Junk Art Unity adaptation

# Pitch research

* Does video display knowledge of area of study and previous work?
* Does video critically evaluate previous work?
  + Find the gap that nobody’s done
  + Find a technique that works well to be incorporated
  + Find a technique that doesn’t work well, to be avoided
* Is project concept justified based on domain, users?

## Existing physics games

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## Board games background

Ancient:

Senet  
Michael Sebbane (2001) Board Games from Canaan in the Early and Intermediate Bronze Ages and the Origin of the Egyptian Senet Game, Tel Aviv, 28:2, 213-230, DOI: 10.1179/tav.2001.2001.2.213 [1]

Go/Baduk  
Peter Shotwell (2003) Some New Approaches to the Study of the History of Go in Ancient China and Siberia, The 2nd International Conference on Baduk, <https://www.earticle.net/Article/A24755> [2]

Chess  
Henry Davidson (1949), A Short History of Chess, David McKay Publications, NY [3]  
<https://archive.org/details/shorthistoryofch0000davi/page/n1/mode/2up>

Ur Excatvations. [4]

First G.A. 1880s-1920s: Margaret Hofer, The Games We Played: The Golden Age of Board & Table Games (New York: Princeton Architectural Press, 2003), 11. [5]

2nd G.A./renaissance: 1990s-present. Epicentre in Germany  
Andrew Curry, “Monopoly Killer: Perfect German Board Game Redefines Genre,” Wired Magazine, March 23, 2009. [6]

Eurogames: The Design, Culture and Play of Modern European Board Games [7]

<https://www.theguardian.com/technology/2014/nov/25/board-games-internet-playstation-xbox>

<https://web.archive.org/web/20130601124655/http://www.shutupshow.com/post/34426556753/su-sd-present-the-board-game-golden-age>

As a focus for a new 3rd Space:  
<http://bazekon.icm.edu.pl/bazekon/element/bwmeta1.element.ekon-element-000171561541>

Online platforms increase popularity during pandemic:  
<https://www.insidehook.com/article/games/play-online-board-games-during-quarantine> [8]

<https://www.vox.com/culture/2020/4/9/21214076/board-games-online-arena-internet-play> [9]

<https://blog.tabletopsimulator.com/blog/one-year-later-covid-and-the-future-of-virtual-gaming> [10]

<https://boardgamearena.com/news?f=10&t=31756&s=SUMMER+of+GAMES+2023%3A+a+full+month+of+daily+releases%21> [11]

Physics-based dexterity games:

* Stacking
  + Jenga (#10168, 5.6), Rhino Hero (#778, 7.2), Junk Art (#507, 7.4)
* Flicking
  + Crockinole (#49 8.0), Pitch Car (#463, 7.3), Cube Quest (#2060, 6.8), Ice Cool (#1040, 6.8)
* Fine control
  + Operation (#25132, 4.1), Klask (#252 7.6)

[8] [9] [10]

[11] [12]

[13] [14]

## Existing board game adaptations and platforms

<https://www.reddit.com/r/boardgames/wiki/play_online>

TTS, BGA, Tabletopia

[15] [16] [17]

TTS: no junk art. Jenga, crockinole…  
Very generalised sandbox - learning controls can be overwhelming. Paid  
~7k users online at a time <https://steamcharts.com/app/286160#All>

In-browser multi-game platforms eschew dex games. No need to build physics environment for most other games. Subscriptions required for both Tabletopia, BGA for popular games.

BGA claim 8m+ users <https://www.reddit.com/r/boardgames/comments/y40joy/im_greg_isabelli_founder_of_board_game_arena_bga/#:~:text=I'm%20Greg%20Isabelli%2C%20founder%20and%20CEO%20of%20Board%20Game,players%20from%20the%20whole%20world>.

Games in progress: <https://boardgamearena.com/gameinprogress>

Tabletopia low player counts - hard to find a game with randos

Aim to create game which could be build for Web or standalone binary execution. Implement physics of object stacking, and rules, scoring of game. Hope to include local multiplayer through ‘hotseat’ mode.

## Video script

For my final project I will be using the Physics-based game template

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My proposed game design will be based on simulating a tabletop board game.

/

Humans have been playing boardgames for thousands of years and throughout the world. Archaeological examples exist from ancient cultures, and records show the evolution and propagation of games throughout history.

/

The late 19th and early 20th centuries are considered the first ‘Golden Age’ of board games. With the advent of commercial production, the variety and proliferation of these games dramatically increased.

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Since the 1990s the so-called “Board game renaissance” has seen a resurgence in the popularity and innovation of modern tabletop gaming.

