THE ART OF
Puzzle Design

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Puzzles

- Part of many games.
- Adventure, education, action, web
- But how do you create them?

Puzzles are an important part of many computer games. Cartridge-based action puzzle games, CD-ROM puzzle anthologies, adventure game, and educational game all need good puzzles.
Good News / Bad News

Mental challenge  Marketable?
Nonviolent  Dramatic?
Easy to program  Hard to invent?
Growing market  Small market?

The good news is that puzzles appeal widely to both males and females of all ages. Although the market is small, it is rapidly expanding, as computers become a mass market commodity and the internet shifts computer games toward familiar, quick, easy-to-learn games.
We’ll start by discussing genres of puzzle games. We’ll study some classic puzzle games, and current projects. We’ll cover the eight steps of the puzzle design process. We’ll hear from guest speakers. Finally we’ll do hands-on projects, with time for question and answer.
What is a Puzzle?

Five ways of defining puzzle games

First, let’s map out the basic genres of puzzle games.
1. Definition of “Puzzle”

A puzzle is **fun** and has a **right answer**.

- As opposed to everyday “problems”
- As opposed to a game (no answer) or a toy (no goal)

Fun, as opposed to mundane problems like fixing your plumbing. Of course to a plumber, that might be fun. And as a puzzle designer, I bet I could make a series of challenges that turn plumbing into a game.
Is Fun

Here’s my first puzzle. Can you figure out which letter of the alphabet I folded just once to make this shape? Hint: the answer is not L. How does it fare with our definition? Is it fun? Certainly not fun for everyone. Moral: fun is in the eye of the beholder.
Does it have a right answer? What constitutes a letter is not clearly defined, since R or J could also be an answer. So while most people would agree that F is the right answer, it’s a bit fuzzy. We can eliminate ambiguity by showing the target alphabet.
2. Varieties of Play Activity

There are four types of play. Noninteractive experiences include books and movies. A Toy has no set goal. A Puzzle has a goal: find the solution. The goal of a Game is to beat another player. Each type of play builds on the previous type: a puzzle should first be a good toy.
SimCity is a toy because there is no fixed goal. As with a set of building blocks, the player sets his or her own goals.
A puzzle has a goal to be attained. In Cogito, the goal is to arrange the nine red objects in a 3x3 centered square by sliding rows and columns with wraparound.
Games like chess are not puzzles, since there is not a fixed solution to be found. Instead the goal is to beat another player.
Experience

Noninteractive computer experiences include screen savers like After Dark, movies, and electronic books. As computers merge with TV and other media, we can expect to see more and more experiences that focus on content, not interaction.
3. Genres of Puzzle Games

Action puzzle games have time pressure and a way to fix mistakes. Story puzzle games have puzzles that advance the plot. Strategy puzzle games are based on multiplayer games. Construction puzzle games let you build something. Pure puzzle games are just puzzles.
Action puzzle games have time pressure. Since the player is more likely to make mistakes when making decisions quickly, every action puzzle game needs a way to recover from mistakes. In Tetris players can recover from badly placed pieces by clearing lines.
In a story-based games like Myst, puzzles are subsidiary to plot. Like songs in a musical, the puzzles serve to amplify characters and themes in the story. Ideally puzzles should emerge naturally out of the elements of the story, and move the plot forward.
Scrabble, like many games, is essentially a series of randomly generated puzzles that players take turns solving. Although there is some strategy, players can do well by considering each move separately, trying to score well on each turn.
In a construction puzzle game like The Incredible Machine, the challenge is to assemble parts to solve puzzles. For the game designer, the challenge is to create a set of pieces that are fun to manipulate and interact with each other in rich unexpected ways.
A pure puzzle game, like Smart Games, is purely a collection of puzzles. The design challenge is to tie the puzzles into a larger experience, so players want to play the whole game. Smart Games gives you a cumulative score based on how well you do on each puzzle.
Different people play puzzles for different reasons. Some see puzzles as metaphors for spiritual journeys. Puzzle fans like the challenge of finding the answer. Tetris and Solitaire players use puzzles as light distractions. People buy Disney titles for the familiar characters.
Challenge

People who are deeply into puzzles play for the thrill of conquering difficult challenges. Expert puzzle players are interested in finding the best solution to a puzzle, not merely solving it, so score is important.
Mindless Distraction

Games like Tetris and Solitaire can be played as time-wasters while you are on the phone or doing something else. They serve to keep your mind pleasantly occupied during a break or while you are waiting.
Character & Setting

Games can be an entertaining way to engage with characters you love. For instance children’s games are often based on well-known storybook characters. A big part of Myst’s appeal is that it is a beautiful place to be in.
Deeper Meaning

