3 Introduction to Computer Game Programming

Literature:

Chris Crawford: The Art of Computer Game Design,
http://www.vancouver.wsu.edu/fac/peabody/game-book/Coverpage.html

Andrew Rollings, Dave Morris: Game Architecture and Design,
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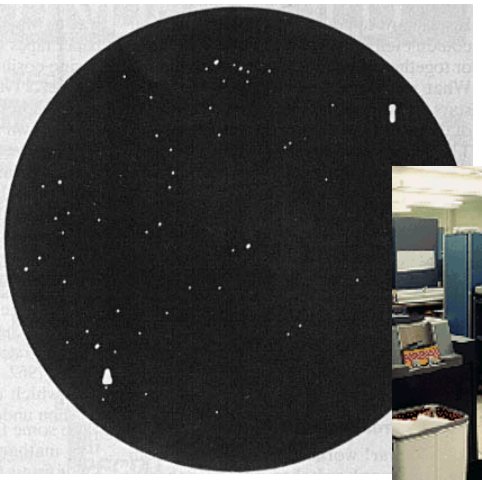
Game Design Fundamentals, MIT Press 2004

Why Computer Games in this Lecture?

- Computer game programming aims mostly at an immersive experience for the user
  - Same motivation is in the background for multimedia programming
- Game programming is a special case of multimedia programming
  - Uses highly interactive graphics, sound etc.
- Computer game programming is a huge market
  - But mostly ignored in university education
- Macromedia Flash is an adequate platform for simple computer game programming
  - Considered too slow by most game programmers
  - But flexible, net-based, cross-platform, ...

"A game designer does not create technology.
A game designer creates an experience."
Salen/Zimmerman

SpaceWar: The First Computer Game (?)



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History of Computer Games

- 1962: First computer game “SpaceWar”
- Early 1970s: First commercial video game “Pong”
- Late 1970s: First text based adventure game “Adventure”
- 1980: Pac Man
- 1989: Nintendo Gameboy
- Early 1990s: Multiplayer action game “Doom”
- Mid 1990s: “Deep Blue” wins a chess game against world champion
- 1994: Sony Playstation
- 1998: Action game with level editor “Unreal Tournament”
- 2000: Microsoft XBox, Sony Playstation 2
- Current:
  - Mini games for mobile devices (phones, music players)
  - Multi-user online games (e.g. Ultima Online)

Pong

Doom

Unreal Tournament

(Partial) source: Elisabeth André

Eras of Computer Games

- Era 1: Simply programmed games for specialists
  - High quality by competition & selection
- Era 2: Mass-market consoles
  - Quality partially problematic
  - "Platform games"
- Era 3: High-performance (3D) graphics technology
  - Presentation as important as game rules

Three eras according to Rollings/Morris

- Era 4: Online multiplayer games

- General observation:
  - Core game mechanics do not develop dramatically
  - Really new game ideas are rare
  - Game industry is conservative

Definitions of Games (1)

- Examples of games
  - Board games, card games, athletic games, children's games, and: computer games
- Johann Huizinga (Dutch anthropologist, *Homo Ludens* 1938):

  "[Play is] a free activity standing quite consciously outside 'ordinary' life as being 'not serious', but at the same time absorbing the player intensely and utterly. It is an activity connected with no material interest, and no profit can be gained by it. It proceeds within its own proper boundaries of time and space according to fixed rules and in an orderly manner. It promotes the formation of social groupings, which tend to surround themselves with secrecy and to stress their difference from the common world by disguise of other means."
- Elliot Avedon, Brian Sutton-Smith (*The Study of Games* 1971):

  "Games are an exercise of voluntary control systems, in which there is a contest between powers, confined by rules in order to produce a disequilibrial outcome."

Definitions of Games (2)

- Fundamental elements common to all games (Chris Crawford 1982):
  - Representation
    - » Closed system with explicit rules subjectively representing a subset of reality
    - » Games are objectively unreal, subjectively real
  - Interaction
    - » Reaction to actions of the player
    - » Is a race a game?
  - Conflict
    - » Goals of the player <—> obstacles
    - » Violence is the most natural expression for conflicts
  - Safety
    - » Experience of dangerous situations without real risk

Why do People Play Games?

