



LUDDY
SCHOOL OF INFORMATICS,
COMPUTING, AND ENGINEERING

Department of Intelligent Systems Engineering

Career Development Game

E101

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1. Problem Definition and Customer Requirements

1.1. Problem Definition

- Initial problem statement:
 - Design a career exploration game geared towards 8th graders in a college and career prep class.
- Revised problem statement after communication with client:
 - Design a career exploration game geared towards 8th graders in a college and career prep class. The game should be fun and interactive, should allow students to explore various career paths within different levels of education, find a career that fits their interests and skills.
- Final problem statement:
 - Design a career exploration game geared towards 8th graders in a college and career prep class. The game should be engaging and educational, including both physical and digital components. The game should allow exploration of career paths within various levels of education.

1.2. Objectives Tree

- The objectives tree (Figure 1) breaks down the main objective into smaller, more specific objectives. It clarifies the steps needed to reach the overall objective.
- Objectives list:
 - Test students' critical thinking and problem-solving skills.
 - Provide a rewarding career path specific to each student.
 - Offer multiple career paths for students to explore.
 - Include basic career information.
 - Cover careers for various education levels.
 - Use a game-based approach with board game elements.
 - Include a broad range of careers
 - Structure a point system where certain responses count towards a career.
 - Ensure the game is fun and engaging while providing educational value.

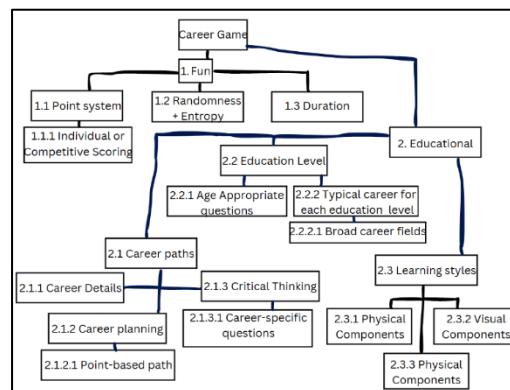


Figure 1: Objectives and constraints tree.

1.3. Pairwise Comparison Chart

- A pairwise comparison chart (Figure 2, Figure 3) pits different solutions and gives the best solution without any bias.

Goal (Fun)	Point system	Duration	Randomness	Total
Point system	...	1	1	2
Duration	0	...	1	1
Randomness	0	0	...	0

Figure 2: A pairwise comparison chart for the “Fun” objective.

Goal (Education)	Specific info	Critical thinking	Appropriate ?'s	Broad careers	Learning styles	Total
Specific info	...	1	1	0	0	2
Critical thinking	0	...	0	0	1	1
Appropriate ?'s	0	1	...	0	1	3
Broad careers	1	1	1	...	1	4
Learning styles	1	0	0	0	...	1

Figure 3: An additional pairwise comparison chart for the “Educational” objective.

1.4. Constraints

- A constraint is a limitation or a restriction that the solution must satisfy.

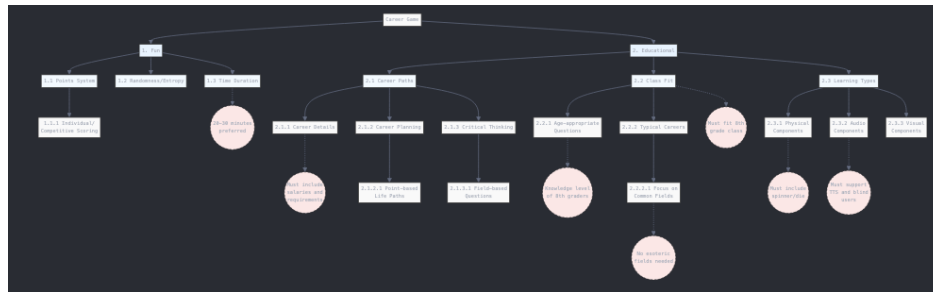


Figure 4: Objectives/constraints tree. Constraints are the circular components.