All puzzles appeal to the basic human desire for finding order in a chaotic world. Puzzles like Labyrinths can be seen as metaphors for life journeys. The abstract ritualistic act of solving a puzzle is not far the ceremony of religious rituals.
People who play puzzles tend to prefer one of three basic types: Word, Image or Logic puzzles. Each of these types of puzzle uses a different mode of thought. Of course some puzzles combine more than one mode. For instance, Hangman is a logical word game.
The most popular word puzzle is the crossword puzzle. A couple interesting statistics: a Gallop poll revealed that 25% of all Americans have played a crossword puzzle in the last month. Approximately 70% of crossword puzzle players are women.
A game like Sokoban requires appeals to people who enjoy solving purely abstract puzzles.
Image puzzles appeal to people who are visually oriented. The most popular image puzzle is the jigsaw puzzle. People play jigsaw puzzles as much for the enjoyment of looking at interesting images as for the challenge of assembling shapes.
Pipe Dream is a good example of how one great concept can produce many good design solutions, and how different features may change the game. Pipe Dream is the simplest constructive puzzle. Other examples of constructive puzzles include Lemmings, The Incredible Machine, and Puyo-Puyo.
Pipe Dream

The birth of the concept

- The simplest construction on the regular grid is the path from one cell to another.

Although Pipe Dream could be classified as an action puzzle game, at its heart it is a construction game. Other examples of constructive puzzles are: Lemmings, The Incredible Machine, Puyo-Puyo.
Pipe Dream

The birth of the concept

After obvious straightening of the path we realize that we need a very simple set of pieces:

To make the concept of constructing a path more suitable for a computer game we restrict lines to a square grid.
Seven pieces is a magic number. Tetris has seven pieces. Psychologists have found the human short term memory can hold about seven things (plus or minus two). That is why 7-digit telephone numbers are so much easier to remember than 10-digit numbers.
Pipe Dream

Concept

To build a path from one cell to another using one-cell elements

So this is the concept.
Pipe Dream

Design elements

- Environment or playing field
- Game objects
- Rules
- User interface
- Scoring, levels, overall organization

To turn the concept into a game, we need to specify these design elements.
Pipe Dream (original)

CONCEPT: Build a path from one cell to another using one-cell elements

<table>
<thead>
<tr>
<th>Topic</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Playing field</td>
<td>Regular grid 7x10</td>
</tr>
<tr>
<td>Objects</td>
<td>4 corners, 2 lines, 1 cross</td>
</tr>
<tr>
<td>Rules</td>
<td>Source of pieces: 5-cell stack, fills up</td>
</tr>
<tr>
<td>User interface</td>
<td>Click to place; replacement takes time</td>
</tr>
<tr>
<td>Scoring, levels</td>
<td>Nothing special</td>
</tr>
</tbody>
</table>

For the original Pipe Dream, published by LucasFilm Games, these were the design decisions.
The player clicks on the board to place the next piece, which is the bottom element in the stack of pieces at the left side of the screen. After a time, green liquid starts slowly flowing through the tubes. The game ends when the green liquid can flow no further.
Pipe Dream (Microsoft bonus level)

CONCEPT: Build a path from one cell to another using one-cell elements

- Playing field: Regular grid 7x10
- Objects: 4 corners, 2 lines, 1 cross
- Rules: Sliding tiles
- User interface: Click to slide, restriction on drawn path
- Scoring, levels: Nothing special

But other games can be built based on the same concept. The Microsoft Entertainment Pack version of Pipe Dream includes a sliding tile variation as its bonus level. Quite a good game.
Pipe Dream (Microsoft bonus level)

The player clicks a tile to slide it into the empty space, just like in a sliding block puzzle.
Pipe Dream (Lucasfilm bonus level)

CONCEPT: Build a path from one cell to another using one-cell elements

- Playing field: Regular grid 7x10
- Objects: 4 corners, 2 lines, 1 cross
- Rules: Falling tiles (like Tetris)
- User interface: Control while falling
- Scoring, levels: Nothing special

The original Lucasfilm version includes a Tetris-like variation of Pipe Dream as its bonus level. Very hard game; it is almost impossible to construct paths of more than about five tiles.
Honey Way

CONCEPT: Build a path from one cell to another using one-cell elements

- Playing field: Variable hexagonal grid
- Objects: All corners and lines, 3 crosses
- Rules: Preset sources, crosses and obstacles
- User interface: Drawing the path as freehand
- Scoring, levels: Nothing special

For the Mind Aerobics daily puzzle on the Internet Gaming Zone, Alexey created a simpler game based on the same concept. The grid was changed from square to hexagonal, the player could build paths freely by drawing lines, and sources, crosses and obstacles were given.
The hexagonal grid suggested the theme: bees and honey.
Honey Way

The player tries to construct a line of honey from one honey blob to another by drawing lines from one cell to another. Here we see the player in the middle of extending the honey trail three cells to the right.
Honey Way

