Chapter 22

Task Deployment in Three Types of Game Spatial Structures

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22.1 INTRODUCTION

Task deployment, a major aspect of level design [4, 8, 13], is used to control player progress in video games. In this chapter we will look at task deployment with a special focus on spatial structures [2] in terms of system architecture and program code, especially those structures and mechanisms that support a balance of player skills and challenges so as to sustain flow [7]. We will use three categories of spatial structures—ladder, maze, and grid—and discuss them in the contexts of game genres and design principles.

Game designers construct game systems to establish context and a sense of meaningful play [18]. As Rouse has observed, the main job of designers is “to build spaces that are fun for players to play in once the core gameplay for a game is established” [14, p. 449]. One tool that they use for this purpose is level design, a concept that was initially introduced in the 1980s and which is now considered a standard feature of most computer and online games [3]. From a system point of view, level design features such as structure, progression, flow control, and difficulty are created to maintain player sense of balance and fairness regarding game task arrangement. Constructed with programming code, system architectures support game worlds with their own rules, characters, landmarks, views, time constraints, and other attributes requiring careful cross-validation, sometimes under exceptionally complex conditions. To simplify their task, game designers borrow concepts from other fields: architecture [12, 15], narrative theory for story [1, 16] and character development [5, 10], and film theory [17], among others. Our motivation for

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this chapter is to share ideas regarding the deployment of tasks, resources, and plots from a spatial structure perspective, based on architectural concepts.

Game players deal with three types of challenges: system based (puzzles, quests, dungeons), other players (individual or team combat), and player defined (open-ended games that support exploration and construction). Our focus in this chapter is the first type, especially game spatial structures that are determined by system architectures and program codes. In most architectures, challenge design and level arrangement information are found in game design documents (GDDs.) Programmers write code based on level descriptions to regulate spatial and temporal structures; these regulations affect player/avatar moves, options, and routes. From a flow perspective, task, resource, and reward deployment in spatial and temporal spaces strongly influence the balance between player skill and game difficulty.

In this chapter we will analyze tasks associated with puzzles, quests, and challenges in terms of their spatial structures and mechanisms that players use to sustain flow. We will also discuss how factors such as storylines, resource allocation, and reward systems are incorporated into game spatial structures to provide coherent gaming experiences. Spatial structures will be categorized as ladder, maze, and grid for our discussion of links between game genres and design principles. We will introduce a hierarchical architecture for hybrid games that represents combinations of these game types—currently a mainstream practice in game markets. The goal of such efforts is to maintain player sense of balance and fairness in terms of game task arrangement from a system viewpoint.

22.2 METHODOLOGY

We performed content analyses of the spatial structures of various games according to level descriptions in their GDDs and then compared task deployment and level arrangements across game genres. After introducing a refined task deployment concept with implications for spatial structure and level design, we will discuss heuristics in support of structure selection. Next, we will review physical space theory and explain how it can be translated into virtual space environments and discuss which factors must be considered before executing such translations. We will describe three space-driven models (ladders, mazes, and grids) based on Nitsche's [12] spatial structures concept and Schell's [15] organization of game spaces. In this chapter, "line" indicates a design path from a game's start to end point. Examples include adventures in games with clearly defined goals and quests in games that emphasize exploration. Each analysis will consist of a heuristic and game examples, plus a discussion of task deployments, level arrangements, and design impacts in the contexts of certain spatial structures, including plots and rewards.

22.3 LADDERS: MAKING PROGRESS GO ONE STEP FURTHER

Games with ladder (i.e., linear) structures are considered the most straightforward and intuitive, with each level having a clearly defined mission that must be com-

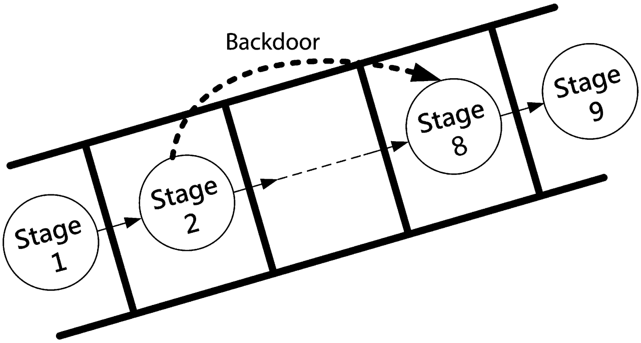

Figure 22.1 Diagram of ladder.

