Problem Solving with LEGO

A series of challenges to solve with LEGO that support discussion about programming and general problem solving.

Setup

Divide attendees into groups of 2-4; each group is given a selection of LEGO. Slide deck showing on screen (picture heavy, very little text - session relies on discussion).

Can support up to 5 groups.

Introduction

Aim of today is to give you some fun challenges to attempt by building with LEGO. My job is to cause it to fail… and to show you how the same issues crop up when developing code.

Part 1: What by when?

Challenge

Introductory slide is shown explaining that the LEGO is to be used to build a vehicle given their specification. Groups are given a set of LEGO each and 5 - 10 minutes to meet their specification.

Options

See appendix for specification sheets (handouts). Note that extra bricks should be added just to cause confusion.

Discussion

Groups asked how they got on - any issues?

- Enough information or too vague?
  - Over specified - solutionised, no room to determine a better solution
  - Too vague - “ooooh you meant…”
- Distracting?
  - What they’d like vs what they’d need…
- Was the language clear?
- Did you use all the bricks?
  - Don’t need to

Learning Points

- You need to confirm what you will deliver - is it possible?
- Ambiguity? Common language used?
- What did the customer actually need vs what they thought they wanted?
- Can you prove you met the brief?
- Bricks cost $$$ - think of it as too complex code, or covering more than you need to “just in case”. So try to be economical.

Part 2: Testing, testing, 1, 2, 3…

Next slide - reveal the map.

Challenge

The groups have to use their vehicles to transport various items across a route. Vehicles must be land based. There are various challenges - bridges, tight areas, winding roads, etc. It is a 15 hour journey across the entire map.

This is what the customer actually needs vs what they may want…

How will they get meet the requirement? How will you prove you can do this? You can use more LEGO to help (reveal shared pile). 5 minutes given. Best solution is one that uses minimal bricks proving you've met the requirement - this is a shared resource…

Map features:

- Low tunnel (6 tall)
- 45 degree camber (don't drop the load!)
- Sharp bend (road barriers - but if you're above 3 tall you can go over them - long items need to go over)

Options

Bucket of LEGO made available; the aim is for groups to realise they can represent the "special features" on the map and trial with these representations.

- Arches - map size of tunnel
- Long bricks to represent narrow straights / bridge sections?

Discussion

Go around the groups as a discussion point.

- A lot of the map is nothing special; the bridges, tight areas, etc. are special
- These are "edge cases"
- If you can create these in LEGO, you can test it "in the garage"
  - No need for 15 hour journey only to fail at the last challenge

Learning Points

- How do you think this maps to programming?
  - Unit testing
  - Small datasets to show the code works
  - "Fail early" - fix it and move on or change your approach
  - If you fail when learning - you've learnt something! Try to avoid it when there's a big project with a deadline - in which case fail early, avoid the rabbit hole / booby trap.

Part 3: Extending with a KISS

Next slide - reveal new mission.

Challenge

You must now extend your transportation to carry very long objects… or wide… or liquid… etc. [select different challenge per group - aim for their weak spot to provide a challenge]

Meet this requirement with the minimum of rebuilding. 5 mins to rebuild, then discuss. As before, fewest new bricks is best.

Options

Cargo could be:

- Very long bars
- Top-heavy shape (aircraft wing)
- Carry people (mini figures!) - boy are they a pain to fit in [caveat - just stash them in, no comfort requirements]; 3 per group
- Pallets [4x4 flat with 1x4 rails underneath, goods on top]
- Very large tyre (technical LEGO)

Discussion

- Did you have to tear the vehicle apart? Why?
  - If it was built in sections that weren't totally tied into each other, easy change
  - Did you notice the enforced / implicit pattern: locomotion separated from freight by flat base (wheels underneath, everything else above)
    - Could change to tracks easily
- Hopefully gets to show modularity
- Did your vehicle still make it around the map?
  - Tests must still pass!