The path must pass through every cell of the grid once, crossing over itself at the flowers in the directions indicated by the petals. Here is a complete solution. It looks complicated, but the hexagonal grid is actually more forgiving for path construction than a square grid.
Dangerous bees complicate some of the puzzles by giving the player an enemy to avoid.
Lineman

CONCEPT: Build any cyclic path using one-cell elements

- Playing field: Regular grid 10x10
- Objects: 4 corners, 2 lines, 1 cross
- Rules: Pieces appear on field; loops collapse
- User interface: Click to rotate pieces in place
- Scoring, levels: Nothing special

Lineman, from the Russian Six Pack (Interplay) uses the same seven objects but different rules. Pieces appear directly on the playing field and can only be rotated, not moved. The goal is construct loops, which collapse, not paths from one place to another. Excellent game.
Here the player is rotating a piece just above the middle of the board. Pieces rotate only 90° clockwise. Shaded pieces cannot be rotated. New pieces keep appearing around the perimeter of the growing mass of pieces. The game ends when the board is full.
EXAMPLES

Fool’s Errand, Incredible Machine, Puzzle Zone

Three games,
Three genres

Here are other puzzle games that demonstrate some of the design challenges in other puzzle game genres.
The Fool’s Errand

“Who dares to interrupt my errand?” he demanded impatiently.

Disheartened, the fool wandered toward a small cave in the side of a sloping hill. As he peered into the darkness, a fierce lion leapt out of the shadows and pinned him to the ground.

“Stop, my pet!” a voice commanded and out stepped a beautiful woman in a white silk robe. “I am Strength. Why have you come here?”

As she petted her lion, the fool eagerly stated the purpose of his errand.

“Ah, but such a task would take an ERA,” the woman advised.

“Then you cannot help me?” the fool replied sadly.

“But I have,” insisted Strength. “It is you who do not listen very well.”
The puzzles use a bold silhouette style that looks good on the small black and white screen. The puzzles are based on familiar puzzles, so they can be played without instruction, yet have original twists that set them apart from the ordinary.
The Fool’s Errand

Solving a puzzle unlocks a piece of a larger “meta-puzzle” called the Sun map that unifies the game. By the end of the game the player can assemble a map of the fool’s journey. To get to the end game, the player must also read the entire story in sequence, looking for clues.
The Fool’s Errand plays to the computer’s strengths, instead of fighting the medium. Previous to Fool, Cliff created a puzzles for “mystery weekends,” in which people gather in a real location to solve a simulated crime. After Fool, Cliff created 3 in Three, and other games.
The Incredible Machine (TIM) is a construction puzzle game. There are three important design decisions. Decision 1: allow the player to build things. SimCity, shown above, allows construction, but does not give the player a fixed goal and is thus a toy, not a puzzle.
The Incredible Machine

Decision 2. No realtime decision making. In contrast, Lemmings, shown above, requires players to solve the puzzle by repositioning lemmings while they are walking around. In The Incredible Machine, building and running machines happen in separate modes.
Decision 3: Player authoring. In contrast, Marble Drop, shown here, has separate build and run modes, but does not allow the player to construct original puzzles. Instead, all the puzzles come preconstructed, which allows Marble Drop to have beautifully rendered screens.
In The Incredible Machine, players can build their own puzzles in a separate freeform construction mode, separate from puzzle mode. The goal of this particular puzzle is to get all balls into all the aquariums using a motley collection of ropes, pulleys, ramps and other devices.
The Incredible Machine

- Physical simulation
- Player authoring
- Integrated controls

The designers of TIM did a brilliant job of including a broad range of play elements that all interact with one another within a rich physics model, while keeping the user interface simple and obvious.
The Puzzle Zone on America Online [editor’s note: now on boxerjam.com] is a good example of an online puzzle. Following the model of newspaper puzzles, Puzzle Zone delivers four new puzzles every day. The puzzles add new twists to familiar word games.
Flexicon, shown above, is a twist on a crossword puzzle. The problem with crossword puzzles on computer is that the screen is too small to hold a large puzzle. The solution here is to save space by overlapping four rectangular regions, only one of which is visible at a time.
Strip Search adds new twists to the familiar word search. The theme here — Joes — was inspired by the topical event of Joe Dimaggio’s death. Found words appear in order of length, giving the player a hint. When all words are found, the leftover letters form a witty phrase.
Finally, the Puzzle Zone also includes elements that build community and encourage players to keep coming back: message boards, high score boards, and a place to buy branded merchandise.
The puzzles in Puzzle Zone are somewhat mundane and obvious, but that is not a bad thing. By using familiar puzzle types, the Puzzle Zone lowers the barrier to entry. Furthermore, word games require very little data to be downloaded, so play is snappy.
CASE STUDY

Jesse’s Strips

Recent design experience with 3 aha’s

Jesse’s Strips, designed by Alexey Pajitnov, is one of a number of image-based puzzles from Pandora’s Box (Microsoft)
Jesse’s Strips

CONCEPT

- To make jigsaw puzzle using long narrow pieces (strips)

One of the members of the Pandora’s Box team, named Jesse, suggested the concept of a jigsaw puzzle in which the pieces are long narrow strips. (By the way, Oddz On, a division of Hasbro, recently introduced a physical puzzle of this sort called Slivers.)
Jesse’s Strips

PROBLEM

- The playing field is too messy.