/

While boardgames are inherently physical objects, a subset - known as “Dexterity games” - make explicit use of their physicality, and may thus be an appropriate influence for a physics-based computer game.

/

These dexterity games can be divided into three types. Flicking games require the players to accurately maneuverer pieces around the game space, negotiating their interactions with other pieces or obstacles.

/

Stacking games involve balancing pieces atop each other, generally with the goal of creating the tallest structure, or avoiding a collapse.

/

Fine control games rely on the players’ hand-eye coordination to perform various tasks.

/

The resurgence of interest in board games in the last few decades has coincided with the expanding availability and capabilities of computers and the internet. This has led to the development of several digital adaptations of these games.

/

Services such as Board Game Arena, Tabletopia, and Tabletop Simulator allow players to participate in a variety of games without requiring the physical space for their components, and with access to an internet’s worth of opponents (or team-mates).

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Tabletopia and Board Game Arena are browser-based services, with subscription models. They host a curated list of licensed games, strongly enforcing their mechanics and rulesets. The game engines used are two-dimensional with no physics simulation, and are thus unsuitable platforms for hosting any type of physics-based dexterity game.

/

Tabletop Simulator is a 3D ‘sandbox’ environment designed specifically to enable a realistic simulation of a board gaming experience. Game mechanics and rules are not enforced by the software, requiring players to move components around just as if playing on a real table. This allows great freedom in the types of games playable, but also requires the players to know - and manually implement - all game rules.  
The intentionally generic nature of the gaming environment makes this software less suitable for some game types, especially dexterity games. The physics engine within the game is functional, but the control scheme can be unintuitive. The platform serves reasonably well at simulating flicking type games such as Crokinole, but even simple stacking games such as Jenga are fiddly, and in some cases virtually impossible to play convincingly.

/

My proposal is to create a piece of software to simulate a single dexterity game, inspired by the physical game Junk Art - a game which revolves around the stacking of objects with unusual shapes.  
The software would include the physics of moving and stacking these objects, with an intuitive control scheme allowing players to move objects with six degrees of freedom. The rules and scoring of the game would be automatically managed by the software. While online multiplayer will likely be out of scope for this project, local multiplayer via ‘hotseat’ or control-passing would be included.

Thank you for your time, and good luck to my fellow students with their own projects.

# Proposal video

Add more on online boardgames since Covid

Add more on stand-alone executables

<https://www.handelabra.com/spiritisland>

<https://www.asmodee-digital.com/en/gloomhaven/>

<https://catanuniverse.com/en/>

<https://www.asmodee-digital.com/en/carcassonne/>

# Literature review

4-6 items of previous work, potentially including:

* Similar projects
* Techniques and methods - not necessarily included in a similar project
* Studies showing effectiveness of approach

Evaluate work, explain relation to the project.

Marking criteria

* Knowledge of area of study, previous work, literature
* Critical evaluation of these
* Proper citation

Evolution of game controls:

<https://d1wqtxts1xzle7.cloudfront.net/4966311/6-libre.pdf?1390839515=&response-content-disposition=inline%3B+filename%3DThe_evolution_of_game_controllers_and_co.pdf&Expires=1699112118&Signature=W8i0mulPnebibiXknj56n-mHScuuYC3qxobD4eCuGjdzLg5BRggQUsXxDNY9rduOzEp2zLjfdL~pMKBhUWzN9E3s3~xk~6UX4-VAvO57-iuaxjKbRJGe77mvPNe~hNCFYT9YIbNp9A6i-ODnXXGh4NNGZl4X1fNF7y-xJsztUNWpGaMMG3PavTHNoQ1eDszXr1V~ctGN-CReVeK9JedmSJEGvucKEcPWb2BEsSG-iw0qS9WDtP-e8~~exFyUMiTiMgR2wFQ-SxP~AUbjJlqMm~bsv~WjLBtSMk1BCQQbo92cxCVPLiAvg0Uxmd7YiCW9pbLSeVBE5do2W2dDCUME9w__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA>

Pick up and place objects:  
TTS

Portal:

* 1st person avatar navigation: WASD, mouse look
* Pick up object with keypress
* Object locked in front of camera centre
* Maintains orientation WRT camera from when picked up
* Can’t be rotated while held, in any axis
* Collisions occur while held
* Can knock other non-static object while held
* Gravity takes over when released

Digital jenga:

<https://www.gamenora.com/game/jenga/> primitive, algorithmic stacking, no actual physics. Hard to establish provenance, reused all over the place in online collections of in-browser games.

