

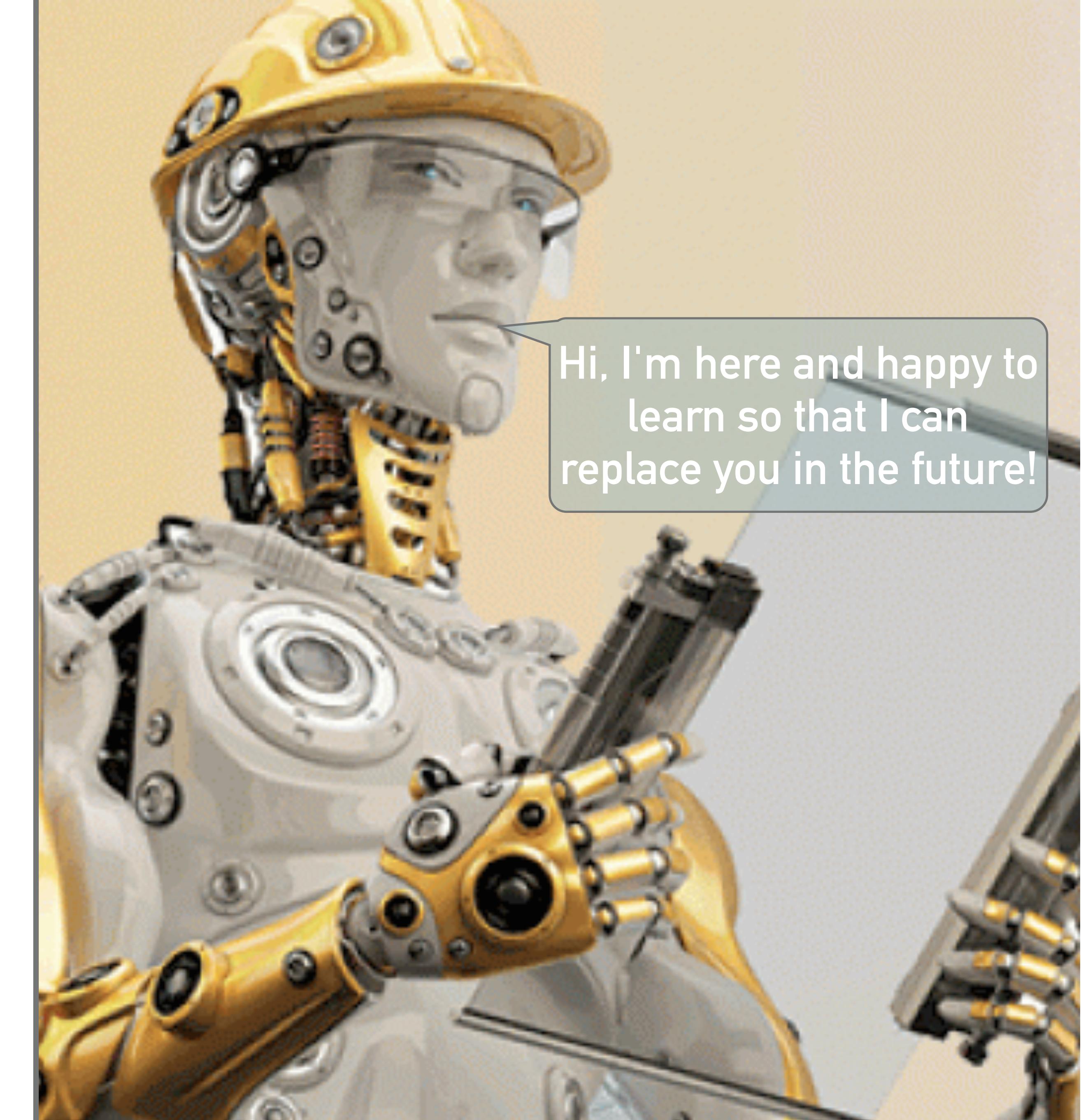


VRND CAPSTONE - ROBO REPLACEMENTS

Eric Zavesky - May-June 2018 - Final Report

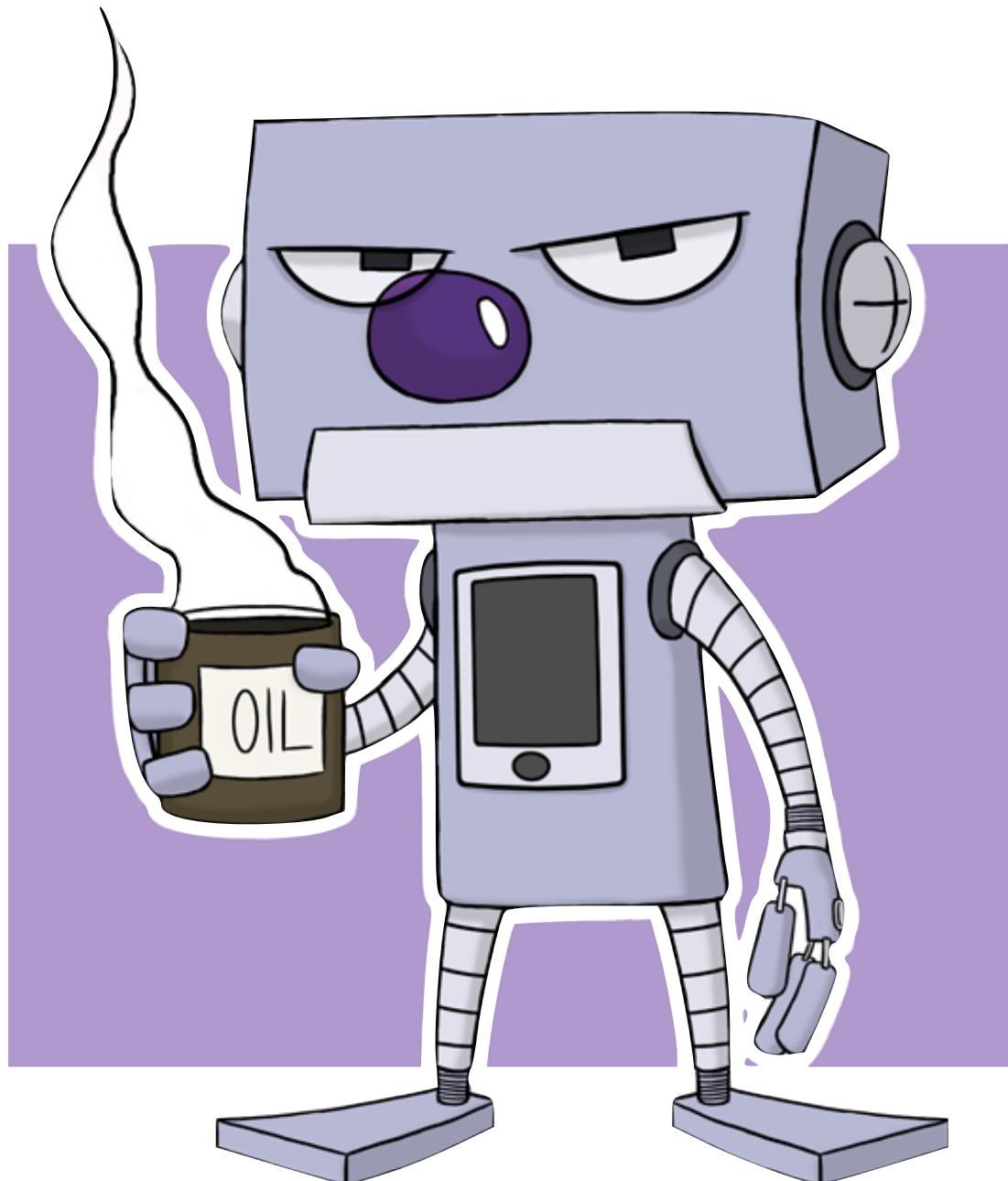
DESCRIPTION

- This capstone will explore the emotive side of robotic automation -- mostly focused on humor, curiosity, and surprise!
- The player's task will be to teach a robot (upper half of a robot avatar) how to accomplish a few simple tasks by demonstration and vocal commands.
- Doing/Listening, Seeing, Speaking
- The focus of this application will be the gameplay and robot interaction, as opposed to extensive graphical interactions.



GAMEPLAY

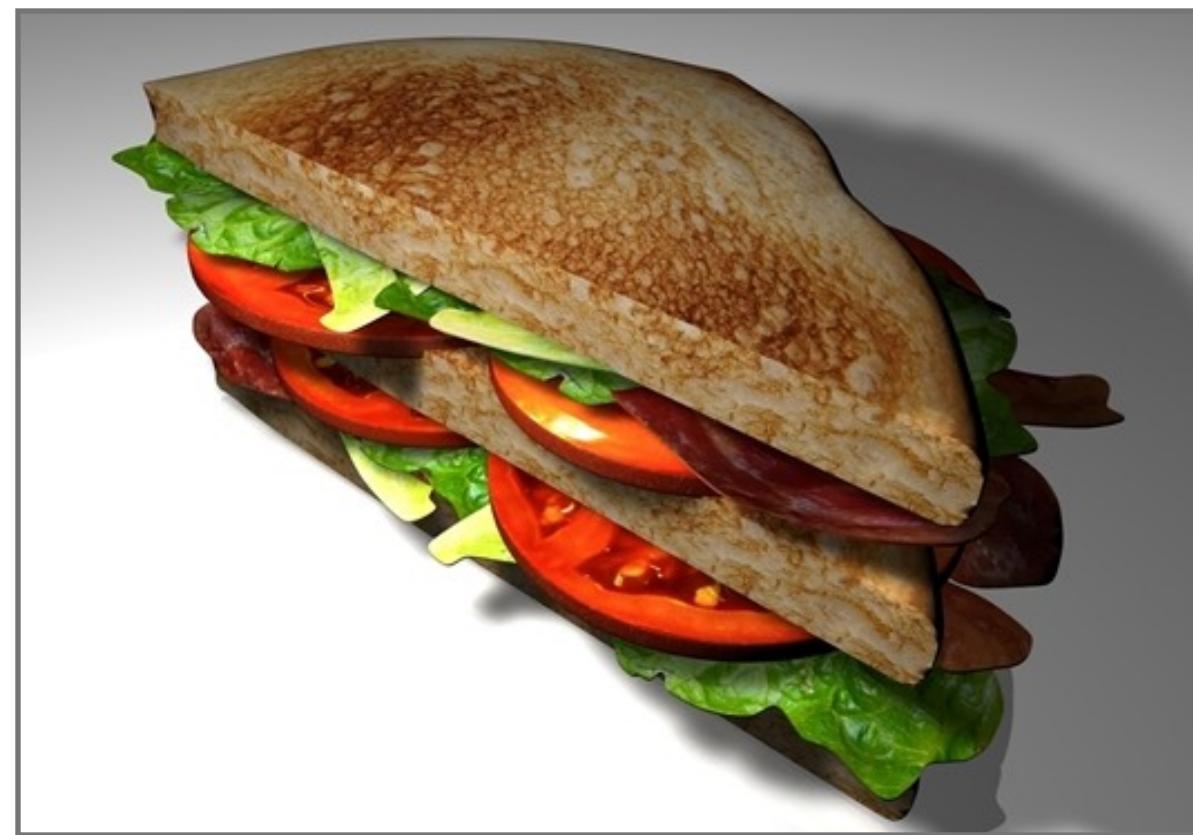
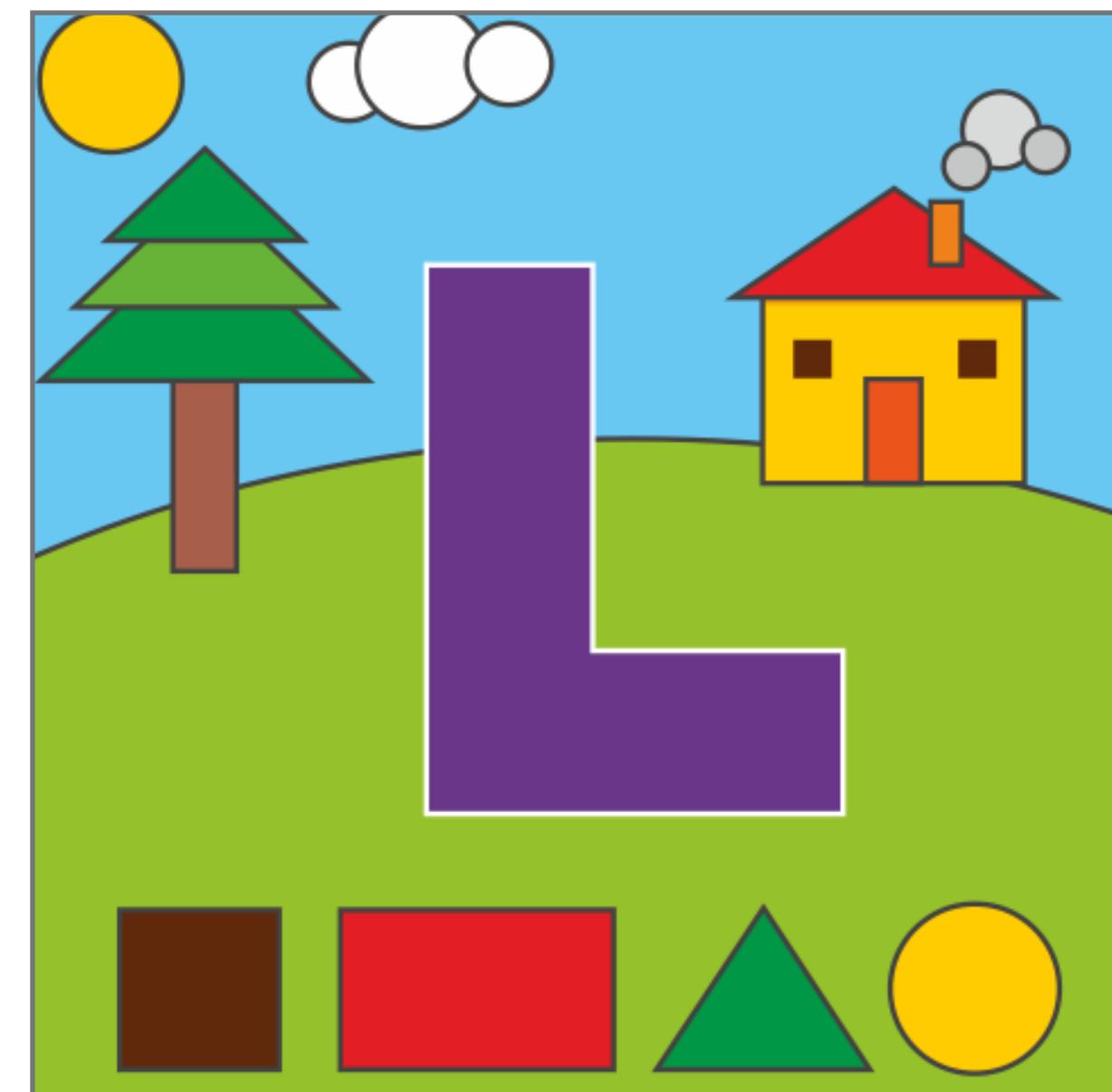
- Task Review
 - Doing/Listening, Seeing, Speaking
 - Robot interjects satirical, comical commentary, a la dialog from games like "The Lab" or "RoboRecall"