The problem with long skinny pieces, however, is that the playing field gets too messy.
This is a common problem with jigsaw puzzles on computer: it is hard to make room on a computer screen for both the finished puzzle and a holding area where unplaced pieces live. Physical jigsaw puzzles can be spread out on a table.
Jesse’s Strips

Problem:
The playing field is too messy

Solutions:

- Stack the pieces  
  No, bad visibility!
- Separate picture and pieces in different windows  
  No, lose natural UI
- Enlarge the space for more than one screen  
  Yes, but how?
- Scroll the playing field  
  No, awful UI
- Paginate the playing field  
  Yes!

I considered many possible solutions before hitting on the idea of spreading the pieces across several different pages.
Jesse’s Strips
First AHA:
To make multiple pages and repeat the picture in progress on each of them, distributing the pieces.

This was the first Aha.
Jesse’s Strips

Problem:
Player does not understand what happens when pages switch

Solutions:

- Change picture position
  - No, takes too much space
- Change background look (color, texture)
  - No, still unclear
- Use animation for changing pages
  - No, too “expensive”
- Change picture in progress.
  - Yes!

But this insight raised another problem...
Jesse’s Strips
Second AHA:
To emphasize certain color for the picture on each page; to do the same with the pieces on the page.

Which in turn required a second Aha.
Jesse’s Strips

Problem:
We need to move the pieces from page to page now and User Interface become too complicated.

Solutions:
- Work on UI: Yes, but we can’t do much
- Connect the piece movements with rotations: Yes!

The final insight was motivated by wanting to keep the user interface simple. Instead of separate commands to rotate pieces and changes pages...
Jesse’s Strips

Third AHA:
To move the piece to the next page together with the 90 degrees rotation.

The two things happen together. This is a good example of how the difficulties in realizing a particular puzzle concept can guide the designer toward novel solutions.
Jesse’s Strips

Third AHA:
To move the piece to the next page together with the 90 degrees rotation.

**PROS:**
1. UI is easier - no pieces selection...
2. Extra chance for hints

**CONS:**
1. Extra rule to explain to player...
2. Not intuitive

Final decision: NO

In the end, however we decided against this clever solution, because it was too hard for the player to understand.
Here is a screen shot from the final product. A lot of work went into giving the game a sumptuous look.
CASE STUDY

The Next Tetris

Designing levels for a sequel to a classic computer puzzle game

This case study illustrates some of the techniques you can use to design a series of puzzles that teach a player the rules of a game. The Next Tetris, recently published for Playstation and PC, is a sequel to the classic action puzzle game Tetris. TNT includes a practice mode that is a series of puzzles.
Tetris is the most popular electronic popular game of all time, with about 50 million copies sold and still going strong. It is the epitome of simple and deep, and has a reputation for being highly addictive. It started the genre of action puzzle games.
So How Can It Be Improved?

1. Same basic gameplay
2. Deeper strategy
3. Better play modes
4. Cooler graphics
5. Easier to learn

The Tetris Company, half owned by Blue Planet Software, continues to update Tetris. The latest incarnation is a pair of games with confusingly similar names — The Next Tetris and The New Tetris — that strive to add new depth while retaining the familiar gameplay.
Let’s look at The Next Tetris, published for Playstation and PC (Hasbo Interactive). Like all Tetris sequels, it includes the original game, plus new modes of play. The idea for TNT was developed by its programmer Vlad, who tried many variations before settling on this one.
The first requirement for TNT was backward compatibility — anyone who knows Tetris should be able to pick up this game and immediately start having fun, without having to unlearn anything. This required a rotation scheme that subsumes every other rotation scheme ever released — a major feat of design.
Challenge 2: Deeper Strategy

- Pieces fall to lowest level
- Blocks of same color join
- Multicolored pieces break apart
- = Cascades

The new feature in TNT is “gravity”. When you clear a line, blocks above it fall instead of staying suspended. When similarly colored blocks land adjacent, they stick. Some pieces are made of several colors. Clearing a line can cause a cascade which then clears more lines.
Challenge 3: Better Play Modes