Learning Points

- How do you think this maps to programming?
  - Isolated chunks of code are easier to modify than a stream of consciousness
  - Termed "single responsibility" - focus code
  - Reduce dependencies
  - Keep it simple, stupid!

Part 4: Blue Peter

Next slide, new mission.

Challenge

Transport occasionally changing goods - need flexibility. More bricks given to each team - and some kept hidden. Tell groups there are more LEGO bricks, just ask and we'll see if we've got anything that can help.

Note: some bricks have logos / stickers on; there's even some fully build segments hidden and only presented if they ask specifically for something…

What's the least effort you can put in (and fewest bricks) to meet the extended brief? 5 mins…

Options

Goods available to assign to teams (don't make it easy - select the ones more likely to cause a challenge!)

- Spare vehicle in case of breakdown
- Lifting palettes
- Water (no, really - real water - but they'll have to imagine… for the avoidance of doubt, LEGO bricks leak along seams…)
- Mini figures - in comfort. Must be able to get in & out (provide hinge bricks as a distraction)
- Rapid dump of bricks
- Scoop bricks

Bricks available:

- Doors
- Trailer and a tow-bar
- Fork lift / complete fork lift truck
- Tipping bucket
- Random bricks with logos but prebuilt into useful shapes
- Articulated lorry bases
- Dump truck back

Discussion

- Anyone use bricks with logos / stickers on?
  - Did you ask what they meant?
  - You mean you didn't check the license? Cash please… and all the data must be open sourced…
- How about a trailer? Bucket? Grab?
  - Insta-fix!

Learning Points

- How do you think this maps to programming?
  - Look for previous solutions - libraries
  - Do you know what to ask for - exactly? Difficult. Hit a search engine and try different ways of phrasing the problem. Someone, somewhere will have asked it…
  - Licensing - lovely bit of code, whats its providence? From where? Yikes. That was copyrighted from a 3rd party library with a horrendous license… $$$$$$
  - A library may be the magic wand that solves your problem
    - Anyone need a trailer?
    - Don’t write it because you can unless for a very good reason
    - Libraries (usually) are work hardened and tested
    - Write your own will teach you about the internals - but does it help?
    - It may also open up other ways of doing things for very little cost - as libraries often “daisy chain” (see scikit learn in Python, or pandas as a common data structure)

Bricks to allocate

All must include extra but very similar bricks to provoke confusion…

Specification 1

Car and lorry parts

Specification 2

Car and lorry parts

Specification 3

- One flat 10x4 block
- Two flat 2x3 blocks
- One 2x4 block
- Two 2x3 blocks
- Three 1x4 blocks
- Two clear ramped 4x4
- Two clear 2x4 block
- One clear 1x2 block
- Two 1x1 blocks
- Two wheel blocks

Specification 4

Car and lorry parts with a tow-bar

Specification 5

Car and lorry parts with a tow-bar… and parts for an aeroplane

Specification #1

Build a vehicle

Specification #2

Build a vehicle that can carry freight

Specification #3

Obtain:

- One flat 10x4 block
- Two flat 2x3 blocks
- One 2x4 block
- Two 2x3 blocks
- Three 1x4 blocks
- Two clear ramped 4x4
- Two clear 2x4 block
- One clear 1x2 block
- Two 1x1 blocks
- Two wheel blocks

Attach one 2x4 block underneath the flat 10x4 block, aligned at 90 degrees to the major axes and positioned at the end

Position wheel block against the 2x4 block

Attach two 2x3 blocks in front of the wheel block

Attach a wheel block in front of the two 2x4 blocks

Attach a 1x4 block in front of the wheel block

Attach ramped clear block at front of flat block

Attach 1x4 behind ramped clear block

Attach 1x2 clear block on top of 1x4 block

Attach two 1x1 blocks on top of 1x4 block, on either side of 1x2 clear block

Attach one 2x4 flat block on top of clear blocks

Specification #4

Build a vehicle that can tow

Specification #5

I need a vehicle - I’d love one that can fly