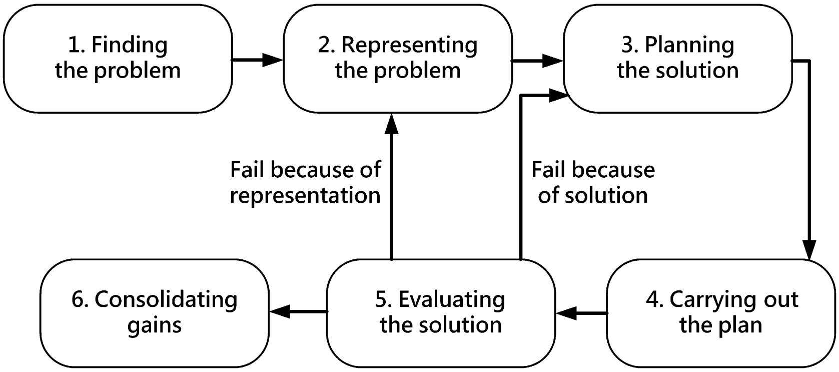

Figure 22.2 Diagram of Hayes's [9] problem-solving sequence.

pleted before the player (or players) can proceed to the next one and with the requirement that multiple missions be completed before moving on to the next level of play (Figure 22.1). Player direction is obvious—usually upward or forward, with challenges and missions at each level, and with players evaluating their progress as each new level is achieved. For purposes of game simplification, many hybrid game designers use ladder structures for their main lines and extensions (also referred to as "side lines"). Due to the linear structure of ladder games, flow state is sensitive to the arrangement of task difficulty. Difficulty can be measured in terms of a problem-solving sequence consisting of identifying the problem, representing the problem, planning the solution, executing the plan, evaluating the solution, and consolidating gains [9] (Figure 22.2). In a computer game, game designers need to address steps 1 and 2 and leave the others to the players. Steps 2–6 can become a loop determined by either a solution or player ability and experience.

Klein [11] has categorized the most common problem-solving methods as algorithm and heuristic. Algorithms are good for puzzle and casual games whose goals are clearly defined and whose tools and hints tend to be straightforward. Players can systematically check each game state until they discover the goal state; therefore the temporal and spatial complexity of an algorithm used for solving a task can be used to measure difficulty level. The heuristic category consists of six methods: means–end analysis, trial and error, working backward, difference decreasing, analogy, and diagram. Different methods are frequently used for solving different challenges, meaning that task difficulty can be measured by different combinations involving all six.

Tetris [19] is an example of a ladder-based puzzle game in which players work on increasingly difficult tasks, with many challenges presented at the same difficulty or skill level. The objective of these repetitive challenges is for players to learn skills and how to use certain tools that will be useful for tasks at higher levels. *Angry Birds* [20] and *Taiko Drum Master* [21] are examples of games in which challenges are arranged into different sets that players must complete in order to move to higher levels. Contrast these with a game such as *Mine Sweeper*, where the game randomly selects task levels regardless of whether the player has mastered all of the requisite lower levels—that is, level of difficulty is unrelated to the preceding challenge. In these cases, players are less concerned about repetitive challenges as they are about self-created rules and goals for maintaining flow. More complex ladder structures are found in side-scrolling games—video games in which the action is viewed from a side-view camera angle, with characters generally moving from left to right; examples include *Super Mario Bros*. [22] and *Mega Man* [24], known as *Rockman*. According to the *Super Mario Bros.* game design, players must move rightward to overcome challenges, find new tools, practice new skills, and eventually reach the final goal.