- Doing Task
 - goal: using simple interaction mechanics, move to make a sandwich
 - Robot copies user movements
 - User orders task
- Seeing Task
 - goal: teach the robot how to see different items (house, car, flower)
 - user places item on table, robot classifies them online (AI/ML component)
- Listening/Speaking Task
 - goal: user helps robot with speech recognition to complete a "MadLib"
 - ideally pre-programmed animations will bring in media that adjusts according to a few options presented to the user

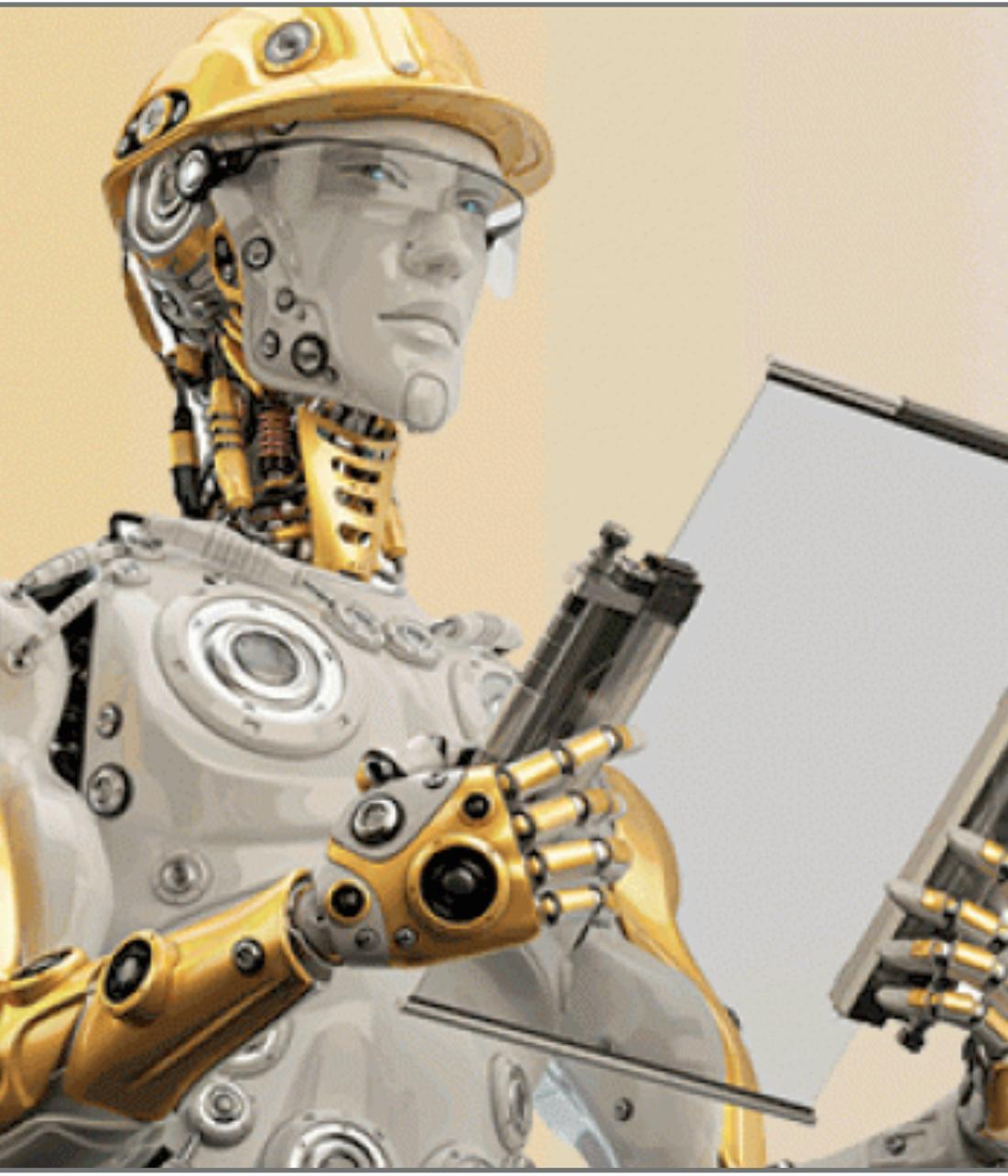
FEATURES AND DEPENDENCIES: MODELS & ANIMATIONS