<https://chandlerprall.github.io/Physijs/examples/jenga.html> tech demo for Physijs plugin. Reused all over the place

# Design phase

Incorporates:

* Project design
* Work/time plan
* Evaluation plan
  + How will the project be tested
* Prototype
  + Test ideas for feasibility

Can test wireframes etc with users

Should test feature prototype (test)

## Design document

* Project overview, inc. template
* Domain, users described
* Justify planned features based on domain
* Describe project structure
  + E.g. UI, software architecture
* Key technologies and methods described
  + Algorithms, libraries, approaches, techniques, development platforms
* Work plan
  + Gantt chart, key milestones
* Evaluation plan
  + Evaluation techniques, aims evaluated against

4 pages + images/refs

# Prototype

Grab object at camera focus <https://www.youtube.com/watch?v=zgCV26yFAiU>

Alternative method <https://www.youtube.com/watch?v=6bFCQqabfzo>

Used combination of above, added scrolling for local Z translation.

Crosshair texture asset pack (free) <https://assetstore.unity.com/packages/2d/gui/icons/crosshairs-25-free-crosshairs-pack-216732>

Video:

* Show how it works
* Show some of the code
* Evaluation as it stands

# Preliminary report

Coursework 1: 10% of total

* Introduction
  + Template, concept, motivation
  + 288/1000 words
* Lit review
  + 1951/2500 words
* Design
  + 1633/2000 words
* Feature prototype report
  + 0/1500 words
  + 3-5 min video

Overall max 3872/6000 words (some sections must be under to comply). Not counting title page, refs

# Custom assets

Blender tutorials from Blender Guru  
<https://www.blenderguru.com/>  
<https://www.youtube.com/watch?v=nIoXOplUvAw>

Colliders - can’t be concave due to Physics engine restrictions (<https://docs.unity3d.com/Manual/rigidbody-configure-colliders.html>)

Build compound collider from multiple convex primitive colliders <https://docs.unity3d.com/Manual/compound-colliders.html>  
<https://docs.unity3d.com/Manual/compound-colliders-introduction.html>  
<https://docs.unity3d.com/Manual/create-compound-collider.html>

(Paid) Assets can generate colliders from object meshes:  
<https://assetstore.unity.com/packages/tools/physics/technie-collider-creator-2-217070>

Used Easy Collider Editor (paid):  
<https://assetstore.unity.com/packages/tools/level-design/easy-collider-editor-67880>  
Uses VHACD (Voxelized Hierarchical Convex Decomposition) to break down hull into multiple convex mesh colliders.  
<https://github.com/kmammou/v-hacd>  
V-HACD algo described in: <https://docs.google.com/presentation/d/1OZ4mtZYrGEC8qffqb8F7Le2xzufiqvaPpRbLHKKgTIM/edit#slide=id.g123758ab003_0_295>

Import blender into Unity:   
<https://docs.unity3d.com/560/Documentation/Manual/HOWTO-ImportObjectBlender.html>

‘Jump’ piece top curve calculated using

Table asset: <https://assetstore.unity.com/packages/3d/props/furniture/dinning-set-186476>

# Multiplayer

Player class; instantiated by game controller. Constructor with name, home location (dependent on player count), player colour.

MonoBehaviour shouldn’t have contstrutors - they’re designed to be components of gameObjects with intialisation in Awake and/or Start.

For scripts not attached to gameObjects use ScriptableObject <https://docs.unity3d.com/ScriptReference/ScriptableObject.html>

Still can’t/shouldn’t use constructors: *“. Design patterns and good programming practices tell us that a constructor should only contruct the object, i.e. allocate the memory needed. Anything related to the goal/function of the object should be set afterwards.”* <https://discussions.unity.com/t/how-to-create-instance-of-scriptableobject-and-pass-its-constructor-a-parameter/50556/5>

ScriptableObjects instantiated with ScriptableObject.CreateInstance  
Use separate methods to set properties.

Use script to instantiate prefab: <https://docs.unity3d.com/Manual/InstantiatingPrefabs.html>

Player name text may scale improperly with resolution - to be tested. Check <https://discussions.unity.com/t/textmesh-looking-fuzzy/4916/2> for possible solution. Or use newer UI solution. Using TextMeshPro fixes this.

Piece heights: for pieces with multiple colliders in child objects, created trigger-only box colliders on parent shape, can be accessed by GameController.StackHeights() func.