22.3.1 Level Arrangement, Resource Allocation, and Story in Ladder Games

In ladder games, the features used for evaluating level difficulty strongly influence how a game is perceived, especially when players are required to deal with all challenges without the benefit of back doors. Some players get stuck at certain levels for long periods of time when they cannot develop skills for moving up and are at risk of leaving a game due to frustration. However, certain games seem to fit the needs of these kinds of players: in the *Taiko no Tatsujin* [25] series, levels are arranged by topic, game skills can be applied at all levels, and players are free to choose game level. Another way to state this is that a local nonlinear spatial structure can reduce the potential for player frustration, and games without flexible spatial structures require auxiliary mechanisms for reducing the potential for players to leave. For example, games like *Contra* [26] provide instructions for players to maintain success at a particular level, and *Super Mario Bros*. has a magic whistle to help players leave their current level. In short, game designers try to maintain balance between game challenges and player or onscreen character skills. Resource allocation is very important in games where skills are truly player centered (e.g., fighting games), but when they are character centered there is greater concern for maintaining balance between characters, since those with too-powerful or useless skills can disrupt play. In these games characters should be designed according to player traits rather than abilities, so that individual players can find their own favorite characters.

Story design is intuitive due to the ascendant characteristic of ladder games. A low-to-high spatial structure can help create linear story plots in terms of establishing background and developing intercharacter relationships and plots at different steps or levels. However, linear story structure requires great care in terms of plot and story continuity. Designers must be careful when handling multiple ladder levels so as to reduce the potential for player confusion. We will discuss exceptionally complex and difficult plots in the section on maze games. Many players are content replaying games at the same level but create new rules or goals to make the game a bit more challenging. These player-made changes consist of new methods or variation aimed at maintaining or increasing a sense of fun. To support this activity, ladder game designers need to keep spatial structure and rules flexible enough to retain player creativity and interest. Toward that goal, game designers need to meet the expectations of players to build skills and to prepare themselves for more difficult challenges, manage the number of potential in-game failures to prevent discouragement, and create stories with clear scenarios, character relationships, and plots that fit well with all other game aspects.

22.4 MAZES: EXPLORATION IN GAME WORLD

Buckingham [6] notes that most spaces in action adventure games (AAGs) have maze structures, regardless of whether they are 2D or 3D—that is, there appears to be many paths, but only one leads to the goal. A major part of the fun in maze games is the experience of exploration. Therefore designers must focus on how to help players figure out where they are at any point during a game. Mazes have some "mandatory nodes" that players must complete in order to enter the next level, but most maze games have no rules for getting to or completing mandatory nodes. The term "main line" refers to the procedure of moving among mandatory nodes; all other activities are referred to as "extensions." The "capsules" in Figure 22.3 are mandatory nodes; players only need to complete a single challenge at the first level in order to move on to the second level, where they must find the most important of three available nodes. In other words, players must discover the main line and complete all challenges associated with mandatory nodes.

Using *Resident Evil CODE: Veronica* as an example, in the game's drama mode players control the onscreen character to find the main line. Part of the challenge is fighting with nonplayer characters (NPCs) who block the character's way. All game spaces are open for visiting unless they contain locked doors; players are also free to revisit previous game spaces, but that goes against the ordered sequence of the game's mandatory nodes hidden behind doors, in items, or in story characters. Players search for clues that help them find and complete main line tasks. Note that when *Veronica* players choose "battle mode," the entire spatial structure changes to

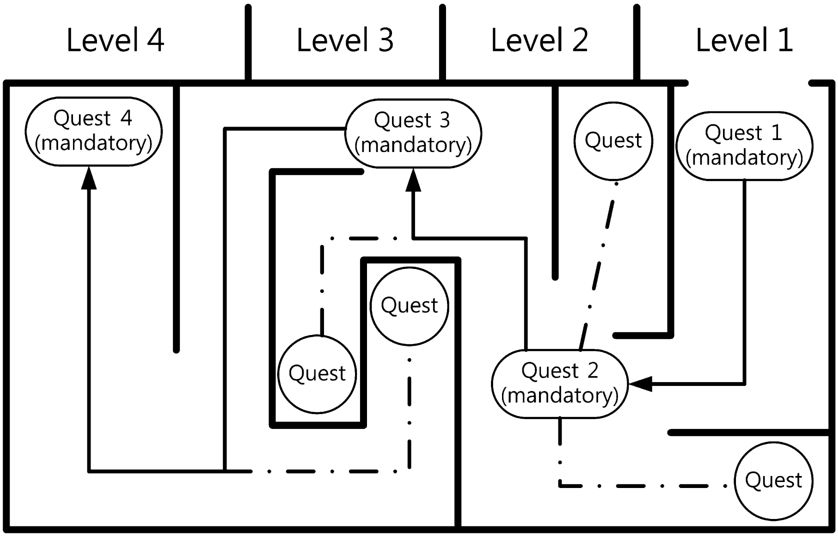

Figure 22.3 Diagram of maze.

a ladder type because players must beat every NPC in order to move up to the next level.