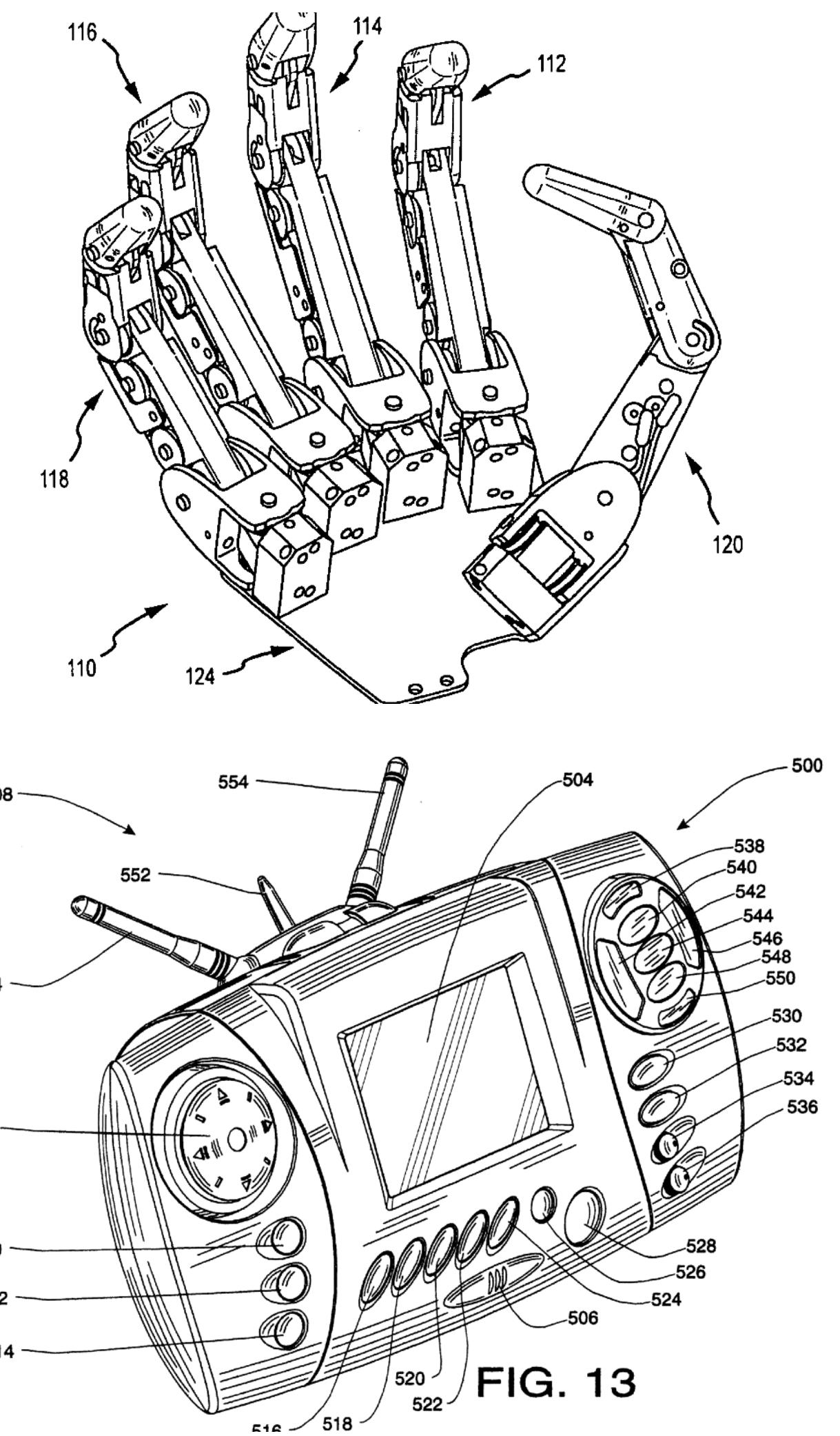
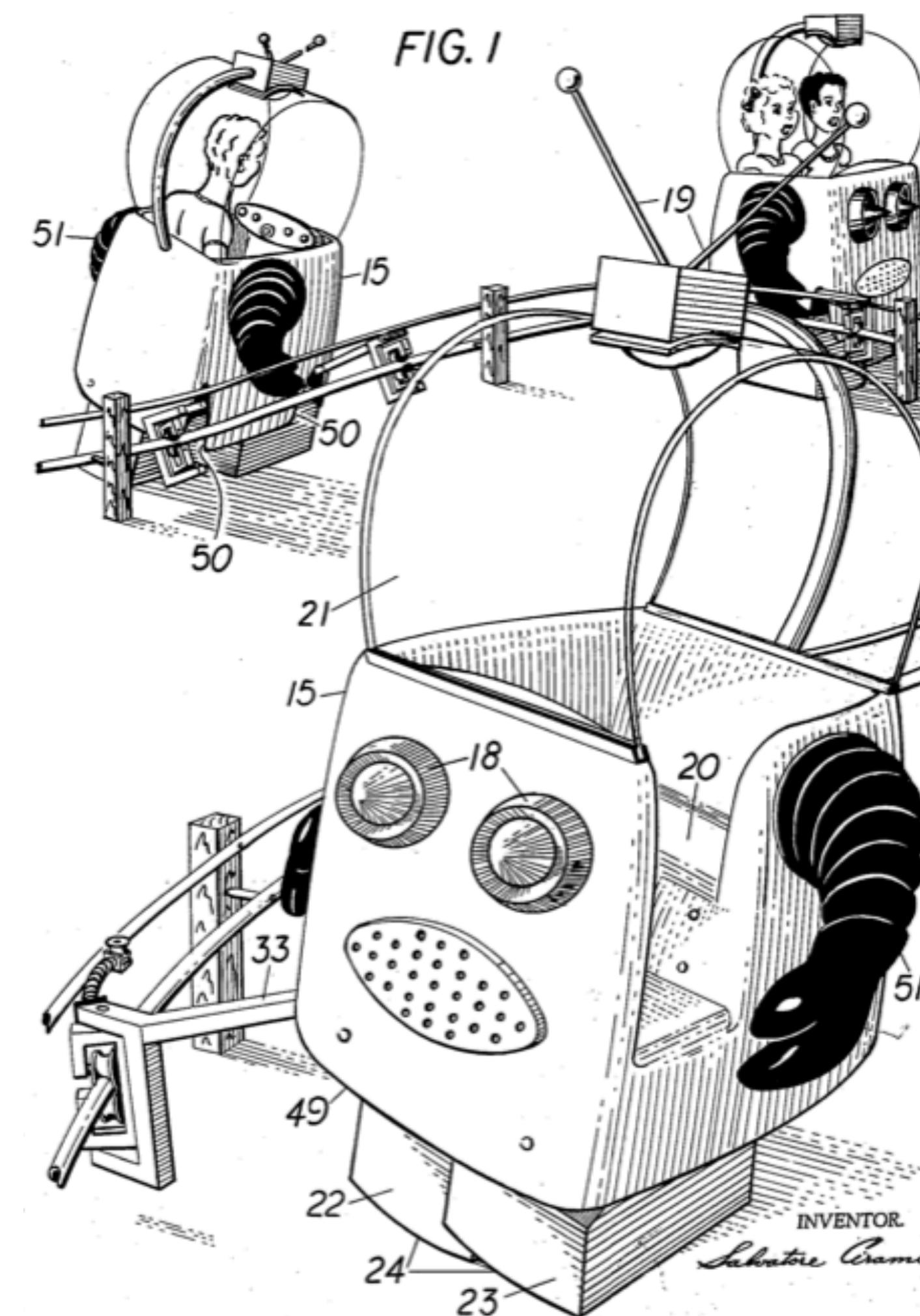
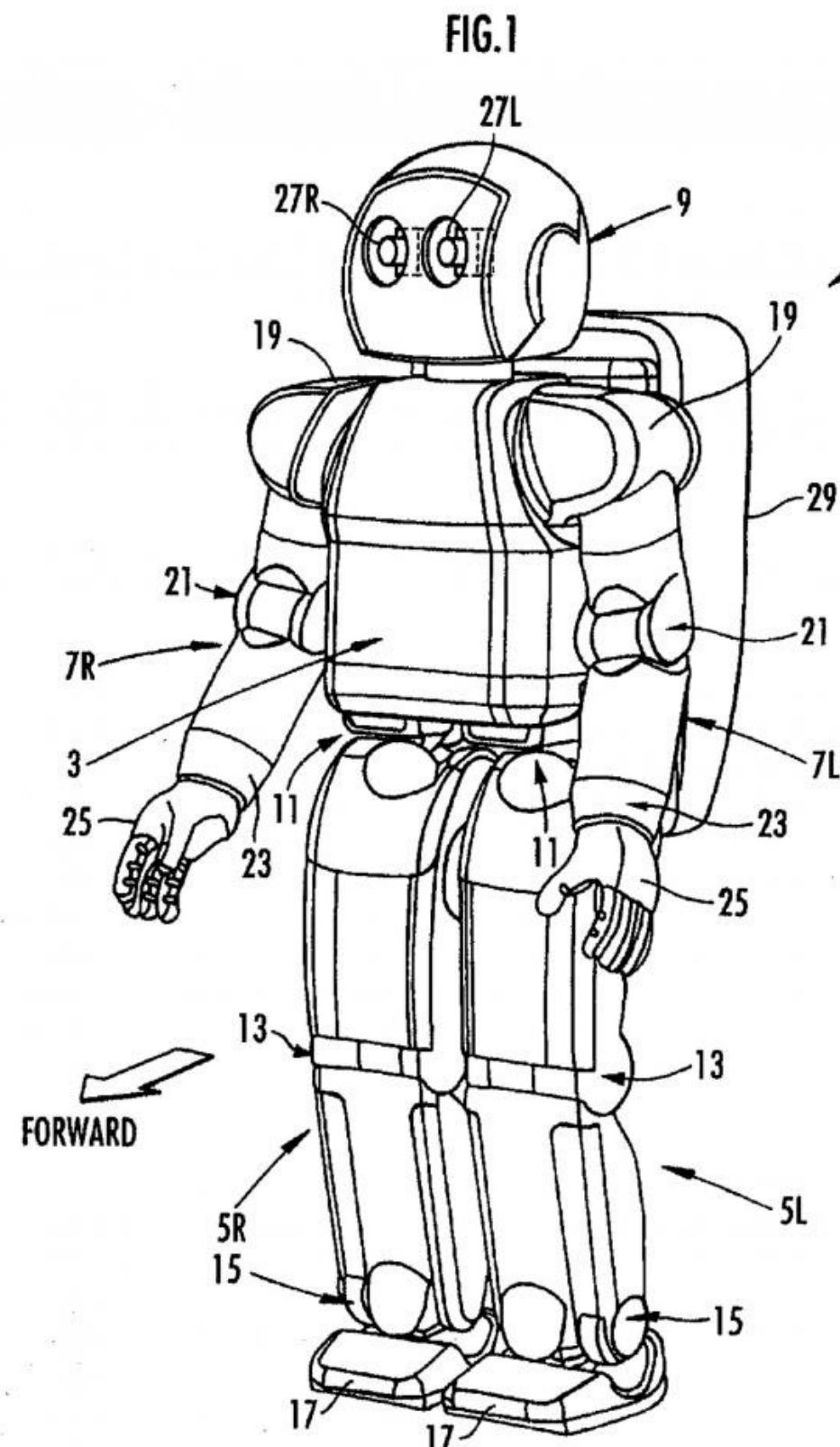
- Robotic avatar
- Doing task
 - food models: bread, jelly, butter
 - tool models: plate, knife
- Simple kitchen environment
 - possibly reusing models from Udacity early models and starter kits
- Seeing task
 - simple shapes created in Unity
 - simple camera or simple office setting
- Listening task
 - news desk + image/video assets
 - animations for a few tasks to present objects



FEATURES AND DEPENDENCIES: SOFTWARE & PROGRAMMING

- Text to speech with funny robot voice
- Doing
 - Link kinematics between robot hand and human hand for testing
 - Simple memory/copier for task
 - Ordering process for task
- Seeing
 - Capability to create shapes and placement
 - Simple nearest neighbor for placement using shape and pallets placement
- Listening/Speaking
 - Create a few words
 - Create recognition model constrained to a few words
- Compose text as output





SOFTWARE & INTERACTIONS

FEATURES AND DEPENDENCIES: TEXT TO SPEECH

- Priority: Text Bubbles in OSD
- Achievable: Recorded voice + audio FX with funny robot voice
- Stretch: an automated TTS generation with personality

- <http://www.acapela-group.com/>
 - would require removal of background
- <https://www.cepstral.com/en/demos>
 - simple demo, apply dizzy droid or other audio effect for robot sound
- Mac "speak" tool plus a visual effect
 - https://www.youtube.com/watch?v=j_FvFAdlbwo
 - <http://www.asktoby.com/#killerringer>
- <https://assetstore.unity.com/packages/tools/audio/speech-auto-detector-86008>
- <https://forum.unity.com/threads/rt-voice-run-time-text-to-speech-solution.340046/>

FEATURES AND DEPENDENCIES: SPEECH RECOGNITION



- Priority: Just using buttons for input
- Stretch: Full speech recognition through Google or Watson

- <https://bitbucket.org/Unity-Technologies/speech-to-text>
 - <https://stackoverflow.com/questions/39611728/how-to-add-speech-recognition-to-unity-project#39613264>
- <https://assetstore.unity.com/packages/templates/tutorials/vr-watson-speech-sandbox-114015>
- <https://assetstore.unity.com/packages/tools/ai/ibm-watson-sdk-for-unity-108831>
-

FEATURES AND DEPENDENCIES: MACHINE LEARNING



- Priority: Simple shape + KNN classification
- Stretch: (this is a fun requirement and will only be skipped under duress)

- <https://github.com/nvnhcmus/kNN> - knn method
- <https://github.com/pavl0v/RandomForest> - simple random forest method
- http://accord-framework.net/docs/html/R_Project_Accord_NET.htm
- <http://accord-framework.net/>

