Warman Design Project

Team 42

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Functional Requirements:

- System must be able to carry 10 Wilson Tour Competition Tennis Balls which have a diameter of 6.75cm.
- The system must also be able to deposit these 10 balls into 4 different vessels, which vary in height from 80mm to 300mm.
- System must be autonomous, cannot have any physical contact with any team members or use any wireless systems to alter its path.
- The system must navigate around or over obstacles on the track, which include a PVC rod and the 4 vessels.

Other Requirements:

- System cannot exceed a mass of 6kg.
- Initial total cubic volume of 500mm x 500mm x 500m.
- System must leave the start/end zone, navigate through the 2.4m x 1.2m track, complete the deposit functions and return to the start/end zone in under 120 seconds.
- The system cannot have any untethered flying systems, and at any given time a part of the system must be in contact with the track.
- Considering the spirit of the competition, the system must be built using off the shelf parts (excluding LEGO), meaning an established system cannot be bought, although parts may be modified.
- Must be started by a single action by a team member without imparting energy (such as pushing).
- System cannot leave parts behind on the track apart from the payloads.

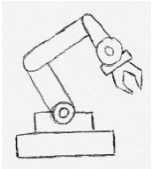
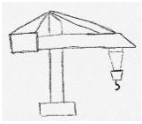
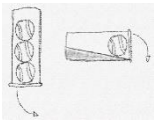
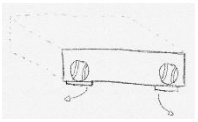
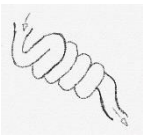
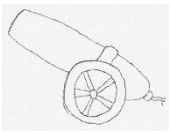
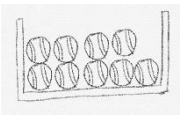
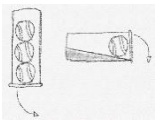
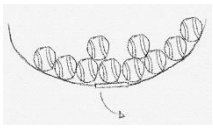
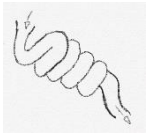
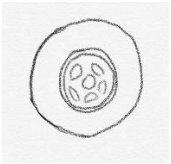
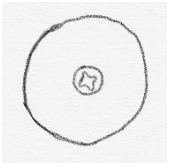
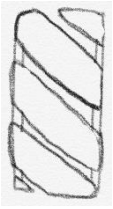
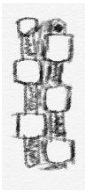
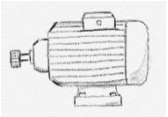
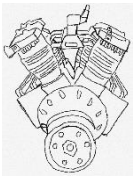
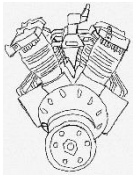
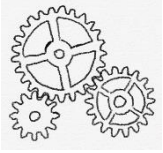
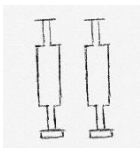
Design Objectives:

- Minimise the time it takes to complete the requirements set out by the Warman Design Competition.
- Maximise the safety precautions such as by conducting risk assessments and testing, to minimise risks to spectators and potential users.
- Minimise the cost of production, to reduce the associated number of parts and difficulty of assembly.
- Minimise the steps of manufacturing so assembling the system is easier.

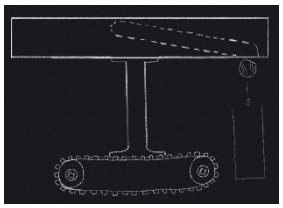
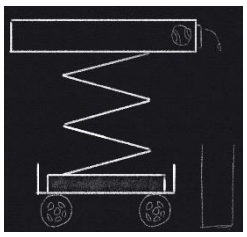
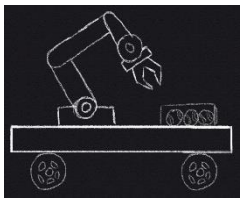
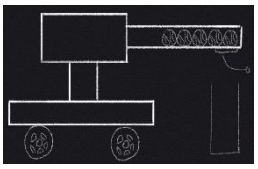
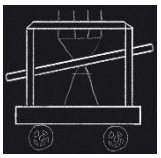
Problem Statement

Move Device > Secure Balls > Avoid Obstacle > Deposit Balls > Control Motion > Return to Start