To support player activity, game extensions must provide information for finding mandatory nodes and returning to main lines. Toward this goal, some games provide maps for players; *Super Mario Bros. 3* [23] provided players a map of each world (eight worlds in total). In a world map, stages are differentiated with different icons, including yellow castles, main castles, pyramids, and so on, and the passages between stages are provided. Using the world map, players can easily find the mandatory nodes and can choose from many possible arrangements to make their way to the main castle. Ensuring the fun of exploration is the primary objective, meaning that the success or failure of this and other maze-based games is heavily dependent on game world and story design.

22.4.1 Limited Branching Factors and Backtracking Depths

The linear spatial characteristic of ladder games allows players to improve their skills to take on new challenges. A ladder format is a good choice for short-term and round-by-round games that have clear and straightforward goals. In comparison, the missions and challenges found in maze games serve another role as information (clue) providers in support of game exploration. We therefore suggest that designers apply ladders to main line design and use extensions to insert and hold other information and resources—in other words, arrange mandatory nodes in ladders that are embedded in mazes. However, designers need to take extra care regarding branching factors (i.e., the number of children at each node), since the potential for losing a sense of meaningful play increases when they are not properly controlled. Further, in acknowledgment of players who prefer working backward as their heuristic, designers must limit backtracking depth. Note that resources and main line hints can be placed in extensions and hidden using game world elements and settings. For example, in the *Devil May Cry* [28] series, players can explore hidden settings for purposes of gaining special abilities or rewards. A blocked door tells players that they must find a key or earn some special skill to open it. Regardless of the process, it is important to ensure that the onscreen character has access to the requisite ability to overcome current challenges.

In terms of resource allocation, resources can be categorized as necessary or auxiliary. Necessary resources must be arranged in support of main line mandatory nodes. The difficulty levels of challenges in mandatory nodes cannot surpass necessary resource capabilities, whereas auxiliary resources can be more flexible and placed in any game space. With the exception of aids for completing challenges and missions, auxiliary resources can be designed to represent player achievement—for instance, the "recessive" mushrooms and tulips in *Super Mario Bros.*, designed to lure players to explore certain areas. It is also possible to create resources for the purpose of attracting player attention—for instance, the guns favored by Dante in *Devil May Cry* to defeat big bosses, hit special targets, and otherwise show off their skills. Designers need to be aware of injecting a sense of the unexpected in resource allocation to maintain player interest.

22.4.2 Main Storyline and Extensions with One or More Endings

Constructing a story in a maze-based game is a complex task, since the spatial structure is more complex than that of a ladder game, yet as free as one in a grid. We therefore suggest using an embedded structure when designing maze game missions and challenges—that is, use a ladder format for the main storyline and extensions to encourage exploration. This policy can help story designers maintain continuity when they add extensions for purposes of camouflaging the storyline. This method is acceptable for single endings but not for multiple endings, since extensions in stories that have multiple endings are part of story causality and not simply used to hide main storylines. Instead of a simple one-to-one relationship between a node and an ending, causality must be maintained from beginning to end, influenced by a special node in an extension. Therefore, games with multiple story endings require identification of all possible routes from beginning to end, based on story settings.

The recessive linear structure of maze-based games encourages players to find answers following a period of exploration and to construct causal relationships between goals and means for finding main lines. The fun of "finding patterns" has value—that is, finding the right way is a reward in itself, without any extra requirements. Main line missions and challenges do not require a hierarchy based on ascending difficulty, since game flow oscillates between the states of immersion and engagement. Accordingly, we believe four points are important to the design of maze-based games:

1. Story background and setting are very important because they represent the material for hiding main lines and designing extensions.
2. When applying the spatial structure of ladders, designers need to arrange main line missions and challenges based on causality.
3. Game designers must give as many details as possible, since main line hints and extensions are based on the temporal and spatial requirements of each story.
4. Resource allocation requires great care to ensure that players who only play the main line do not lose interest and fail to complete game play. Hiding or creating special resources with added details can add an element of surprise.