FEATURES AND DEPENDENCIES: DOING TASK IK SOFTWARE

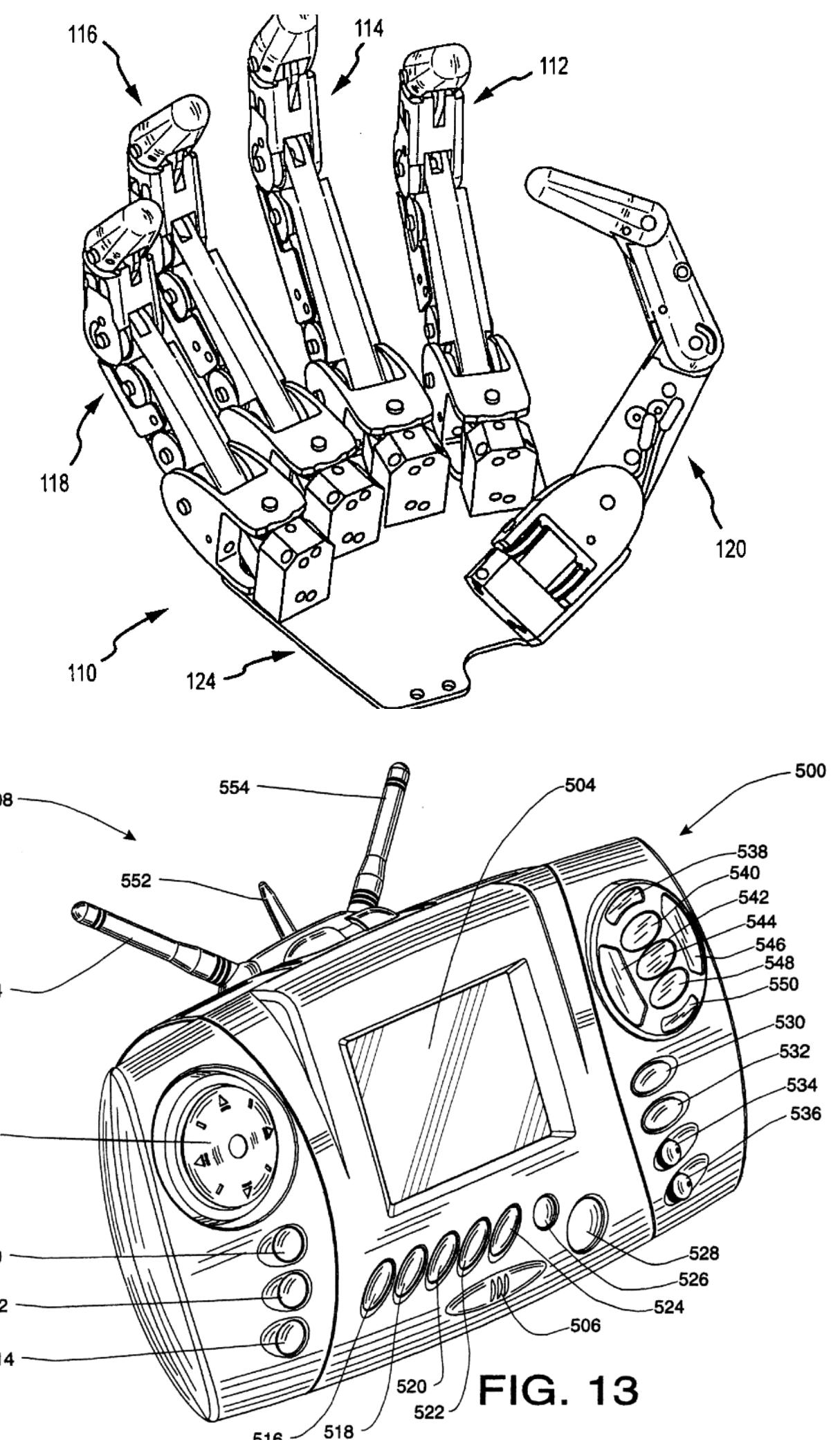
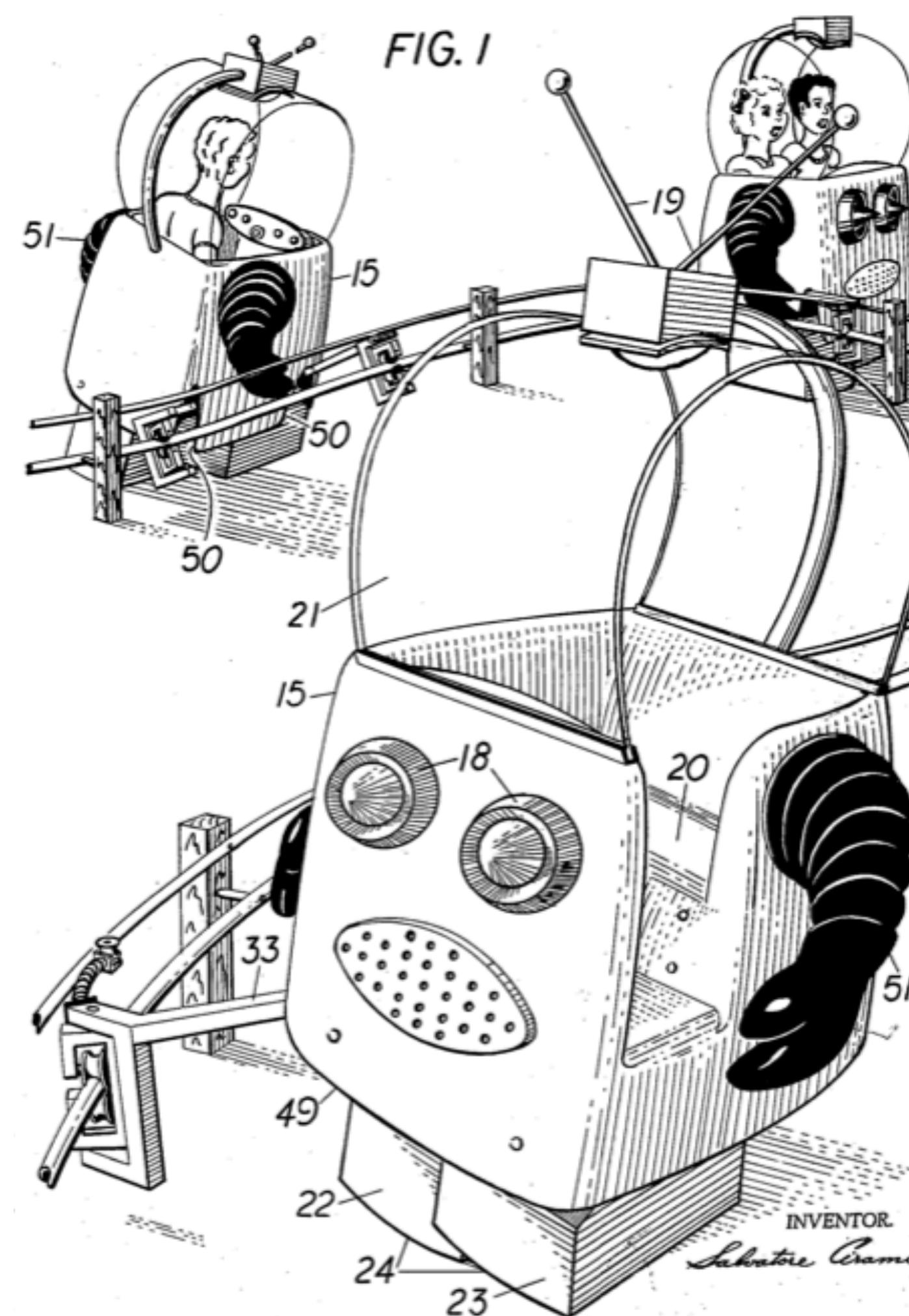
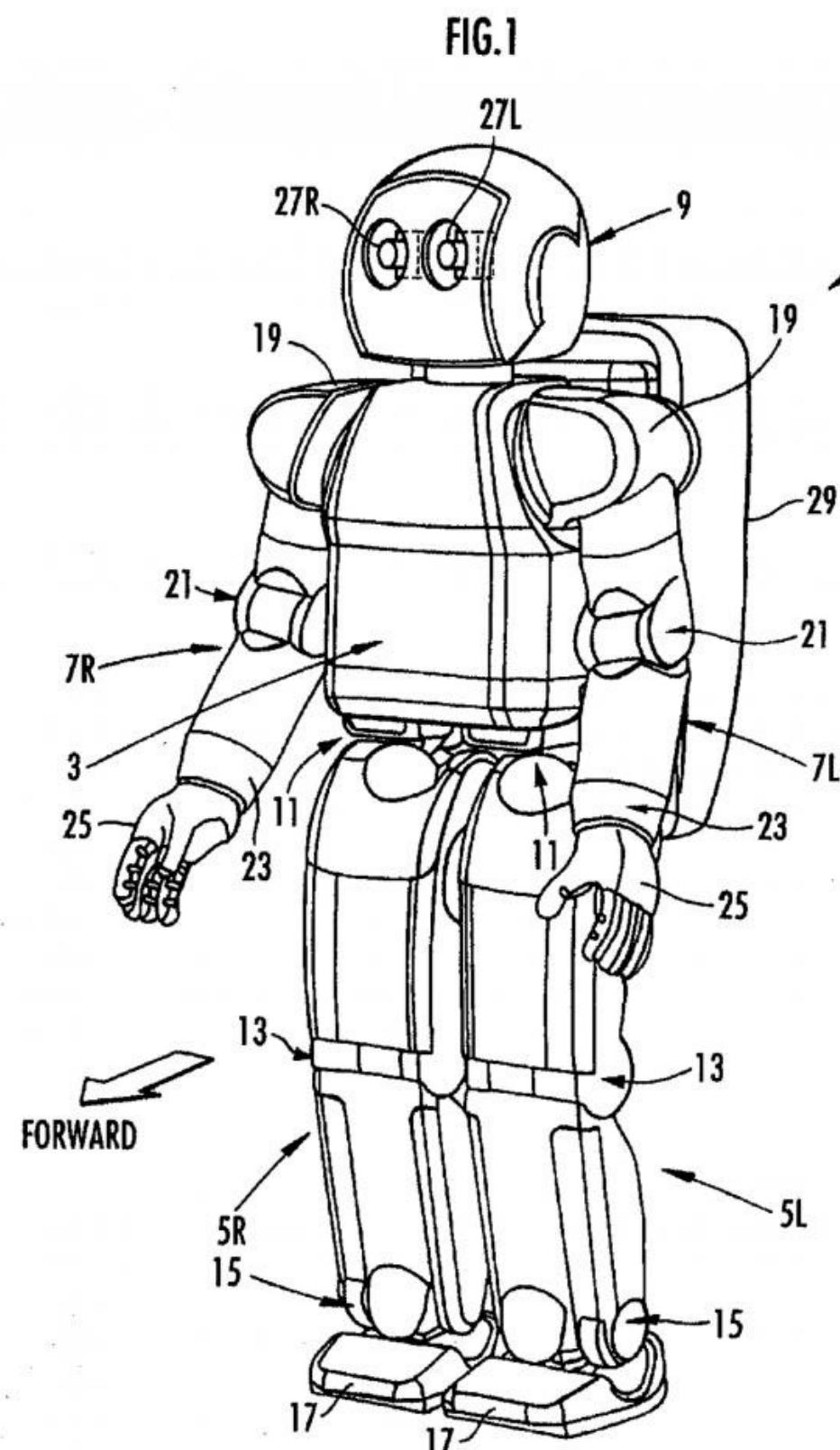
- Priority: Simple IK following of user and objects
- Stretch: Tasks out of order, different sizes, etc; also more complicated ordering requirements
(instead of linearly asking for user help)

- Discovery of bound avatar with desired actions (e.g. full IK+bones)
- Create method for "doing" task
 - Robot will follow user object with head when something is held
 - Backend script tracks which object is grabbed
 - ~~Backend script captures position in update as driver for robot behavior~~
 - Robot follows own grabbed object when manipulating
 - Display will update with task, allowing user to go back or forth with grips
 - ~~Push button between tasks to record them as done or restart~~
 - ~~Push button when task is completed~~
 - Realtime computation of similarity based on object position differences

FEATURES AND DEPENDENCIES: LISTENING AND READING

- Priority: OSD for story and text prompts, buttons
- Stretch: Spoken prompts, speech recognition for constrained reply

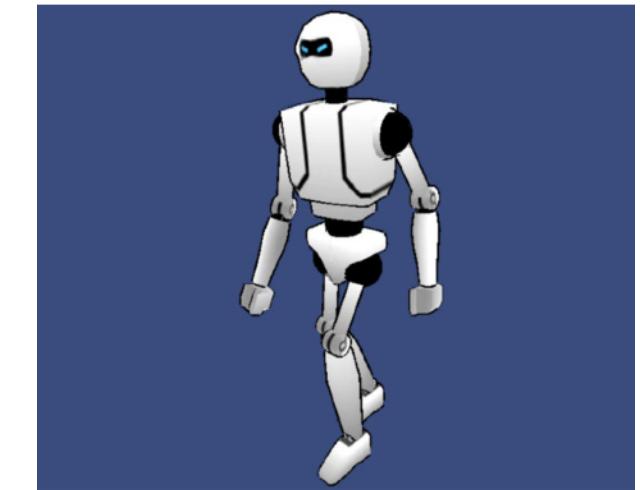
- Propose the use of animations to accomplish much of robot animation
 - <https://assetstore.unity.com/packages/3d/animations/everyday-motion-free-115067>
 - CMU motion capture -> FBX (search first, then find which one it is)
 - <http://mocap.cs.cmu.edu/search.php>
 - <https://assetstore.unity.com/packages/3d/animations/huge-fbx-mocap-library-part-2-20282>



MODELING

FEATURES AND DEPENDENCIES: KINEMATIC ROBOT

- <https://assetstore.unity.com/packages/3d/characters/robots/space-robot-kyle-4696>
 - simple kinematic robot
- <https://assetstore.unity.com/packages/3d/characters/robots/robot-1-65726>
 - larger kinematic robot, may be too scary
- <https://assetstore.unity.com/packages/3d/characters/robots/cyber-soldier-52064>
- <https://assetstore.unity.com/packages/3d/characters/robots/sleek-toon-bot-free-34490>
- <https://assetstore.unity.com/packages/3d/characters/robots/dummy-animation-64322>
- Software IK