- **Sprint (vs. Marathon)**
- **Goal: clear bottom line of garbage**
- **Initial garbage does not fall**
- **Handicapping for multiplayer game**

Original Tetris is a “marathon” — play till you drop. For good players, there is no such thing as a short game. To solve this problem, TNT adds a “sprint” mode in which the game ends when a certain number of the initial lines of “garbage” are cleared.
Challenge 4: Cooler Graphics

- 3D physics in a 2D game
- Board spin
- Continuous motion
- Jostling

Of course new game machines bring higher expectations for graphics. TNT features full 3D motion physics. 3D effects are used only where they add to gameplay, e.g. in multiplayer mode clearing several lines spins your opponent’s board, making it harder to play.
Finally, several features make TNT easier to learn, such as a voiceover that explains the rules as you play. There are also tutorial puzzles in “practice” mode. A more sophisticated algorithm could have let the game offer suggestions in response to your actual play.
Designing Levels: The Task

- 13 fixed piece sequences
- Only uncolored initial garbage
- Submit designs on paper

My assignment was to design a set of puzzles for the practice mode. Because time was short, I had to work with limited design tools, and submit designs on paper. I was given a fixed set of 13 piece sequences to choose from. Fortunately this gave me plenty to work with.
Designing Levels: Strategies

- Ranked easy to hard
- Teach gameplay techniques
- Each puzzle has a clear focus
- Limit of 4-8 pieces per solution

Since the puzzles were intended for a tutorial practice mode, I focused on teaching the player basic techniques through sequenced puzzles. I limited the number of pieces per puzzle to about 6 — few enough that you can remember them all. More gets too hard.
Tactic 1. Start with a Bang

The first puzzle should be easy. But easy doesn’t have to be boring. This gem, by TNT producer Steffan Levine, tempts you to place the T piece tail down, clearing two lines. But this is TNT, not Tetris. To clear the bottom line in one move you must rotate the T tail up.
Tactic 2. Teach Techniques

The goal in all my TNT puzzles is to clear the bottom line. A basic TNT technique is “delayed drop,” which is like triggering a trap door. First you drop a piece onto a layer covering a hole, then use a second piece to clear the layer, allowing the first piece to drop into the hole.
Tactic 3. Gradual Complication

I teach the delayed drop through a series of puzzles. All puzzles use the same sequence of four pieces. The first puzzle is easy and has no delays. The second requires a little planning to accomplish three delayed drops. The third puzzle is harder still, with fragmented holes.
A completely different approach is to start with what it looks like, instead of how it works. Here I drew the word Tetris, then looked for a solution. The key here is to clear the second to bottom line first, then spin pieces into place. Not the most elegant technique, but adequate.
Tactic 5. Develop a Theme

Inventing a lot of puzzles is hard work, so I look for themes that can carry me through several puzzles. Here the theme is that the garbage blocks form a giant sized Tetris piece. Within the theme I tried to make the puzzles as varied as possible.
How far could I push the delayed drop? I came up with this mammoth delayed drop. Placing the last piece causes a 10-level cascade, far beyond anything that would ever occur in normal play. Not hard to solve, once you get the idea, but immensely satisfying to watch.
Tactic 7. Do the Unexpected

This is the last and hardest puzzle in TNT. The checkerboard pattern in the middle is a nightmare. There is a red herring: the I piece does not drop into the right-hand slot, as you might expect, but into the middle, where it prevents the yellow blocks from sticking together.
Tactics for Designing Levels

1. Start with a Bang
2. Teach Techniques
3. Lead up to a Hard Puzzle
4. Develop a Theme
5. Paint a Picture
6. Exploit a Feature
7. Do the Unexpected

When I design levels for a puzzle game, I try to give each puzzle a clear, focused theme worthy of being given a name. Beyond that I try to make different puzzles as different from each other as possible, by using a wide variety of design tactics.
Lessons Learned

- Keep puzzles tightly focused
- Include both very easy and very hard
- Build a flexible level editor
- Plan early for player authoring

Over all, designing the TNT puzzles went smoothly. The key was to keep the puzzles tightly focused by limiting the number of pieces in a solution. My job would have been easier had there been a level editor program.
CASE STUDY

Scott Kim’s Puzzle Box

Creating a monthly puzzle for a children’s web site

The second case studies a monthly puzzle called Scott Kim’s Puzzle Box, which Scott created for the kid’s online service Juniornet. This example highlights issues in designing puzzles for the web.
JuniorNet is an online service that gives kids a safe, fun, rewarding, and ad-free experience. Content comes from such well known brands as Highlights and Weekly Reader. Subscribers receive a CD-ROM, with more frequently updated content streamed across the internet.
My feature on Juniornet is an original content area called Scott Kim’s Puzzle Box, which delivers a new collection of puzzles every month. The type of puzzle changes from month to month. Players can create their own puzzles, some of which are posted on the site.
Design Challenges