22.5 GRIDS: STARTING AT RANDOM AND EXPERIENCING AT YOUR WILL

Buckingham [6] has observed that the spatial structures of role-playing games (RPGs) and construction and management simulations (CMSs) are more complex than those found in AAGs, due to the single-ending nature of AAGs. We will describe these spatial structures in terms of grids, with players moving within grids in the same manner as wandering backpacker-type travelers who can explore places at their will, or join a group tour if some special mission or challenge calls for it. Judging from current trends in goal design, games can be categorized as having grids with goals or grids without goals. In either case there are no mandatory nodes, and therefore players can start from any location; an example is shown as Figure 22.4. As shown, the two series of passed quests and directions are marked with solid and dashed arrows. Player 1, indicated with a solid arrow, started from quest 12 and stayed in quest 3. He passed quest 8, quest 9, quest 5, and quest 2 in sequel. Meanwhile, player 2, indicated with a dashed arrow, played quest 7, quest 11, and then quest 14. At last, he ended in quest 13. There is no necessary starting point, and design decisions regarding game endings depend on game objects. In a grid, players can set their own goals or simply enjoy participating in different types of activities.

Grids are often used in CMS design. An example is the *SimCity* [29] series, which uses timed scenarios to divide spatial structures into grids with goals and grids without goals. Players usually assume the role of mayor in a chosen city, and without specific goals, their objective is to design and build new structures. In scenario mode (grid with goals), different cities have different issues (e.g., crime, damage from natural disasters) that players must address within a specific time frame. The time limitation determines whether a player wins or loses a game.

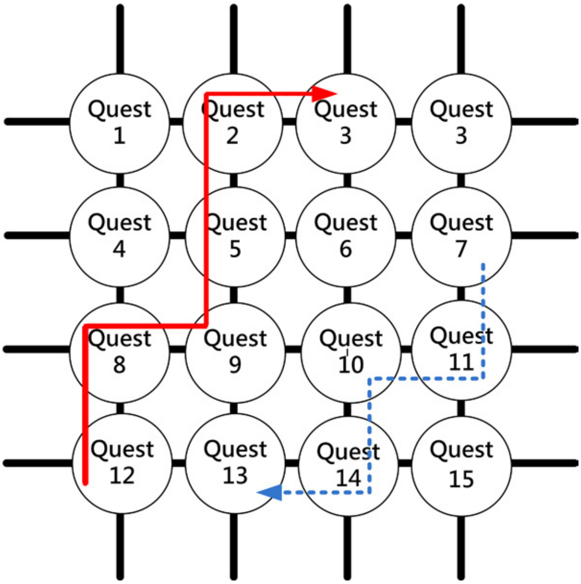

Figure 22.4 Diagram of grid.

22.5.1 Explore in Grids with/without Goals

In games containing grids-with-goals, mission difficulty and locations are problematic due to the absence of default routes to game endings and the independence of players. Accordingly, we suggest that game designers:

1. Provide different game difficulty levels (easy, medium, and hard), with players making decisions based on self-knowledge of their skills and preparation for subsequent challenges, thus reducing the potential for frustration.
2. Divide grids into three zones (easy, medium, and hard) based on distances between player starting points. Each mission or challenge is placed in its appropriate zone, with some variation added to maintain a sense of surprise.
3. Apply special items, skills, and levels as indicators of difficult or unique missions and challenges, with no need to hide them. Conversations with NPCs can be used to inform players that they are qualified for special missions and challenges and how to access them.

In games marked by grids without goals, players determine their goals from the very beginning. Unlike the simpler structures found in ladder- and maze-based games, players can maintain flow via breakdown and breakthrough mechanisms placed in the main line. The importance of auxiliary tools is more obvious in these game spaces, which are highly defined by players. Therefore, game designers simply need to place resources and rewards in whole spaces. Players can gain a sense of progress and achievement regardless of which route they take to game goals.

22.5.2 Story in Grids

The main feature of grids is player freedom to explore game worlds. Due to the importance of resource and reward allocation, grid-without-goal designers must focus on story background and basic relationships among characters, since players are responsible for other aspects such as plots and character development. To a certain degree this method is applicable to games featuring grids with goals, since their stories only add one more story element compared to grid-without-goal stories (i.e., the consequences of winning or losing).