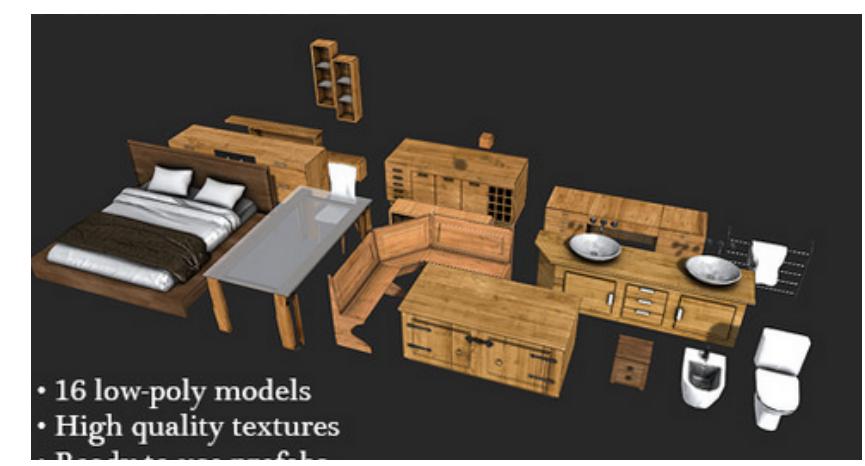
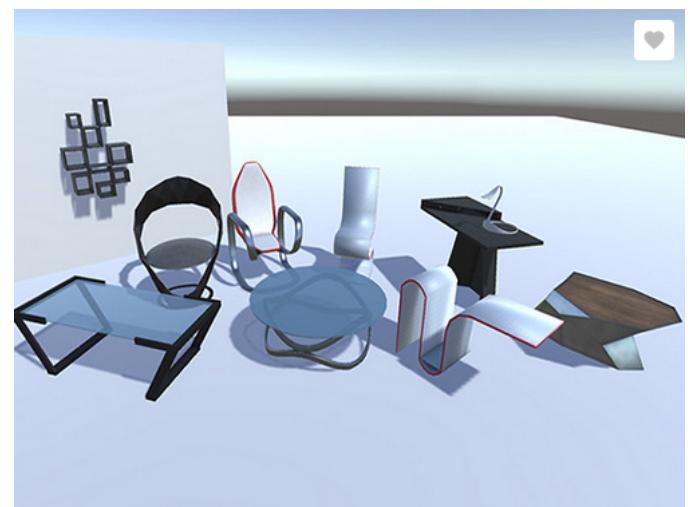
FEATURES AND DEPENDENCIES: ENVIRONMENT MODELS

- <https://assetstore.unity.com/packages/3d/environments/sci-fi/sci-fi-styled-modular-pack-82913>
 - comprehensive space outpost package
- <https://assetstore.unity.com/packages/3d/props/furniture/big-furniture-pack-7717>
 - some beds, couches, etc
- <https://www.turbosquid.com/3d-models/virtual-tv-studio-news-dxf-free/991615>
 - <https://assetstore.unity.com/packages/3d/environments/virtual-news-studio-91126>
 - example of news studio (no model, inspiration)
- <https://assetstore.unity.com/packages/templates/tutorials/the-great-fleece-110186>
 - museum example
- <https://assetstore.unity.com/packages/3d/characters/cozy-cabinet-117482>
 - interior "study" room
- Udacity apartment/kitchen model example
- <https://assetstore.unity.com/packages/audio/music/absolutely-free-music-4883>
 - music!?



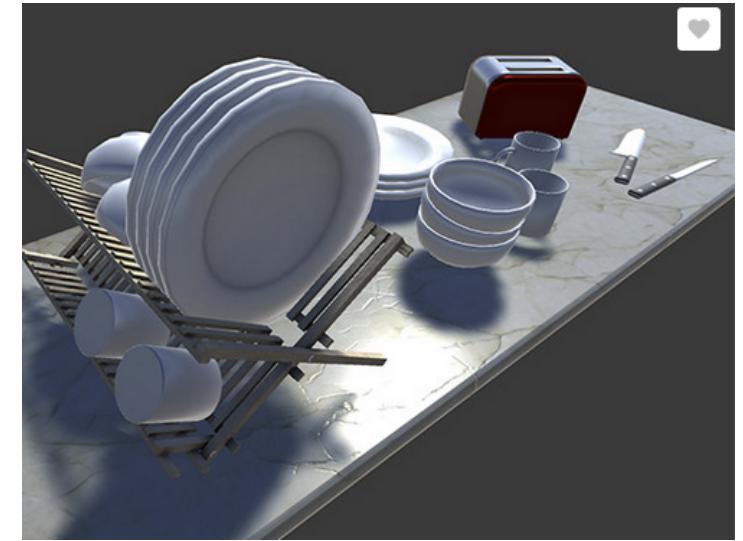
FEATURES AND DEPENDENCIES: OBJECT MODELS

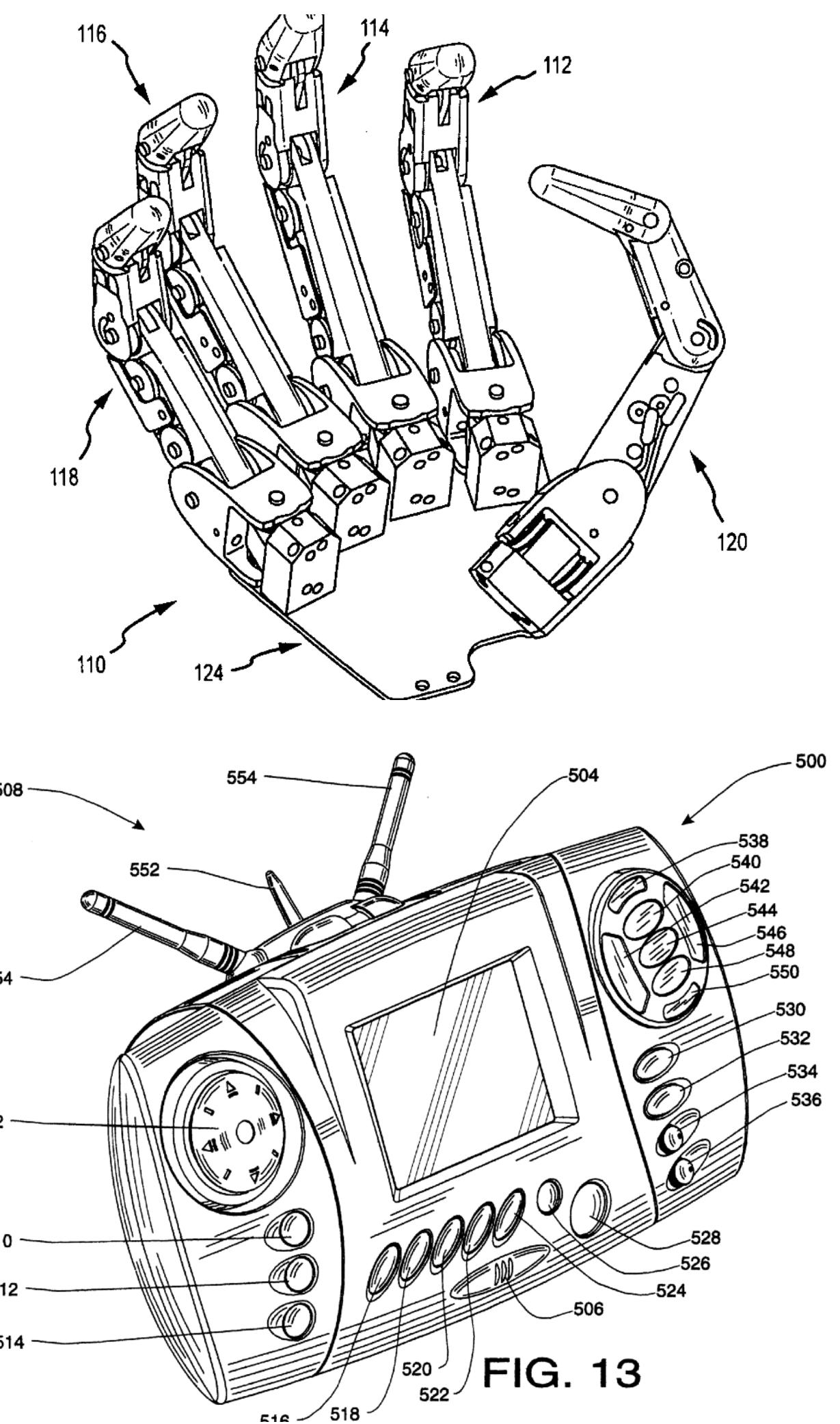
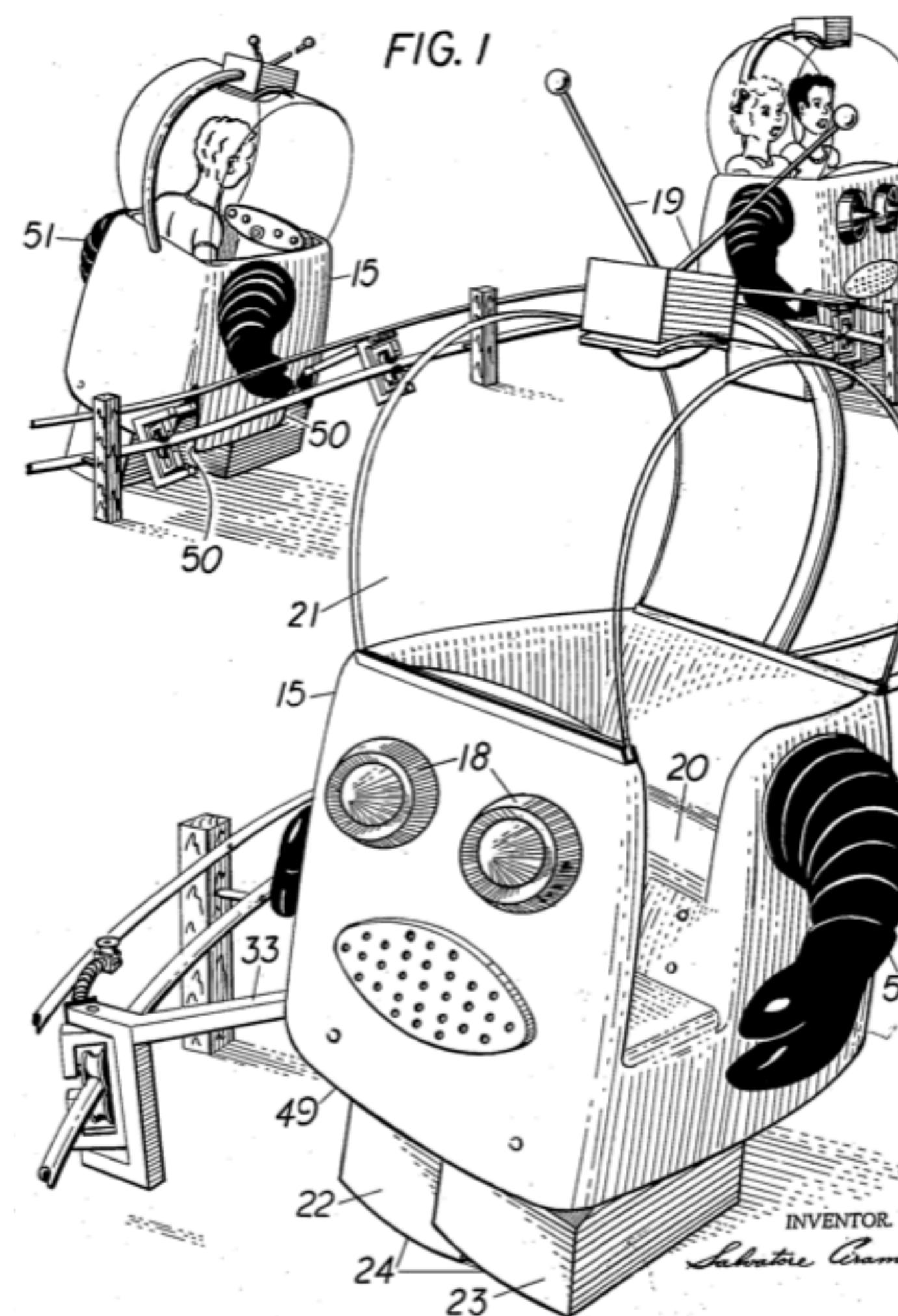
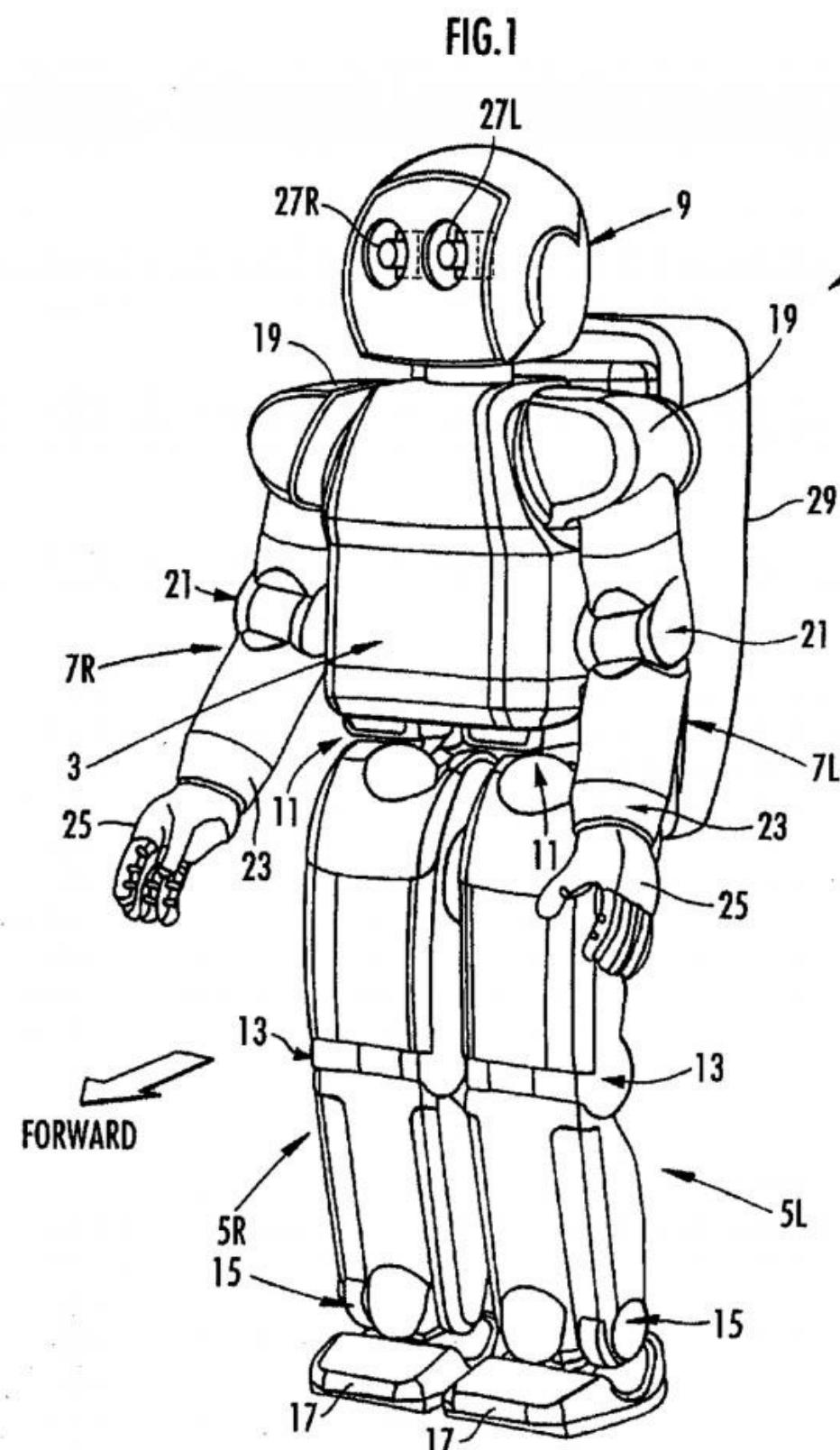
- <https://assetstore.unity.com/packages/3d/props/tools/carpenter-tools-118471>
 - joking tools for cooking
- <https://assetstore.unity.com/packages/3d/props/furniture/modern-furniture-pieces-pack-81417>
 - additional furniture pieces
- <https://assetstore.unity.com/packages/3d/props/furniture/gray-furniture-pack-40580>
 - gray furniture
- <https://assetstore.unity.com/packages/3d/props/furniture/chalet-style-furniture-31966>
 - chalet dark wood furniture
- TV from museum example



