a game, the space of all possible meanings which can emerge from a game design. The concept of the space of possibility not only bridges the distance between the designed structure and the player experience, but it also combines the key concepts we have presented so far. The space of possibility is *designed* (it is a constructed space, a context), it generates *meaning* (it is the space of all possible meanings), it is a *system* (it is a space implied by the way elements of the system can relate to each other), and it is *interactive* (it is through the interactive functioning of the system that the space is navigated and explored).

The space of possibility springs forth out of the rules and structures created by the game designer. The space of possibility is the field of play where your players will explore and cavort, compete and cooperate, as they travel through the experience of playing your game. But like David Sudnow who wishes he could reach out and touch the electronic blip of his Breakout paddle, as a game designer you can never directly craft the possible space of your game. You only can indirectly construct the space of possibility, through the rules you design. Game design is an act of faith—in your rules, in your players, in your game itself. Will your game create meaningful play? You can never know for sure. But understanding key concepts like design, systems, and interactivity can help bring you closer to a meaningful outcome.

Further Reading

Computers as Theater, by Brenda Laurel

Although Laurel is not speaking about games directly, her discussion of a dramatic theory of human-computer activity has many connections to the interactivity of games. The most relevant discussions to game design focus on the mechanics of interaction and the way people interact with machine interfaces.

Recommended:

Chapter 1: The Nature of the Beast

Chapter 5: Design Principles for Human-Computer Activity

The Design of Everyday Things, by Donald Norman

Norman's book is a must read for any designer involved in the design of interactive systems. His approach has been formalized more recently within the catch-phrase "experience design," which places the user at the center of any designed activity. Although Norman is writing about everyday objects such as telephones and car doors, his observations have direct application to the design of games as interactive systems.

Recommended:

Chapter 1: The Psychopathology of Everyday Things

Chapter 2: The Psychology of Everyday Actions

Chapter 3: Knowledge in the Head and in the World

"Designing Interactive Theme Park Rides: Lessons From Disney's Battle for the Buccaneer Gold," by Jesse Schell and Joe Shochet

In this design postmortem of one of Disney's interactive theme park rides, Schell and Shochet discuss the reasons for the ride's success. Their analysis is design-driven, and offers insight into the tools, techniques, and psychology used to create an effective and entertaining interactive experience. Available at <www.gamasutra.com>.

"Formal Abstract Design Tools," by Doug Church

In making one of the most robust arguments for the development of a common vocabulary for games, Doug Church establishes a precedent for critical thinking within the emerging field of game design. "Formal Abstract Design Tools" is written from a game design perspective and explores concrete concepts of interactivity in the design of player experience. Available at <www.gamasutra.com>.

Pilgrim in the Microworld, by David Sudnow

This first-person account of one man's genuine obsession with the Atari 2600 game Breakout offers a clear portrait of the aesthetics of interactive systems. Concepts related to the anatomy of a choice, discernability and integration of player action, pleasure, and core mechanics are discussed in terms of player experience, making it a valuable resource for those intent on understanding just what is happening from moment-to-moment during game play.

Recommended:

Memory
Interface
Cathexis
Eyeball
Coin

The Art of Interactive Design: A Euphorious and Illuminating Guide to Building Successful Software, by Chris Crawford

The Art of Interactive Design is a non-technical book about the design of interactivity. Crawford uses his experience as a designer of games and interactive systems to discuss how interactivity works. For Crawford, interaction is "a cyclic process in which two actors alternatively listen, think, and speak." This conversational model of interaction is used throughout the text to good effect.

Recommended:

Part I: Chapters 1–6

Notes

1. <dictionary.com>.
2. Stephen W. Littlejohn, *Theories of Human Communication,* 3rd edition (Belmont, CA: Wadsworth Publishing Company, 1989), p. 175.
3. Brenda Laurel, *Computers as Theater* (Reading, MA: Addison-Wesley Publishing Company, 1993), p. 112.
4. Andy Cameron, *Dissimulations: Illusions of Interactivity* (MFJ No. 28: Spring 1995), <http://infotyte.rmit.edu.au/rebecca/html/dissimulations. html>.
5. Chris Crawford, *Understanding Interactivity* (San Francisco: No Starch Press), 2002, p. 6.
6. Ibid; p. 7.
7. Doug Church, "Formal Abstract Design Tools." <www.gamasutra.com>, July 16, 1999.
8. Jesper Juul, Computer Games and Digital Textuality. Conference at IT University of Copenhagen, March 1–2, 2001.
9. David Sudnow, *Pilgrim in a Microworld* (New York: Warner Books, 1983), p. 117.

Interactivity SUMMARY

- **Interactivity** is closely linked to the concepts of design, systems, and meaningful play. When a player interacts with the designed system of a game, meaningful play emerges.
- There are many valid definitions of interactivity. Cutting across all of them are **four modes of interactivity:**

  Mode 1: Cognitive interactivity; or interpretive participation;
  Mode 2: Functional interactivity; or utilitarian participation;
  Mode 3: Explicit interactivity; or participation with designed choices and procedures;
  Mode 4: Beyond-the-object-interactivity or cultural participation.

- These four modes are not distinct categories but are instead overlapping ways of understanding any moment of interactivity. They usually occur simultaneously in any experience of a designed system.
- Not all interaction is **designed interaction.** When an interaction is designed, it has an internal structure and a context that assign meaning to the actions taken.
- An interactive context presents participants with **choices.** Choices can be **micro**-choices of moment-to-moment interactivity or **macro**-choices, which concern the long-term progress of the game experience.
- The basic unit out of which interactive meaning is made is the **action** > **outcome** unit. These units are the molecules out of which interactive designers (including game designers) create larger structures of designed interaction.
- Within each action > outcome event is a series of five stages that help construct a choice in a game. These stages are expressed through the following questions:

  1. What happened before the player was given the choice?
  2. How is the possibility of choice conveyed to the player?
  3. How did the player make the choice?
  4. What is the result of the choice? How will it affect future choices?
  5. How is the result of the choice conveyed to the player?

- Each of these stages represents either an **internal event,** in which the system of the game processes and receives the choice, or an **external event,** in which the choice is represented to the player.
- The **space of possibility** of a game is the space of all possible actions and meanings that can emerge in the course of the game. This concept ties together meaning, design, systems, and interactivity.