2. Functional Analysis

2.1. Function Enumeration

- In order to create design alternatives, functions of a game must be determined.
- Functions of an educational career board game include:
 - Player movement
 - Storing and viewing of points
 - Delivering info/education
 - Testing player on information
 - Inclusion of entropy/randomness in the game

2.2. Functions/Means Tree

- The functions/means tree (Figure 5) visually represents the relationship between the main function (teach 8th graders about careers), its sub-functions, and the means used to achieve them. The tree branches from the main goal to the sub-goals, and finally how these goals are achieved through gameplay mechanics.

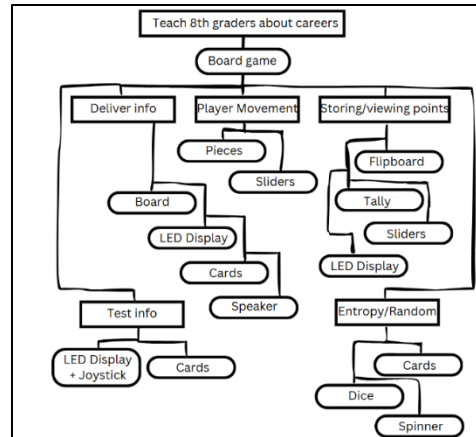


Figure 5: Functions/means tree.

3. Evaluation of Design Alternatives

3.1. Morphological Chart

- The morphological chart (Figure 6) explores various solutions to the design problem by breaking it down into its main functions and identifying possible means for those functions.

Means	1	2	3	4
Functions				
Player movement	Pieces on board	Sliders mounted to board	...	...
Storing/viewing points	Pi display	Paper	Abacus sliders	Flipboard/tally
Deliver career info	Pi display	Cards	Board	Speaker
Test career info	Pi display/joystick	Cards	...	...
Introduce entropy	Dice	Spinner	Cards	...

Figure 6: Morphological chart.

3.2. Design Alternatives Chart

- Three designs for the game were created (See Figures 7-9), with each aimed to prioritize meeting different constraints and performing different functions as well as possible.

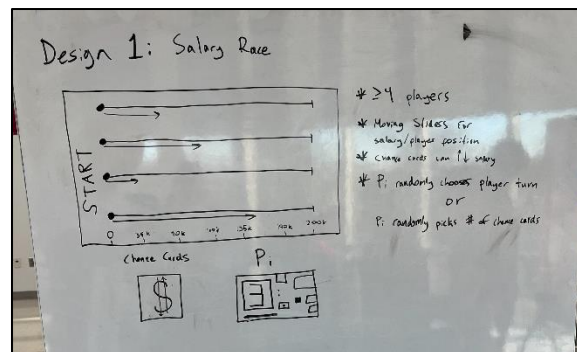


Figure 7: A “Salary Race” in which players race across the board to get the highest salary.

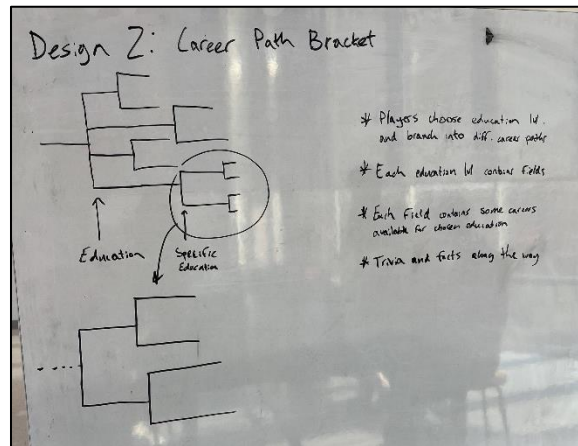


Figure 8: A bracket-style game where players navigate their respective career paths.