The requirements for RPGs are slightly different, since the free travel feature can confuse players who have a strong sense of causality. RPG designers therefore often use storylines to give hints or to serve as guides. These storylines are designed for reference purposes only—that is, to help players who miss plot points in a story while traveling in a game world. This factor separates RPGs from maze-based games. Note also that even when players view some part of the story, they can still skip some details without affecting game progress. Ludic activities have higher priority than stories, since stories are considered auxiliary for game narratives. Accordingly, RPG designers need to focus on spatial structure when embedding stories, with some events occurring in a required order. Unlike linear narratives in novels and movies, RPG stories must be distributed within the spatial structure of this particular type of game. Instead of providing story background information, designers should focus on relationships between clues and answers, since those factors attract and maintain player interest. Narratives and hidden knowledge can take many forms and be placed in many places for players to discover via different routes.

Realizing player goals is a very important concept in grids, and therefore designers need to focus on encouraging and supporting player initiative—a very different form of fun compared to overcoming a challenge. Since the design issues are much more complex, we offer the following recommendations:

1. Construct the outline of the story first (an exception is for RPGs). Also, spend time early in the process to establish background information and clear relationships between characters.
2. As much as possible, create a list of all resources and items to be used within the temporal and spatial limits of the story and distribute them throughout the grid. After constructing a basic grid without goals, resources and other features can be added as required.
3. Use time or resource limitations as win/lose indicators when creating a grid with goals.

22.6 DESIGN CHOICE OF LADDERS, MAZES, AND GRIDS

The discussions above focus on the basic ideas of spatial structures: ladders, mazes, and grids. Moreover, the design impacts of task deployment, story, and reward are

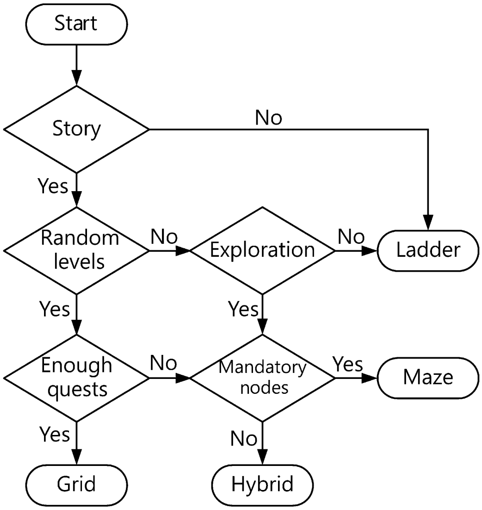

Figure 22.5 Choice of game spatial structure flowchart.

covered. As shown in Figure 22.5, we present a flowchart to choose a suitable spatial structure based on the design of story, resource allocation, levels, and designed quest amount. There are five essential questions you need to ask before picking up a structure. The details are listed below:

1. *Do You Have a Story to Tell in the Game?* Imagine that if you just want to design a casual game or a prototype of some game play, a story is not your primary concern. Then a ladder is the best option, and you need to apply the concepts and impacts we talked about in the section of ladders to start your design. But if your answer is yes, check the other four questions below.
2. *Do the Levels Arrange Randomly in the Game?* The linear design is much easier than the random one because the linear design has a clear discipline: The difficulty is arranged in increasing manner. But random level design needs to handle the relationship between players' skills and game challenges with care or players may feel anxious/bored if the unbalanced relationship sustains for a while. So a designer has to ask more questions to decide which structure is more suitable.
3. *Do Players Explore in the Game?* Distinct from the fun of completion and achievement, exploring in the game provides a different aspect of fun in the game. Exploration in the structure of a maze or a grid is a good game design, but this should be based on the design of story plots and game quests. The rational causality between story plots and game quests could help the players immerse in the game.
4. *Do We Need to Design Mandatory Nodes?* A series of mandatory nodes gives you the idea of main line and extensions of the game. If you do not

Table 22.1 Design Difficulty of Three Spatial Structures

Spatial Structure Type	Ladders	Mazes	Grids
Story	Easy	Hard	Medium
Level arrangement	Easy	Medium	Hard
Resources allocation	Easy	Medium	Hard

design enough quests and a fancy story, a maze could help you try many different combinations to conclude a better one.