- Games are the natural way of education
  - The question “Can games have educational value?” is slightly absurd
  - Good education has characteristics of a game
- Games lead to perfection of some skills
- Further motivations:
  - Fantasy: Escape from the tawdry world
  - Nose-thumbing: Overcoming social restrictions
  - Proving oneself: Competition
  - Social lubrication
  - Exercise
  - Need for acknowledgement
  - Sensory gratification: Immersive experience

Computer as Game Platform

- Interactivity
  - Fast reaction
  - Fully flexible
  - High-quality output towards user
  - Limited input from user
- Manipulation of information
  - Limited information given to players
  - Can act as referee
  - Can perform large administrative tasks
- Automated complex systems
  - Real-time play
  - Intelligent non-human opponent
- Networking

Games and Similar Concepts

- Game vs. Simulation
  - Simulation for computational or evaluative purposes, game for educational or entertainment purposes (middle ground: Flight Simulator)
- Game vs. Toy
  - Toy is more manipulable in the ways it can be used
- Game vs. Puzzle
  - Game is interactive, may involve many players
  - A game relying on puzzles loses its challenge once all puzzles are solved
- Game vs. Interactive Fiction
  - Interactive fiction is a story with branches
  - Game is more interactive than storytelling, many ways to explore causal relationships are possible, surprise effects may be lost
  - Game may be based on story

Taxonomy of Computer Games (1982 & 2004)

- Skill & Action games (targeting perceptual and motor skills)
  - Combat games
  - Maze games
  - Sports games
  - Paddle games
  - Miscellaneous games
- Strategy games (targeting cognitive effort)
  - Adventures
  - Dungeons & Dragons (D&D), now Fantasy Role Playing (FRP) games
  - Wargames
  - Games of chance
  - Educational games
  - Interpersonal games
- Trend: Fusion of various game classes

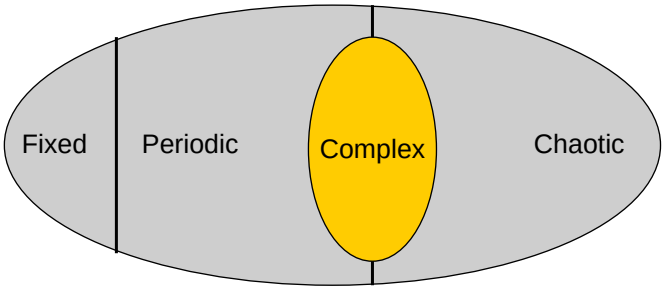
Chris Crawford 1982

Alternative taxonomy (Rollings/Morris 2004):
- Action
- Adventure
- Strategy
- Simulation
- Puzzle
- Toy
- Educational

Pure Strategy Games: Logic Games

- A logic game may take 10 minutes to make and 20 minutes to play a round...
  - Simple rules, simply coded --> excellent gaming experience
  - Minimal set of logical rules can allow huge numbers of different games to be played
  - Keep problem solvable (sometimes extremely difficult for the author)
  - Avoid too simple solution strategies
- Example: Rules for checkers
  - You move your pieces in a diagonal fashion, always forward.
  - If one of your pieces ends up diagonally adjacent to your opponent's piece, you may jump over his piece as long as your piece lands in an empty square. At this point, his piece is removed from the board.
  - You may take more than one of your opponent's pieces at a time if your diagonal jumps make this possible.
  - When your piece reaches the far end of the board, it is turned into a king, and then it earns the right to move diagonally forward and backward.
  - The game is over when you've taken all of your opponent's pieces or he's taken all of your pieces.

System Categories (Christopher Langton)



- Interesting games are cases of complex systems

Levels of Randomness

- Games include a level of *uncertainty*
- Purely strategic games (logic games)
  - Uncertainty through complexity
  - Uncertainty through behaviour, skill of opponent player
- Pure risk games, fully random
  - Certainty about the outcome on a stochastic level
  - Examples: Lotto, Roulette
- *Uncertainty*: Both players have no idea of the final outcome
  - Open-ended-ness
- Feeling of randomness
  - May be created by multi-player behaviour even in purely strategic games
  - Example: Chinese checkers (Halma)

Dimensions of Games

- Rules
  - Game as a formal system
  - Complexity, randomness, balance
- Play
  - Game as an experience
  - Immersiveness, rewardingness
- Culture
  - Game in context
  - Communication, community building, symbolic value

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Computer Games as a Dramatic Form