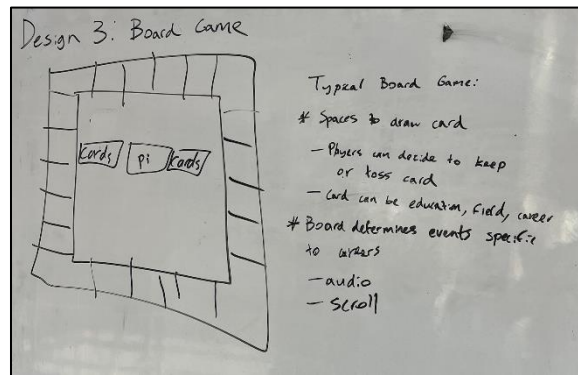


Figure 9: A traditional board-game styled game where players move around the board, landing on different spaces which can trigger certain events.

3.3. Numerical Evaluation Matrix

- The numerical evaluation matrix (Figure 10) compares different designs based on certain criteria. The highest total score determines which design is the best. Design 3, the typical board game design, has the highest total score, indicating that it is the best design.

Objectives (O) Constraints (C)	Design 1 (Salary Race)	Design 2 (Choose your own adventure/bracket)	Design 3 (Typical board game)
No exposed electronics (C)	x	x	x
No sharp edges (C)	80	100	100
Includes physical and digital components (C)	100	80	100
Disability accessible (C)	60	40	50
Random aspect (O)	x	x	x
Ask players questions (O)	60	100	80
Include variety of career paths and education levels (O)	0	50	80

Figure 10: Numerical evaluation matrix.

4. Design Description

4.1. Game Description

- The game and board operate in a linear manner, with players moving from the START to the END. Players utilize a software spinner on the Pi to roll how many spaces they move and receive chance events/answer career questions using the Pi. Players move pieces corresponding to their careers across the board. Certain spaces are linked to certain events, like chance and career spaces.

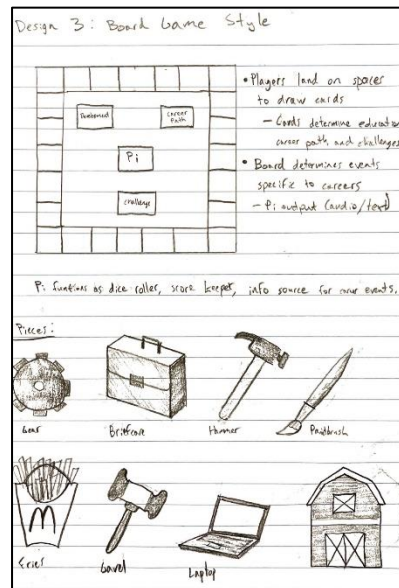


Figure 11: Sketch of an early design concept. Careers, card system, and board's design were all changed.



4.2 How to Play the Game

1. Setup
 - a. Use the joystick to choose how many players you have (1-4)
 - b. Each player chooses a career to follow
 - i. T - trades (wrench)
 - ii. R - retail (shopping cart)
 - iii. F - food service (fries)
 - iv. C - college (more careers within college menu)
 1. S – STEM
 - a. C - computer science (laptop)
 - b. E - engineering (gear)
 2. A - Arts and Humanities
 - a. H - health (stethoscope)
 - b. B - business (briefcase)
 - c. L - Law (gavel)
 - c. Players must choose the game piece relevant to their chosen careers
 - d. On each player's turn, they may choose from:
 - i. E - End turn (after moving & performing any space-related actions)
 - ii. ? - Chance space (career specific event)
 - iii. C - Career space (true/false question)
 - iv. M - Move (spinner)
2. Gameplay
 - a. Once careers are selected and the game is ready to play, the first player will select "M" to move. A spinner animation will play and will determine the number of spaces you move.
 - i. Yellow space - no event
 - ii. Red (career) space - player selects "C" on the menu
 1. Landing on a career space will generate a true/false question. Watch the text scroll on the screen, then select true (T) or false (F).
 - iii. Blue (chance) space - player selects "?" on the menu
 1. Landing on a chance space generates an event that is specific to the player's chosen career. Watch the text scroll on the Pi and take note of the event. The event determines how many points you earn/lose.
3. End
 - a. Game ends once all players reach the "END" space.
 - b. Pi will display winner

5. Final Product Development

5.1 Fabrication Specifications and Designs

- Design: The board was designed in Adobe Illustrator (See Figure 12). The Pi case and game pieces were designed in Fusion360 (See Figure 13).
- Fabrication: The board was cut using a Trotec 300 Laser Cutter within the FabLab. The board was painted with acrylic paint. The Pi case and game pieces were printed using the Prusa MK4 3D printer in the Luddy LLC Innovative Lab.
- Material choices: Balsa wood was used for the game board because it was thin and lightweight, making it the best choice.
- Specifications: The game board is 15in x 15in, with each space being 2.5in x 2.5in. The game pieces are designed to fit within the spaces.