FEATURES AND DEPENDENCIES: OBJECT MODELS

- <https://assetstore.unity.com/packages/3d/props/interior/ygs-mugs-96665>
 - coffee mugs
- <https://assetstore.unity.com/packages/3d/props/interior/kitchen-props-free-80208>
 - mugs, plates, toaster
- <https://assetstore.unity.com/packages/3d/environments/fantasy/pirate-tavern-113463>
 - mugs, plates, etc
- <https://assetstore.unity.com/packages/3d/props/interior/props-for-the-classroom-5977>
 - classroom objects



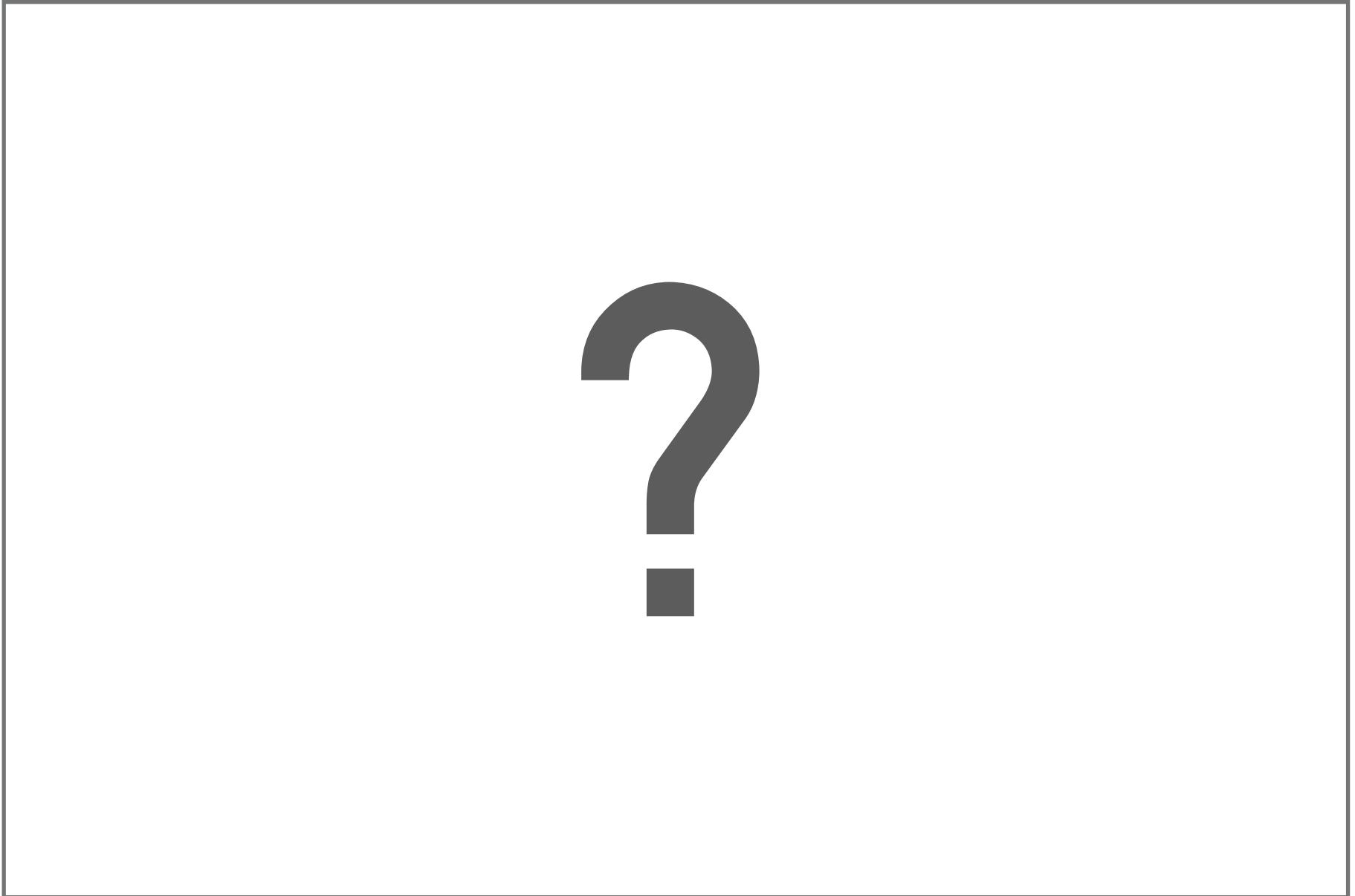
**FIG. 13**

USER TESTING AND FEEDBACK

USER PERSONA AND NEEDS

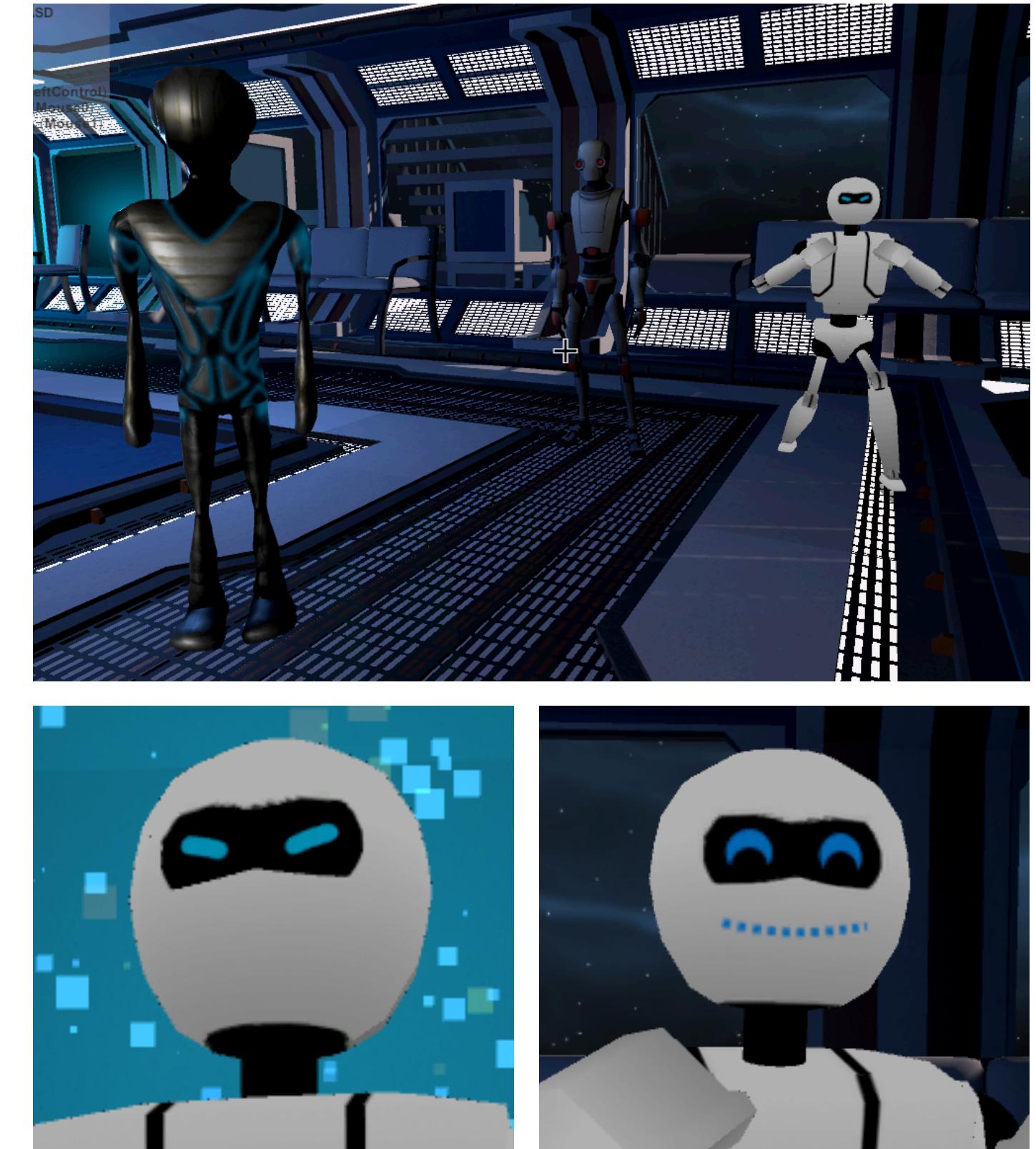
- (child) - ~7 yr old
 - Goals: have fun, learn a little
 - Experience: very little
 - Requirements:
 - Visually interesting for short-attention span
 - Possibly, ability to read prompts