- Following the six elements of dramatic form (Aristotle)
- **Plot** *(mythos, Handlung)*
  - What happens
  - Closed, with defined start and end
- **Theme, Thought** *(dianoia, Absicht)*
  - What is illustrated and illuminated
- **Style, Diction** *(lexis, Darstellung)*
  - The way how things are presented
  - Genre
- **Character** *(ethe, Charaktere)*
  - Personification
- **Spectacle** *(opsis, Schau, Szenerie)*
- **Music, Song** *(melapoiia, Musik, Gesang)*

Key Elements of Story-Telling

Rollings/Morris' toolbox:

- Obstacles
- Foreshadowing
- Personalization
- Resonance
- Resistance
- Plot points
- Suspense
- Dialogue
- Theme
- Resolution
  - Hard won, not obvious, satisfying, consistent, closing

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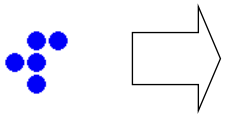
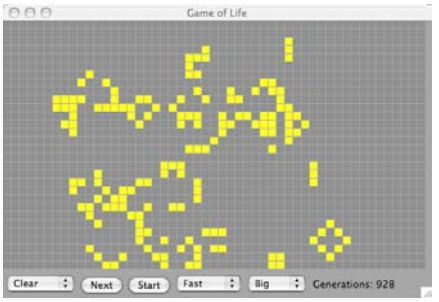
Emergent Behaviour: Convey's Game of Life

Simple rule set:

- For a space that is 'populated':
- Each cell with one or no neighbors dies, as if by loneliness.
- Each cell with four or more neighbors dies, as if by overpopulation.
- Each cell with two or three neighbors survives.
- For a space that is 'empty' or 'unpopulated'
- Each cell with three neighbors becomes populated.





Emergence in Adventure Games

- *Populous: The Beginning*
  - Foreign soldiers stop when seeing a priest chanting
  - After some time listening, the soldiers are converted
  - A soldier who has fought never can be converted
- Emergent strategy:
  - Leave the priests as a defense ring
  - From time to time, move converted soldiers behind the priests!
- Implicitly created rules of game (interaction of explicit rules)

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Game Balance

- Player/Player Balance
  - The art of making a multiplayer game fair
  - Each player does not get advantage beyond his/her skills and some luck
- Player/Gameplay
  - Ensuring a smooth learning curve for the player
- Gameplay/Gameplay
  - Balancing the features of the game against each other

Example: Virtua Fighter

Player–Player Balance

- Is there a “best” fighter e.g. in *Virtua Fighter*?
  - The search for the best character is one of the more interesting parts of the game
  - Functional symmetry vs. presentation symmetry
- Perfect symmetry
  - The story of the two Chinese martial arts heroes, unmoving
- Just-Broken symmetry
  - Aesthetic appeal

Player–Gameplay Balance

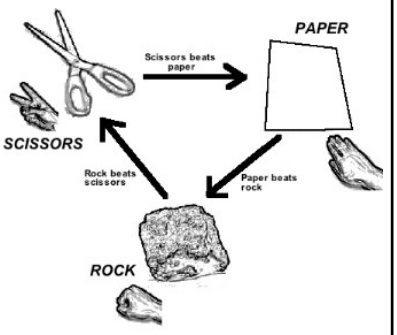
- Crawford: Balancing between the “skills” of computer and human
  - How to challenge a human through a computer?
    - » Vast resources (intelligence balanced with material)
    - » Artificial smarts (reasonable but unpredictable)
    - » Limited information (for human player)
    - » Pace (human cannot follow)
- Smooth learning curve
  - Game is winnable, player is rewarded for progress
    - » Progress opens new options (and does not simply add e.g. strength)
  - Machine does the hard work
    - » Don’t bother the player
  - Design a game to play *with*, not *against*
    - » Avoid the “Save Game” iteration loop

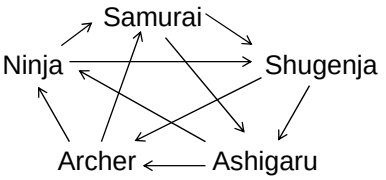
Game-Internal Balance

- Component balance
  - Value of game choice must not be reducible to a simple value relative to other choices
- Attribute Balance
  - Which play value is given by a specific property of a component?
  - May change during course of play
- Central idea for balancing components & attributes on many levels:
  - Intransitive game mechanics