# Scorecards

Ruler image from [https://www.svgrepo.com/svg/109166/ruler CC0](https://www.svgrepo.com/svg/109166/ruler%20CC0) Public Domain license

Sorting player objects by their score property: <https://www.tutorialsteacher.com/articles/sort-object-array-by-specific-property-in-csharp>

# V-HACD

Voxelized Hierarchical Convex Decomposition

Previously Volumetric Hierarchical Approximate Convex Decomposition  
<https://books.google.co.uk/books?hl=en&lr=&id=vHSmCwAAQBAJ&oi=fnd&pg=PA141&dq=Voxelized+Hierarchical+Convex+Decomposition&ots=5YNMrnOd6L&sig=nDVUUzgolkH1YXcC5275NAFXMzw#v=onepage&q=Voxelized%20Hierarchical%20Convex%20Decomposition&f=false>

<https://docs.google.com/presentation/d/1OZ4mtZYrGEC8qffqb8F7Le2xzufiqvaPpRbLHKKgTIM/edit#slide=id.g123758ab003_0_295>

John W Ratcliff v1: Approximate Convex Decomposition  
Khaled Mamou v2: Hierarchical Approximate Convex Decomposition  
Khaled Mamou v3: Volumetric Hierarchical Approximate Convex Decomposition (book)  
John W Ratcliff v4: Voxelized Hierarchical Convex Decomposition (presentation)

Steps:

* Create AABB around source mesh
* Create voxels within AABB at every point on surface of source mesh faces. Voxel size defined by resolution parameter
* Flood fill inside of mesh with voxels
* Recursively divide set of voxels until completion criteria met:
  + Create a convex hull to enclose all voxels in division
  + Compare volume of hull to volume of voxels in division
  + If volumes are within parameter-defined tolerance, hull is assumed to be a reasonable approximation of voxels
  + If not, must divide:
    - Create axis-aligned splitting plane at midpoint of longest edge
    - Split surface voxels between children
    - Split interior voxels between children
      * If interior voxels lie on splitting plane, they become surface voxels for children
  + Stopping points for recursion (any of):
    - Voxel patch at minimum size (can’t get good hull below 4\*4\*4 voxels)
    - Recursion depth reached
    - Error between hull volume and voxel volume below threshold
* Will produce hundreds/thousands of hulls. Merge proximate hulls to hit target hull count
  + Merging based on volumetric cost. If vol HullA + vol Hull B close to vol HullAB, considered low cost. Ratio of volumes is cost.
  + Create priority queue for merging from costs
  + Merge from lowest cost. Each time compute new costs for merged hull to other hulls and insert into queue.
* Translate vertices of final hull set from voxel space to nearest vertex of original mesh

# Third-party testing feedback

Bases could maybe be larger, to compensate for increased difficulty of placing pieces vs. real game.

High score board?

Can’t rotate beyond certain point - solved; use Transform.Rotate() not Transform.eulerAngles =+…

Can’t distinguish held object from placed. Solved, using:  
Highlight/outline specific items (held items). Could write entire shader. CBA. Use Arvtesh UnityFx.Outline <https://github.com/Arvtesh/UnityFx.Outline>   
Tutorial <https://www.youtube.com/watch?v=AY2TpLobxa4>  
MIT licence

# Draft report

Due Monday 12 February (end week 18)

* Introduction
  + 2 pages (1000 words?)
* Lit review
  + 5 pages (2500 words?)
* Design
  + 4 pages (2000 words?)
* Implementation
  + this should describe the implementation of the project. This should follow the style of the topic 6 peer review (but expanded to cover your implementation to date), describing the major algorithms/techniques used, explanation of the most important parts of the code and a visual representation of the results (e.g. screenshots or graphs)
    - A statement of which template you are using.
    - An overview of the project and an explanation of how this prototype fits in to the project as a whole.
    - A description of the features being implemented in the prototype.
    - An explanation of the algorithms, techniques and methods used. You are encouraged to use diagrams to explain them.
    - An explanation of your code. You should not include your entire code, but should quote important parts and explain them (do not just paste in code without explaining it).
    - A visual representation of the product or results. This could be a screen-shot of the user interface or graphs and tables for a data science project.
    - An evaluation of how successful the prototype is and how you intend to improve it.
  + max 3 pages (1500 words?)
* Evaluation
  + Describe the initial evaluations that you have carried out (e.g. unit testing, user studies or testing on data) and give the results. This should give a critical evaluation of the project so far, making clear what you have achieved and what you can improve
  + max 3 pages (1500 words?)
* Conclusion
  + This can be a short summary of the project as a whole, but it can also bring out any broader themes you would like to discuss or suggest further work
  + max 2 pages

# Final report

Due Monday 11th March, 13.00 GMT (end week 22)  
Feedback received by others:

* Final report should have table of figures and list of tables
  + Each should be numbered and captioned
  + Separate numbering for tables and figures
* Introduction should contain
  + Project concept, motivation
  + Introduce other chapters to give overview of whole project
* Critical analysis of project’s strengths, weaknesses against original objectives
  + Should incorporate evaluation metrics
* Figures should be effectively linked to text

# References

|  |  |
| --- | --- |
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