- (adult) - ~30-40 yr old
 - Goals: laugh, quick in+out for game
 - Experience: moderate to high
 - Requirements:
 - Comical
 - Simple but entertaining game play



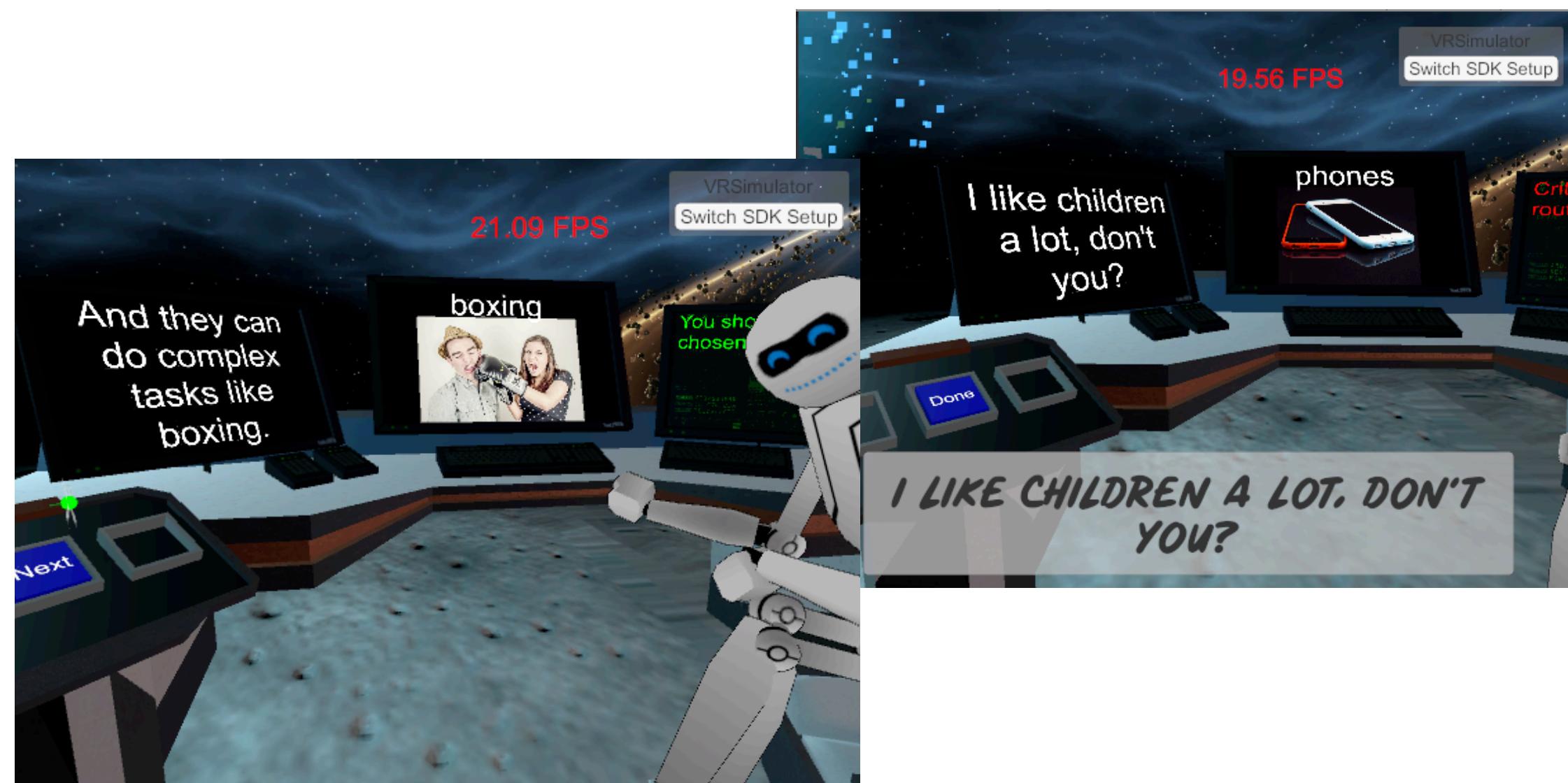
USER TESTING RESULTS (RECORDED IN TIME ORDER)

- 7/6 - Child was tested with several robot appearances. She choose the white "toon" robot for primary use.
- Child user preferred "happy" toon face, so minor material updates were made to source robot.
- Child wanted to let each robot have a different name. This modification can be evaluated as a canvas on the robots, but will likely get scoped out due to time.



USER TESTING RESULTS (RECORDED IN TIME ORDER)

- 7/8 - Adult play tested with dialog and initial comical sense of robots in different scenarios
 - results were very positive and encouraging
 - font and mild sarcasm was appreciated
 - additionally, "cartoon" nature of robot was appreciated and did not detract from the game
- 7/10 - Developed with a child, the reading/listening game should be fun for most
 - based on simple stories with silly substitution parts
 - simple textual and visual responses should make it easy to appreciate



USER TESTING RESULTS (RECORDED IN TIME ORDER)

- 7/12 - testing with cooking/doing stage added a few cute details to the robots, like a chef's hat
- 7/13 - a few profiling rounds found nothing remarkable
 - some of the render textures are expensive but okay
 - no scenes are particularly lagging
 - no excessive script calls, some 4.5k draw calls
 - in testing on development desktop (not VR rig), frame rate did drop to 10FPS or below



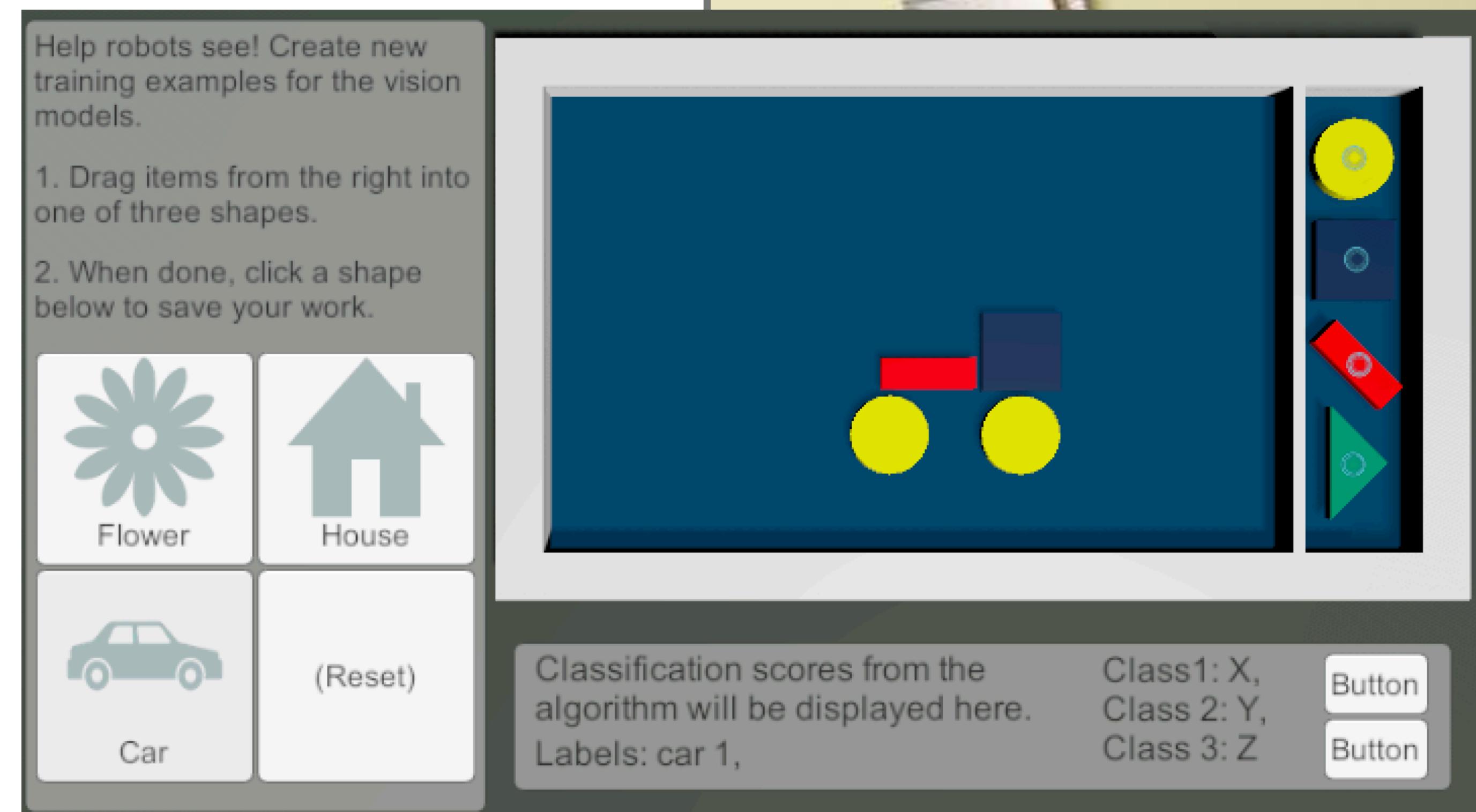
DELIVERABLE SCOPING (FULL LOG)

- 7/5 - Created design docs (this log) and scoping
- 7/6 - Scene and environment scoping, after discovery of the stylized sci-fi module, it appears that environment creation time can be reduced.
- 7/6 - Kinematics for robotic actions
 - Kinematics for robot more challenging than suspected, a "follow IK" script is good example
 - Deferred: Initially kinematics for repeated actions will loop on one task, but eventually they should be programmatically conditioned
- Text-to-Speech and audio generation for robot speech will be deferred until almost the last point in the game; instead text captions will be used.
 - `AudioClip clip2 = Resources.Load<AudioClip>("Sounds/cube_up");`
- 7/8 - The dialog system appears to work well for showing robot conversations with triggers.