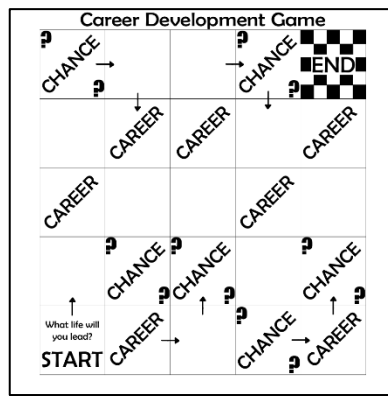


Figure 12: Game board in Adobe Illustrator.

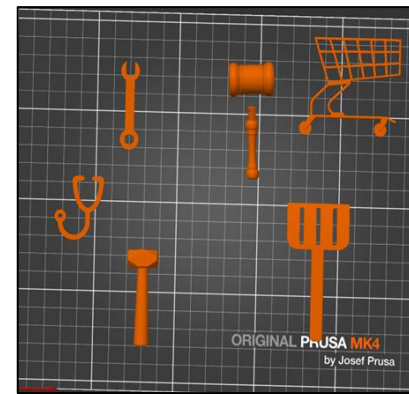


Figure 13: Game pieces in Prusa Slicer

5.2 Code

- This section of code shows the main menu function, rolling function, and main turn loop.
- In the mainMenu() function, it checks to see if players have seen the directions yet, before waiting for a user input, and calling the correct function based on that event.
- Roll calls the spinner() function which plays the spinner animation and calculates the player's roll, then displays that roll, and adds its count to the player's space count.
- The while loop exists to check if players have finished, then, if they haven't, the menu is displayed, player-by-player.

```
# Complete game can be found at https://cass.coralcmd.net/game.zip
# Download contains game.py and all audio files associated with game
# Main menu is used for each player's turn
# Players choose from moving, chance & career spaces, & ending turn
def mainMenu(player):
    if player.firstMenuRun:
        printMenu(player)
        player.firstMenuRun=False
    else:
        sense.show_message("Player {playerNum}'s
turn.".format(playerNum=player.number),scroll_speed=0.06)
    while True:
        sense.set_pixels(mainPix)
```



```
event = sense.stick.wait_for_event()
if event.direction=="right":
    sense.stick.wait_for_event()
    sense.show_message(chance(player),scroll_speed=0.06)
elif event.direction=="left":
    sense.stick.wait_for_event()
    quizMenu(player)
elif event.direction=="up":
    sense.stick.wait_for_event()
    break
elif event.direction=="down":
    sense.stick.wait_for_event()
    roll(player)
# Rolling method calls the spinner() animation and informs the player
of their roll, adds to their roll count
def roll(player):
    rolledNum=spinner()
    sense.show_message(str(rolledNum),scroll_speed=0.06)
    player.rolls+=rolledNum
# Main loop for turns, checks if players have finished and provides
them with the main menu
while True:
    for i in range(1,playerCount+1):
        if i==1 and p1.rolls<25 and not p1.gameOver:
            mainMenu(p1)
        elif i==2 and p2.rolls<25 and not p2.gameOver:
            mainMenu(p2)
        elif i==3 and p3.rolls<25 and not p3.gameOver:
            mainMenu(p3)
        elif i==4 and p4.rolls<25 and not p4.gameOver:
            mainMenu(p4)
    if p1.gameOver and p2.gameOver and p3.gameOver and p4.gameOver:
        break
```