Intransitive Game Mechanics

- The prototype: Scissors – Paper – Stone
  - Transferrable to various weapons, attacks etc
  - E.g.:
    - » Leg sweep beats forward kick
    - » Forward kick beats stomp
    - » Stomp beats leg sweep
- Strategy: Adapt to the frequency by which opponent plays the elements





Payoff Matrizes and Equilibrium Analysis

	Leg sweep	Fwd kick	Stomp
Leg sweep	0	+1	–1
Fwd kick	–1	0	+1
Stomp	+1	–1	0

	Leg sweep	Fwd kick	Stomp
Leg sweep	0	+6	–3
Fwd kick	–6	0	+6
Stomp	+3	–6	0

Net payoff:
$L = 6f - 3s$
$F = 6s - 6l$
$S = 3l - 6f$
(f, s, l frequencies)

Zero-sum game:
$L = F = S = 0$

Strategy:
$l{:}f{:}s = 2{:}1{:}2$

Intransitive Structures and Game Development

- Complex structures may lead to rarely or never used components
- Reduction of complex structures is difficult
  - Stepwise upgrade preferred
- Game design relies on abstract internal “model”
  - Model/logic design vs. interface/presentation design

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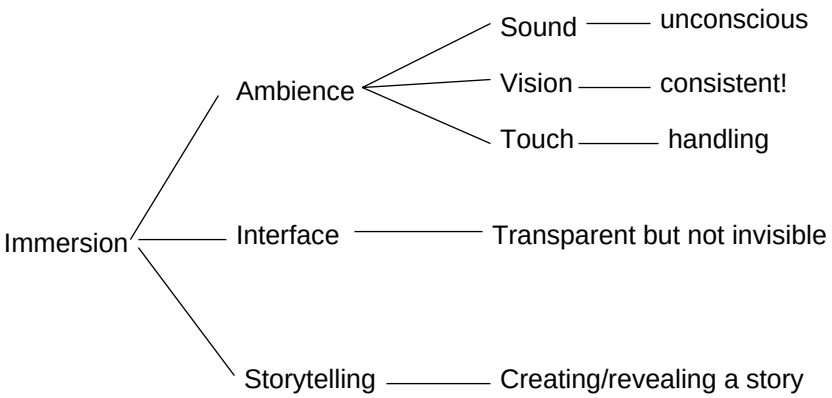
The Game Design Sequence (Crawford 1982)

- Choose a goal and topic
  - Example (Chris Crawford, Eastern Front 1941):
    - » Goal = Nature of war, especially firepower vs. effectiveness
    - » Topic = War between Russia and Germany
- Research and preparation
  - Obtaining background information on the topic
- Design phase
  - I/O structure (interface)
  - Game structure (casual relationships, “model”)
  - Program structure (architecture)
- Rules:
  - Don’t transplant games
  - Design around the interface
  - Keep it clean: Don’t destroy the artistic unit

Programmers and Designers

- Crawford:
  - "Programmers are made but artists are born."
  - The mixed team is like "handcuffing a pole vaulter to a high jumper".
- Rollings/Morris:
  - "Nine out of ten concepts start with nothing but the look & feel." (p. 141)
  - Iterative design must include graphics design early enough
    - » Example from "Warrior Kings", placeholder graphics are not enough

Immersion



Playtesting

- Should not be done too early, some consistency required
- “Real people” are difficult testers
  - Use professionals
  - Carry out interviews
- Project abort is always a possible outcome

History of Computer Game Development

- 1980s:
  - Commodore 64, Sinclair ZX Spectrum, ...
  - 8 Bit, few MHz, 48-64 kB RAM
  - Since then: “write to the metal” attitude of game developers
- 1993:
  - DOS era (16 Bit addresses, 640 kB memory)
  - Doom mainly written in (Watcom) C
- Windows 95:
  - Transition to 32 Bit, DirectX, Microsoft C++ partially used
- Today:
  - On the verge to 64 Bit, DirectX, OpenGL accepted
  - C++ still considered too slow by some developers...
  - Geme engines
    - » e.g. Quake (specific)
    - » e.g. GameEmbryo (generic)

Modeling in Game Design

- Many of the game aspects can be modelled abstractly
- Statecharts for characters, components etc
- Class diagrams for components, worlds, ...

- Currently modeling techniques, MDA etc. not yet frequently used