1. Adapt existing physical puzzles
2. Efficient production pipeline
3. Player authoring

Producing a rich puzzle experience on a monthly schedule posed several design challenges.
Challenge 1: Adapt Hiroimono

- Hiroimono = “Things Picked Up”
- 500 years old
- From Japan

All the puzzles in Puzzle Box are adapted from existing puzzles. For instance, the first puzzle, Pet Tricks, is adapted from Hiroimono, a popular puzzle from Japan traditionally played with Go stones.
Changes to Hiroimono

- Animated characters
- Motivate the goal
- Embody the rules
- Specify start position

To make Hiroimono friendlier to kids I embodied the rules in the characters of a dog that is eating pet treats, and a cat that prevents the dog from backing up in the direction it came. Even with words, kids could be attracted to the game and have a sense of what it is about.
Challenge 2: Adapt Tangrams

- Worldwide popularity
- Hundreds of versions
- 200 years old
- From China

Another puzzle is adapted from the classic puzzle Tangrams. Seven simple geometric shapes, cut from a square, fit together to make thousands of pleasing silhouettes of people, animals and other familiar shapes. Dozens of computer versions exist.
Computer adaptations of physical puzzles often fail because moving pieces with a mouse is harder than by hand. My solution: restrict piece positions to a square grid. Fewer shapes can be made, but the game is more fun. I also allow fewer or more than seven pieces.
In order to control production costs, I planned a modular structure that would allow most of the site to stay the same from month to month. These basic features are always the same.
The type of puzzle changes every month. Instead of building 12 completely different puzzle templates, I reuse 4 basic templates, with minor changes to create 3 variations each.
Every month I deliver 15 puzzles that I created, and 24 puzzles that kids create.
Production is structured so that the most difficult pieces to build change the least often. Templates change only once every three months. The monthly template variations require only art changes. Finally, puzzle specification requires only compact text files.
Players can create and submit their own puzzles. In order to keep puzzle creation kid friendly, I chose puzzles that are relatively easy to author. And I require that players solve their puzzles before submitting them, so I don’t receive puzzles that don’t work.
Lessons Learned

- Start small
- Roll out features gradually
- Prepare to handle player feedback
- Reusable templates

The biggest lesson I learned applies to all online games: start small, and add new features gradually over time. This lets you start quickly, and tune your design based on actual player behavior. In retrospect my initial design for Puzzle Box was too ambitious.
TECHNIQUE
Puzzle Game Design

In eight easy steps

How do you go about designing a puzzle game from scratch?

Scott Kim
The Eight Steps

1. Inspiration
2. Simplification
3. Construction Set
4. Design Specification
5. Levels
6. Testing
7. Sequence
8. Presentation

Here are the eight steps in designing a puzzle game. The process splits into two halves: specifying the rules, and building the puzzles.
1. Inspiration: Previous Game

Where do ideas come from? Here are six ways to get inspired. First, you can look to a previous game. Tetris was inspired by an existing mathematical game called pentaminoes. Tetris in turn inspired Welltris and host of other Tetris spinoffs.
1. Inspiration: Technology

1. Nonphysical moves (Tetris)
2. Algorithmic levels (Pit Droids)
3. Enforce the rules (Sokoban)
4. Allow undo (Solitaire)

If you are going to design a computer puzzle, don’t just copy a puzzle from another medium. Instead, think about how the computer can enhance gameplay. Eight ways are listed above. Thinking about the technology first can inspire ideas for new types of puzzles.
1. Inspiration: Play Mechanic

Every computer game, at its core, has a play mechanic — a basic way that the player interacts with an object — that gets used over and over. Endorfun, for instance, was inspired by the play mechanic of a cube rolling on a square grid, controlled by the four cursor keys.
Like songs, puzzles can be inspired by real life. Stephen Sondheim: A good clue can give you all the pleasures of being duped that a mystery story can. It has surface innocence, surprise, the revelation of a concealed meaning, and the catharsis of solution.
1. Inspiration: Story

Adventure games like Myst are built around the elements of story: plot, character, setting, and mood. When you design puzzles for story-based games, look for puzzles that arise naturally out of the environments and situations, and help advance plot or reveal character.
1. Inspiration: Art

The story game Obsidian started as a series of concept sketches for characters and environments. Story and puzzles came later. Similarly, the puzzle game Spin Doctor (later renamed ClockWerx) started as a graphic concept by an artist on the project.
2. Simplification

The second step is to whittle the concept down to manageable size. Say we wanted to make a puzzle based on the tricky core skill of parking a car in a crowded lot. We eliminate irrelevant details and make pieces uniform by conforming them to a square grid.
3. Construction Set