5.3 Prototype Description and Images

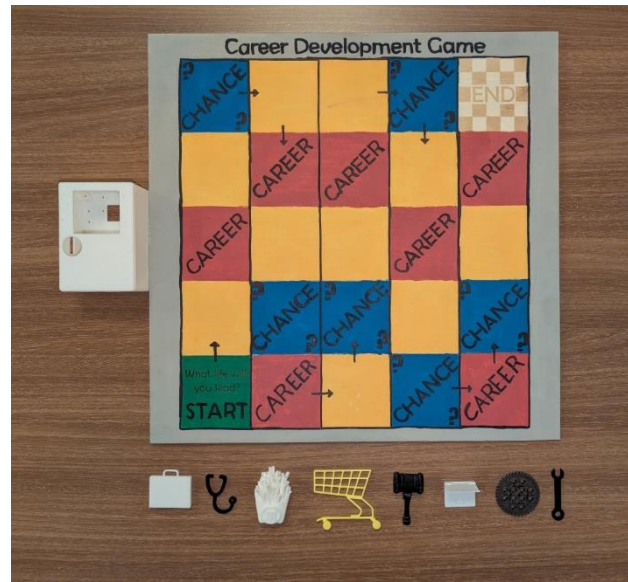


Figure 14: Complete prototype, not including the Pi.

In Figure 14, the game board, pieces, and case for the Raspberry Pi are shown. Unfortunately, the Pi is owned by the Luddy School. Figure 14 does not include it, as the photo was taken off-site.

6. Product Evaluation

6.1 Testing the Prototype

- The efficacy of the career game was tested by playing the game through multiple times. Outside input was received from classmates who played the game as well. Feedback from classmates was taken into consideration and the game was adjusted accordingly.

6.2 Results of Evaluation

- The game performed well in the testing phases, requiring only a few adjustments. One piece of feedback from a classmate was that the game repeats the same instructions for each player, dragging out the game. This was fixed by producing instructions for only one player, reducing the repetition.

7. Ethical Decision Making in the Design Process

- After completing the design of the game and developing the prototype, there are several ethical considerations that must be addressed. These considerations include safety, environmental impact, social impact, cost, and legal.

1) Identification and 2) analysis of ethical issues:

- Safety considerations
 - Sharp edges could be harmful.
 - Materials may be toxic.
- Environmental impact considerations
 - Non-recyclable components may increase waste.



- Toxic materials may harm the environment.
- Social impact considerations
 - Career options may be limited, restricting inclusivity.
- Cost considerations
 - A durable and recyclable board may drive up costs for client.
- Legal considerations
 - Lack of safety labeling may violate regulations.
 - Risk of copyright infringement.

3) Identification and 4) evaluation of solutions:

- Safety considerations
 - Sharp edges: Round off sharp edges, which minimizes risk of injury (feasible).
 - Material toxicity: Research components in product and test for toxicity (somewhat feasible).
- Environmental impact considerations
 - Recyclability: Label which parts are recyclable, use recyclable alternatives to promote environmental consciousness (somewhat feasible).
 - Material toxicity: Use materials that are environmentally friendly. May increase costs by using safe alternatives (feasible).
- Social impact considerations
 - Career options and inclusivity: Include more career fields to ensure inclusivity (feasible).
- Cost considerations
 - Balancing cost with durability and recyclability: Consider sponsorships (somewhat feasible), make design simpler (feasible).
- Legal considerations
 - Safety labeling: Include clear labeling, research regulations (feasible).
 - Copyright infringement: Research existing patents (feasible), create unique designs (feasible).

5) Course of action for V2:

Taking into consideration all the considerations and ethical issues, Version 2 of the career development game will include the following changes:

- Rounded corners and edges on game board.
- More career options.
- Indication of recyclability for each component.

8. Future Directions

In addition to the above changes made based on ethical issues, Version 2 will also include better design choices to make the game more visually appealing, such as a consistent art style for each of the pieces, and possibly a theme for the board, rather than just colors. Version 2 will also include an integrated sound system, replacing the separate and unusually quiet speaker that was used.