Morphological Matrix

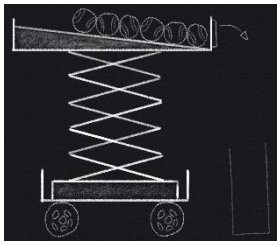
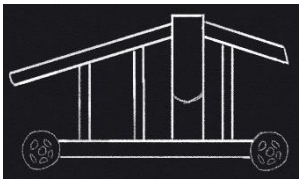
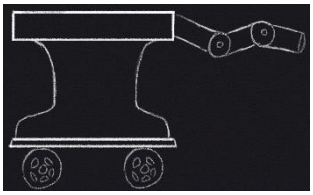
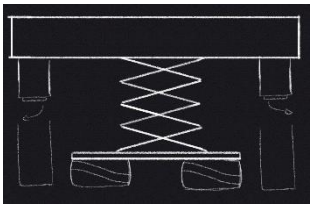
Sub-problem	Sub-problem Alternatives					
Depositing	Robotic Arm 	Crane 	Cylindrical Container 	Box Container 	Spiral Tube 	Projectile canon 
Storage	Hopper 	Cylindrical container 	Dispenser 	Spiral Tubes 	N/A	N/A
Providing Support	Wheels 	Tracks 	Skis 	Balloon Tyres 	Mecanum Wheels 	Omni-directional wheels 
Power	Electric Motor 	Petrol Engine 	Diesel Engine 	N/A	N/A	N/A
Transmitting Power	Gears 	Hydraulics 	N/A	N/A	N/A	N/A

Pugh's Matrix 1

Categories	Concept A (Baseline)	Concept B	Concept C	Concept D	Concept E
					
Stability	Not great because it only has 1 pillar to stand on. Could add more. N/A	Scissor mechanism not very stable. Could make it a double scissor mechanism. -VE	The arm of the robot could change the Centre of Mass, otherwise quite stable. +VE	Centre of Mass would change due to extending arm. Only 1 pillar joining chassis and mechanism, thus unstable. -VE	Quite stable due to the position of the wheels. +VE
Accuracy	Fixed height, therefore, not great because payloads could bounce out of the drop-zones. N/A	Quite accurate due to a varying height. +VE	Very accurate, considering the code for the arm is done correctly. +VE	Accurate due to the extending arm. +VE	If the wheels align themselves properly, it could be accurate. EQUAL
Speed	Tracks would be slower, and they will take time in aligning with the drop-zones. N/A	Scissor mechanism could take time winding and unwinding, and gates could take time opening. EQUAL	Relatively quick, deposits fast, however it will take time to put the tubes back. -VE	5 motors so would be quick. +VE	Would need to slow down when going over the obstacle. EQUAL

Buildability	Depositing Container hard to build. N/A	Depositing container hard to build, as well as scissor mechanism. -VE	Difficult to code the robotic arm and make it precise. -VE	Lots of mechanical parts, so had to build. -VE	Design could be heavy, so materials cost and difficult to get the top part right. +VE
Cost	Expensive due to multiple complex parts. N/A	Quite costly due to the depositing container, as well as the scissor mechanism. +VE	Could be very expensive due to the robotic arm. -VE	Expensive due to the depositing container and multiple motors. -VE	Fairly reasonable as there isn't many complex mechanisms. +VE
Overall	N/A	0	-1	-1	3

Pugh's Matrix 2

Categories	Concept A (Baseline)	Concept B	Concept C	Concept D
				
Stability	Fairly Stable, due to double scissor mechanism. Potentially unstable whilst depositing. Could enlarge wheels. N/A	Fairly stable, could enlarge wheels for more stability. -VE	The mass of the robotic arm while depositing could alter the Centre of Mass of the system, otherwise stable. -VE	Very Stable due to wide wheels. +VE

Accuracy	Fairly accurate, if it aligns itself with the drop-zones. N/A	Could be inaccurate for drop-zones ‘A’ and ‘B’, due to the inability to change height. -VE	As long as the code for the robotic arm is done correct, it will be accurate. +VE	Fairly accurate, due to varying height. +VE
Speed	Scissor mechanism could take time to wind and unwind, otherwise quick. N/A	Quite fast due to low mass and multiple motors. +VE	Robotic arm may take time aligning itself with the drop-zones, otherwise fast. -VE	Rollers with aligned tread means it doesn’t have to jump over the obstacle. +VE
Buildability	Easy to build apart from the scissor mechanism. N/A	Not many complex systems so should be easily buildable. +VE	The robotic arm would be hard to code -VE	Difficult to build due to multiple complex systems i.e Rollers with aligned tread, scissor mechanism and depositing box. -VE
Cost	Scissor mechanism, motors and microcontroller may increase the price but within reasonable range. N/A	The middle segment could be costly to build, maybe 3D print. EQUAL	Costly due to the Robotic arm and the large support wheels. -VE	Lots of complex mechanisms means a high cost. -VE
Overall	N/A	0	-3	1