- Programmer: reusable code
- Rule designer: tweak rules
- Level designer: build levels
- Player: build levels

The only way to test a puzzle concept works is to play it. So the next step is to build a construction set that makes it easy to build puzzles of a certain type. Sometimes a paper prototype is adequate. Once the rules are set, other people can use the construction set to build levels.
4. Design Specification

- Board — grid, network, irregular, none
- Pieces — shape, image, attribute, supply
- Moves — sequential, side effect, primary
- Goal — exact match, partial, condition

Now it is time to write a detailed design specification. Most puzzle game specs will describe puzzles in terms of board, pieces, moves and goals. In addition a design spec may also cover the user interface, scoring, story, art, sound and other aspects of production.
Schematically, a puzzle challenges the player to get from a problem to a solution.
But of course the path is never simple. Every puzzle requires that the player make choices, some of which lead to dead ends.
Puzzles in a game have a larger situation that gives the puzzle meaning. Applying the solution lets you move forward in the game.
Good puzzles have require insight. The insight above is to walk around the outside of the maze. Obsolete insights, however, feel unfair.
Different puzzles emphasize different parts of the journey. Persistence puzzles are a slow steady climb. Aha! Puzzles skip the climb and go straight to the insight. Story puzzles work the setup into the story. Crossword puzzles are full of little insights: each word unlocks more.
6. Testing

- Is it fun?
- How hard is it?
- Are there simpler solutions?
- Can it be improved?

The only way to find out whether a puzzle is fun is to watch someone play it. Often a puzzle you think is easy will turn out to be hard, or vice versa. Sometimes players will find simpler solutions. Or you will realize that the puzzle needs some other improvement.
Next you must put the levels into sequence. Linear is simplest, but can get tiring. A better organization is the sawtooth, which keeps going back to easy puzzles, or to give players freedom to play puzzles out of order. Metapuzzles motivate players to complete the whole game.
7. Sequence: Transitions

- Learning the rules
- Recovering from failure
- One puzzle to the next
- One section to the next

You also need to think about the transitions between puzzles. Whenever the player moves from one place to another in your game, there is an opportunity to lose the player’s interest. How can you bridge these gaps?
Finally there are all the matters of presentation that turn an abstract puzzle into something people can see, hear and touch. I won’t go into detail on production for puzzle games.
Designing puzzles for adventure games has its own special issues. Bob Bates is a veteran adventure game designer.
Outline

- Puzzles for Adventure Games
- What Makes a Good Puzzle?
- What Makes a Bad Puzzle?
- Levels of Difficulty
- How to Design the Puzzle

This talk is based on the presentation “Designing the Puzzle,” available in the proceedings of the 1997 Game Developers Conference.
Building Puzzles for the Web in Shockwave

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Gary Rosenzweig is head of CleverMedia, which creates Shockwave, Flash and Java games for its own gaming sites (e.g. gamescene.com) and for other clients.
Outline

- What are Web-based games?
- Technologies: Shockwave, Flash, Java, etc.
- Design Issues: Distribution, Access, Purpose
- Case study: “Check Out Line”
- Case study: “Event Horizon”
- What you need to know to build Shockwave games

For more information about building Shockwave games, see Gary’s book “Advanced Lingo for Games,” (Hayden Books), and Macromedia Flash 5 ActionScript for Fun & Games (Que).
Case Study: Check Out Line

Check Out Line is an engrossing randomly generated puzzle game based on the popular Japanese shareware game Makigame. It includes a high score board and the ability to switch among several different sets of graphics for the pieces.
Case Study: Event Horizon

Event Horizon takes Check Out Line and wraps it into a cylinder. Same gameplay, but completely different effect. Unlike Check Out Line, Event Horizon is processor intensive, and runs well only on higher-end machines.
We weren’t sure what to expect with the Puzzle Exchange. We viewed it principally as a way to extend the life of the Pit Droids product, as well as an extension of the build-and-create model of our product line. Starwars.com agreed to host the site, which has obvious traffic and exposure benefits, but the development and implementation was less than smooth, since we are such a small part of their business. The puzzles that we have received have been amazing. I think there is something about posting to the web which makes folks self-select for quality. What has been most striking to me is the new uses of our puzzle pieces that we see in the user-submitted puzzles.
The Puzzle Exchange is an experiment.
Getting it running proved challenging.
Submitted puzzles have been of incredibly high quality.
Puzzle Exchange fan sites have cropped up.
Revenue stream? Who knows?
Exchange has provided a unique glimpse into what people do once they get the game.