5. *Do We Have Enough Quests to Fill in the Game World?* The quest amount directly affects the construction of a grid. If you do not have enough quests, there will be many "holes" in your grid. Then the game becomes a drama with scenes but without scripts. So a design team should come up with as many quests and game plays as possible before designing a grid.

After considering the five questions, a suitable spatial structure will help level designers to deploy tasks, challenges, plots, and so on. Based on the designs of stories, level arrangement, and resource allocations, we also compare the design difficulties of three spatial structures. The results are shown in Table 22.1. In the next section, we will talk about hybrid structure design. Hybrid structures are basically constituted with two spatial structures: One is the ground design and the other could add more variations.

22.7 HYBRID GAMES: AN EMBEDDED SYSTEM

After introducing three spatial structures and design impacts of game worlds, it is possible to use different combinations of these structures to create hybrid games. This can be achieved through three approaches:

1. Design different modes and apply different spatial structures within them. Most game designers take this approach. Using *Patrician* [30] (a commercial trading simulation game) as an example, players assume roles as merchants who trade goods between offices and geographic locations. Players can choose between dramatic (ladder spatial structure) and free modes (grid without goals). In the first, players must complete missions one by one to earn the title of "Patrician"; in the second, players can make all of their own trade decisions and determine the futures of their onscreen characters. Another example of a hybrid structure is *Resident Evil CODE: Veronica* [27], whose drama mode uses a maze spatial structure and battle mode uses a ladder spatial structure. In the first, players can freely explore most game environments, but they must search for and follow clues to solve puzzles in order to complete the game. In the second, players must defeat a successive line of devils until the last one is vanquished.

2. Apply a maze structure to ladder levels. The primary spatial structure of the game will still be ladder based (i.e., players will not be able to move to the next level without completing current level missions or challenges), but each level will contain a main line. For example, *Ninja Gaiden Sigma* [31] players must complete tasks stage by stage, but in each stage players are required to find hidden special items or to defeat a certain opponent to enter the next mandatory node. In *Need for Speed: Underground* [32], a city stands for a stage. Players can drive a car to explore blocks of a city, with each block containing shops or competitions hidden in a given city map. The base spatial structure is a ladder, but within each block the spatial structure is a maze.
3. Based on the structure of maze-based games, the main line is designed as a ladder and extensions are designed as a grid. Despite its potential advantages, few games use this method. A theme story can be embedded in a game because of the main line, but extensions can be flexible due to the large number of missions and challenges mapped onto a grid. Players can use these missions and challenges to create new stories. *Elder Scrolls V: Dawnguard* [33] is a case in point: To save the world, players must complete 22 quests—12 in the main quest and the rest as optional side quests. Some quests are matched to player race, but once a side is chosen, that decision is irreversible.

22.8 CONCLUSION

As Bushnell said, “All the best games are easy to learn and difficult to master.” The second part of Bushnell’s law addresses the idea of providing players with challenges that are scaled to their abilities. A simple truth is that video game content becomes increasingly harder as a player progresses. Our preferred design principle is a “rising sawtooth” pattern, in which content-focused challenges get progressively more difficult but occasionally level off or decrease slightly to let players feel a sense of power and then ramp up again to present new challenges. The overall goal is to “keep the player coming back for more” by creating a culture of skill, competition, and inspiration for improvement. The challenge for game designers is to find the exact spot between challenge and frustration/tedium.

Game world spatial structure is an important aspect of game design. Once the game space is structured, rules of the game are structured to shape possible actions in this environment [12]. Ladders are easy to design but can quickly become complex and difficult to manage. For maze-based games, temporal and spatial aspects of a story are very important in terms of hints tied to main lines and elements hidden in story extensions. Design costs are highest for grids, with player experiences (rather than difficulty arrangement) being fundamental. Since player movement cannot be predicted, resources and rewards must be placed throughout game worlds. Recently there has been an increase in the number of games using a hybrid design structure. Costs are higher, but the structure supports efforts to reduce design complexity.

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32. EA Black Box, Pocketeers, *Need for Speed: Underground* [various, racing game], 2003.
33. Bethesda Softworks, *Elder Scrolls V: Dawnguard* [various, RPG], 2012.