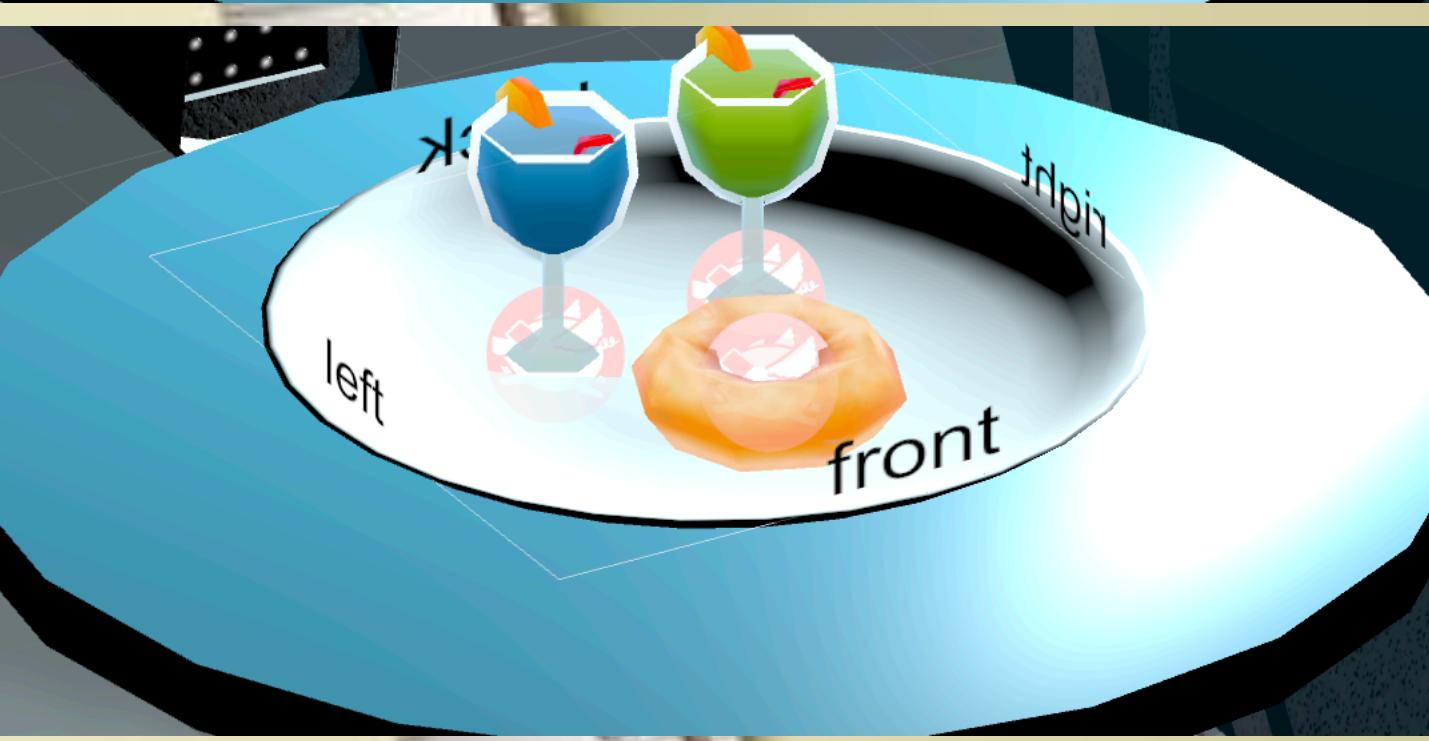
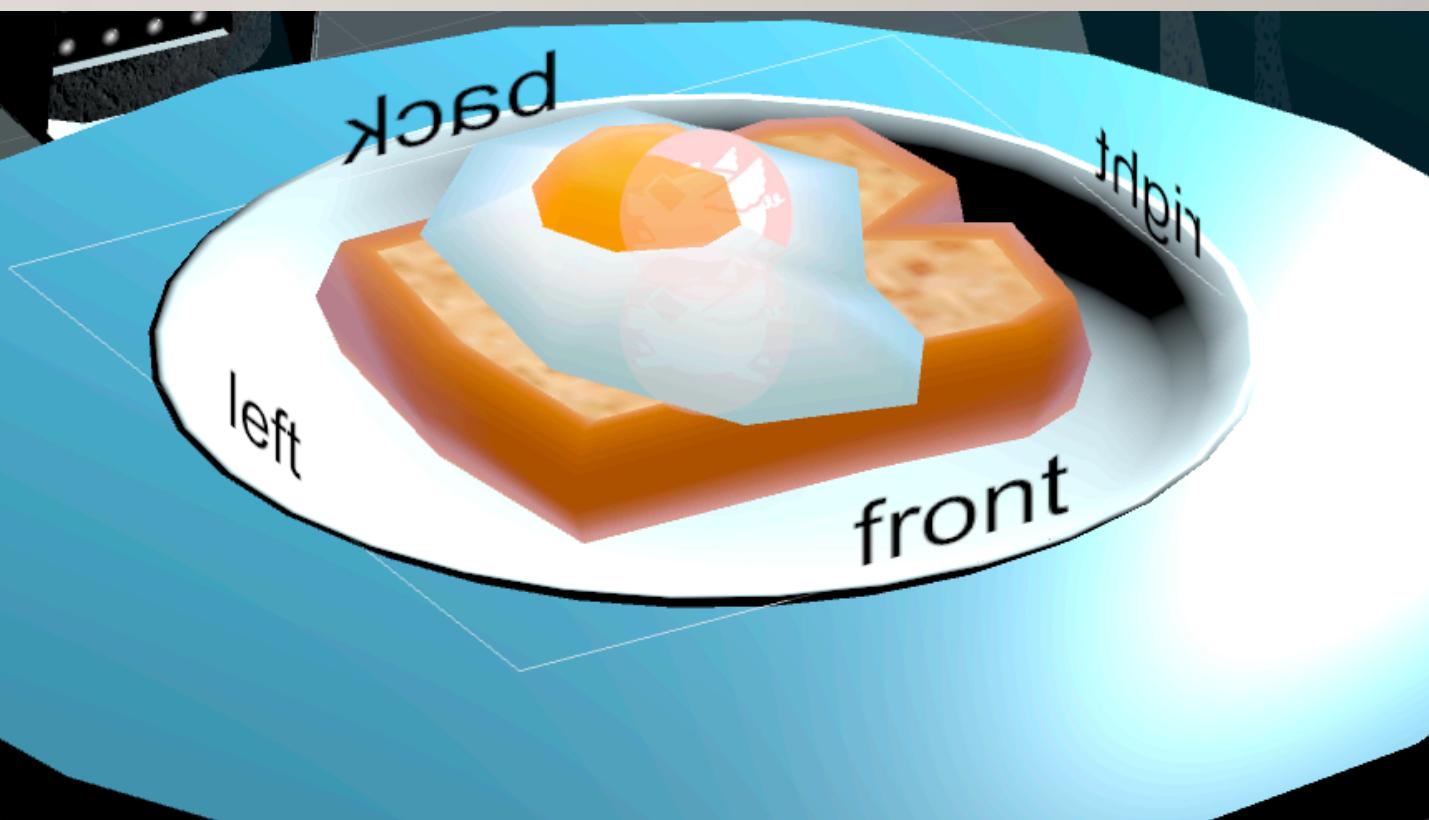
DELIVERABLE SCOPING (FULL LOG)

- 7/8 - inspired by 2D drag+drop tutorial, created 2D tool to seed training and evaluation of seeing (primitive object task, below)
 - serialize to data that can be used for training
 - quick evaluation of interaction schemes with VR tools
- 7/10 - listening/reading was completed with simple button interaction as first pass
 - two stories currently included
- 7/10 - move to simplified IK task
 - make robot mirror person
 - goal is to create an object with robot instead of human alone
 - reduced scope of record+playback



DELIVERABLE SCOPING (FULL LOG)

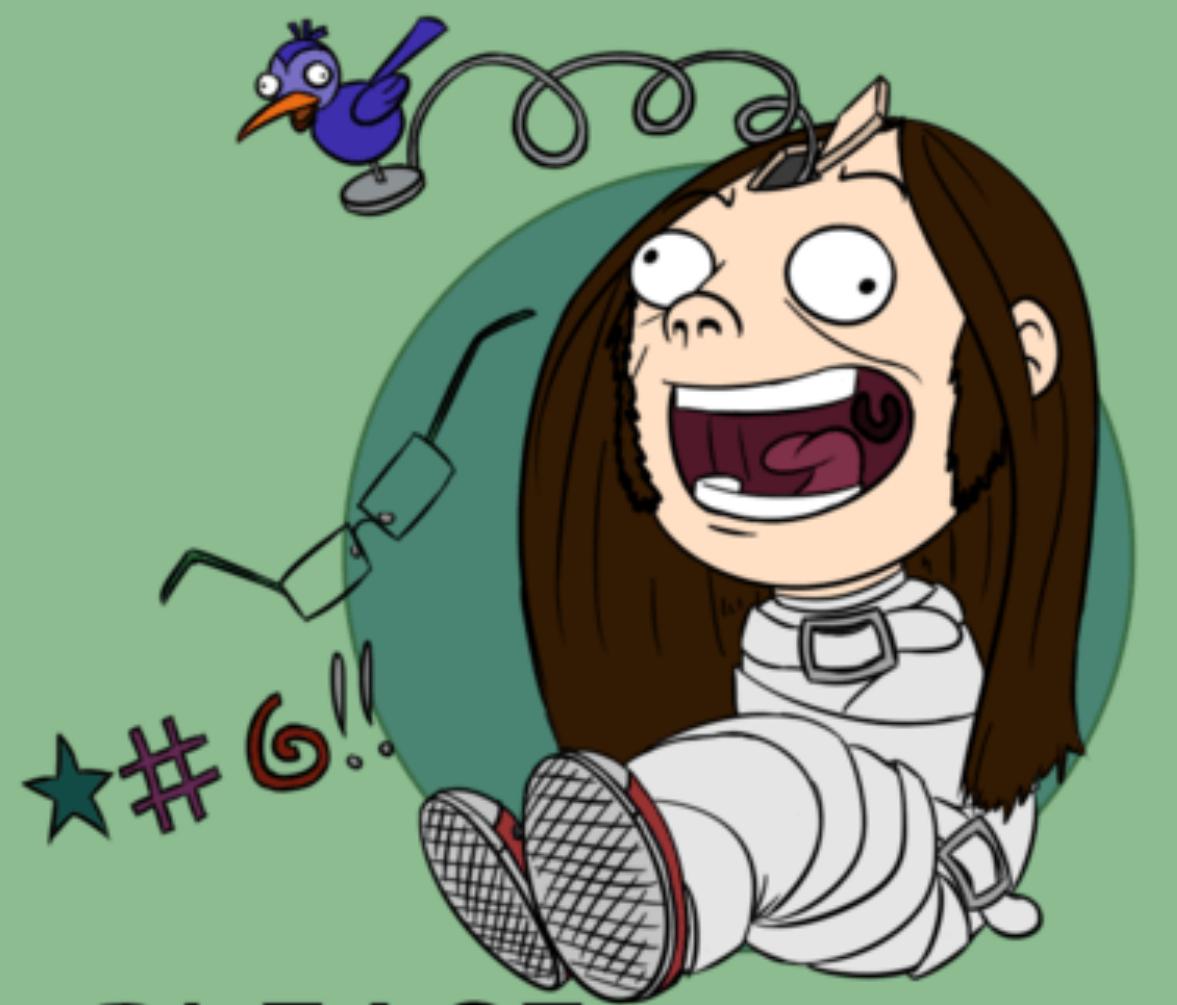
- 7/11 - 2 stories for reading/listening is sufficient
- 7/11 - doing task has one food building right now, need to work on sync with robot IK interaction
- 7/12 - speech recognition libraries may be a non-starter because they require additional builds or hooks for streaming
- 7/12 - reduced complexity of food to mirror
 - turned off physics (although cool) because it made matching too hard and pieces were always moving
 - reduced recipes to be simple 2-3 piece items for evaluation
- 7/12 - finished recording and assigning robot voices
 - completed idle robot "sentry" via IK animation as filler and additional testing within Unity; possibly expand to Boids Flocking?



DELIVERABLE SCOPING (FULL LOG)

- 7/13 - closing notes
 - it was disappointing to not have any home-grown ML, particularly given the effort of collecting data; some flocking code may be investigated, but "seeing" task was incomplete
 - speech recognition was fun to look at but in the end there wasn't a viable solution that was as out-of-the-box as necessary
 - TTS was replaced with reasonable speech + audio processing; additional tools were available for other effects, but not worth the time to evaluate or utilize
 - overall, for just a 6 day period, the final result is quite pleasing

TECHNICAL DIFFICULTIES



PLEASE
STAND BY

RUNNING TODO (FOR TRACKING)

- Primitives for seeing task
 - basic shapes, snapping deposit location
 - display of status via GUI on adjacent screen
 - creation of buttons to submit and reset (trash?)
 - mode to "REPLAY" shapes for a database
 - stretch: mode to upload/retrieve shapes from online database
- Add some gaming capability (like stars in OSD, etc) for accomplishments and time to completion.
- Stretch goal: enhanced dialog state system
- (possible) Improve story telling task - add 1-2 more stories
- Stretch goal: add speech recognition for listening task





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Eric Zavesky - May-June 2018 - Game Planning