We are unsure about a revenue stream for the site, however one possibility we are entertaining is to package and sell the puzzles we receive as exclusive puzzle packs. We are also counting on our fan base to promote the game through word-of-mouth. Additionally, the feedback is invaluable in terms of honing our design sense for next time. It has been a truly unique and gratifying experience for me to be able to witness how people are using the product in their living rooms. [Editor’s note: the puzzle exchange is no longer on the Pitdroids site as of June 2001.]
Pit Droids is a classic puzzle game, in the tradition of Lemmings, in which your goal is to direct Pit Droids (from Star Wars Episode 1) towards goals in a variety of settings on Tatooine. There are 8 levels, and over 400 puzzles in the game.
This is a very simple puzzle in Pit Droids, one that would be encountered at the first level. The player has placed a single arrow tile on the ground, which redirects the stream of droids toward their goal.
This is the Puzzle Maker area, where players can create their own puzzles. The goal was to provide a familiar, straightforward interface with levels of complexity buried beneath the surface.
This is the Puzzle Exchange, where players can check out, download and vote for puzzles others have posted, as well as submit their own puzzles to the Exchange. Exchange puzzles can be browsed by votes earned, puzzle creator, puzzle name, or date submitted. Tables display the top five puzzles as well as the top five puzzle creators (based on votes).
PROJECT

Headliners

Inventing ideas for puzzles based on today’s headlines

At last year’s puzzle tutorial we did a similar exercise. The group divided into teams. Each team got a copy of today’s San Jose Mercury. From the paper, each team invented an idea for a puzzle game based on a story or ad. Finally the groups pitched their ideas to the whole class. Here are some highlights.
Termite Control

- You are a termite
- Goal: eat a floor
- Obstacle: humans

Like most of the puzzles this is a character-driven action game that has been turned into a puzzle game by putting it onto a grid and turning real time action into turn based strategy.
Prison Shuffle

- Put prisoners in cells
- Avoid bad combos
- Can shuffle cells

A dynamic allocation puzzle. Prisoners are arriving at a jail. Allocate them to cells while avoiding certain bad combinations, such as an escape artist plus someone who has a key. Shuffling prisoners between cells takes time.
Cubicles

- Fit cubicles in floor
- Leave path to doors
- Dilbert license?

A clever idea that falls naturally out of a real situation. Irregularly shaped cubicles made of square modules are to be fit within a floor of a building. Additionally, every cubicle must have a clear path from its door to a building entrance.
Get Barbie Home

- **Bust Out Barbie**
- **Barbie Queue**
- **Ken’s Magnetic Personality**

A story about homeless Barbie inspired the most ideas. Get Barbie Home had Barbie wandering through the back streets of a city. Bust Out Barbie required chain smoking Malibu Barbie use Fashion Barbie’s hairspray to fashion a homemade bomb and stage a jail break.
PROJECT
Physical to Computer

Turn a physical puzzle into a computer game

Get into groups of five. Pick a physical puzzle from our collection. Also pick a story from today’s newspaper. Combine the puzzle and the story to create an idea for a new computer game. Avoid literally copying the original puzzle. Present the idea to the whole class.
Look to Physical Games for Ideas

Don’t just look at other computer games for inspiration. There are thousands of time-tested physical puzzles waiting to be turned into computer games.
Literal Translation Can Fail

- Rubik’s Cube works poorly on computer because 3D manipulation is awkward.

But beware: literally translating a puzzle into software often fails, because what is fun to do with your hands is different than what is fun to do with a mouse or game controller. Rubik’s Cube, for instance, works terribly on computer, because you can’t turn it easily.
Instead, Identify the Essence

- Rubik’s cube is a permutation puzzle
- Like sliding block
- But always move several pieces simultaneously

Instead of literally copying a physical puzzle, abstract out the essence of what makes the puzzle tick…
Then Translate the Essence

- *Cogito*
- A 2D permutation puzzle
- Slide whole row or column, with wraparound

Then express the essence in software in a way idiomatic to the computer medium.
Ask Yourself

- What do you give up?
- What stays the same?
- What do you gain?

Any time you translate a physical game into the computer realm, ask yourself these questions.
Combine with a Newspaper Story

Prison numbers reach new high

1.8 million are jailed despite drop in crime

By Fox Butterfield
New York Times

The number of inmates in the nation's jails and prisons rose again last year, to a record 1.8 million, though crime rates have dropped for seven consecutive years, the Justice Department reported Sunday.

In a new study of the factors in the continued expansion of the number of prison inmates, Alfred Blumstein, a criminologist at Carnegie Mellon University, and Allen Beck, a prison specialist at the Bureau of Justice Statistics, calculated that 40 percent of the growth was attributable to increases in the number of people actually sent to prison per arrest and 60 percent to longer time served by inmates.
Design 3 Levels, Show to Group

From a presentation of a game idea at the 1999 Game Developers Conference Puzzle Design tutorial. The assignment was to create a hybrid of Sokoban and a word game. The challenge here is to push the letters to spell a word.