

RSC 'Cliffhanger' – A solution



Known facts



The coach was a Harrington Legionnaire (ALR 453B) from which the seats had been removed. This model is 11m long.



The driver's seat is separated from the body of the coach by a screen

The Italian Job was released in 1969 and was set in the 'present day'.

The stolen gold was worth \$4m.

During 1969 the price of gold averaged \$41 per troy ounce.

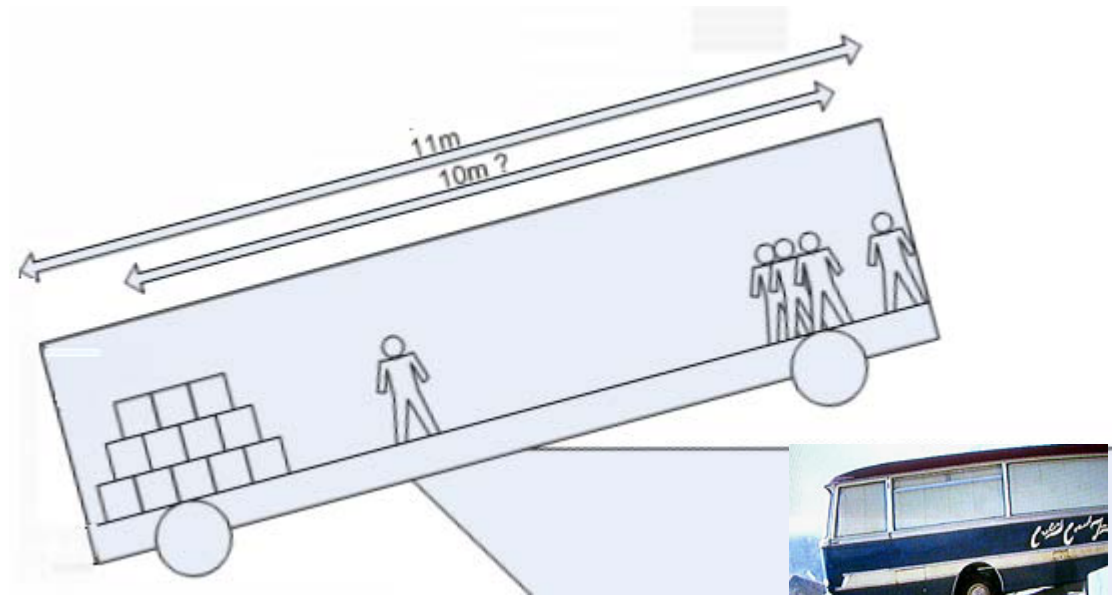
Gold bullion is transported in 400 troy oz bars (approx 12.5kg)

The coach was balanced at the point our plan begins.

There were 14 gang members present in the coach (six from the minis, seven from the dormobile plus William the driver).

Acceleration due to gravity is 9.8ms^{-2}

Assumptions



The gold is roughly 10m from the front door of the coach.

The screen behind the driver is 80-100cm from the windscreen.

The weights of the 14 gang members were roughly as follows:

Name	Weight /kg
Charlie Croker	80
Bill Bailey	80
Chris (mini)	75
Tony (mini)	75
Dominic (mini)	75
Big William	95
Arthur	80
Frank	80
Rozzer	80
Coco	80
Yellow	70
Camp Freddy	75
Roger	80
Dave	80
TOTAL	1105

Note: no assumption about the weight of the coach is required.

The Plan



How to stop the coach from toppling?

The coach is finely balanced. The moment of the gold in the rear of the coach (plus Charlie) about the cliff edge fulcrum is balanced by the moment of the rest of the gang in the front plus the net moment of the coach. If the cliff edge collapses the coach will fall so any further attempt must be supported by increasing the clockwise moment (as viewed on the diagram).

Maximizing the clockwise leverage can be achieved by getting as many of the gang as possible further forward to the front of the coach. William, in the driver's seat, is already well positioned however the rest of the gang are all behind the driver's screen separating the driver from the passengers and could move further forward by at least 50cm.

Minimizing the anticlockwise leverage can be achieved by using the lightest gang member to collect the first bar of gold. 'Yellow' appears to be about 70kg.

So, if the 12 heaviest gang members less William (collectively weighing 940kg) move an average of 50cm further forward to join William this would increase the clockwise moment by $0.5\text{m} \times 940\text{kg} \times 9.8\text{ms}^{-2} = 4606\text{ Nm}$.

Yellow could then move 6.7m ($4606 / 70 / 9.8$) further towards the gold than Charlie could without risk of the coach overbalancing. The coach is only 11m long and less than half is overhanging so this would provide an ample safety margin.

How heavy is each gold package?



\$4m gold bullion =
 $\$4,000,000 / \$41 \text{ per oz} / 400 \text{ oz} = 244 \text{ bars}$.

The bars are packaged but it is unclear how many are in each package. Judging from the film the stack is about 7 packages high, three wide and three deep. This suggests the bars are four to a package and there are 61 packages.

Thus each package weighs approximately 50kg. This is a considerable weight for one person to lift and likely to be too much for the slighter members of the gang. However, we know that some of the gang members are strong enough to move a package by themselves as the film shows three of them filling the minis from the bullion van.

Who should collect the first bar?

If a stronger gang member (perhaps weighing 80kg) were to collect the first gold package instead of Yellow the incremental clockwise moment of the gang (now reduced to 930kg) would only be 4557 Nm. The stronger collector would only be able to move 5.8m further than Charlie however this is still well within safety margins.

Thus, the first person to collect a gold package should not be the lightest but the strongest in view of the considerable weight involved. He should act alone walking as quickly as possible towards the gold (his speed should have no effect on the stability of the coach).

There is no special action to take at the moment the gold package is lifted as the net moment is unchanged. He should return as quickly as the load will allow and deposit it near the rest of the gang at the front of the coach.

How to beat the 30 minute time limit?

There are 61 packages each weighing 50kg to be moved approximately 10m in 30 minutes. This would be too much for one person to do alone.

The time taken for one person to walk 10m, pick up a 50kg package and then stagger back 10m uphill and deposit it could well be 2 minutes if acting alone and probably more for subsequent trips.

Acting with a partner this could be reduced to perhaps 30s.

Once the first gold package has been retrieved the clockwise moment would have been increased by $10\text{m} \times 50\text{kg} \times 9.8\text{ms}^{-2} = 4900 \text{ Nm}$. NB This is more than the entire clockwise moment increase caused by the gang moving forwards 0.5m.

A team of two 80kg collectors would now be balanced by the first gold package and the rest of the gang (now reduced to 850kg) giving a total of $4900 + 4165 = 9065\text{Nm}$. They would thus be able to walk 5.8m further than Charlie. This is still within safety margins.

So, the second trip should be made by a team of two (giving the first collector a rest).

When the second package has been delivered the clockwise moment will have increased again but not sufficiently to make it safe for two teams to be brought into play so a second team of two should make the third trip giving the first team a rest.

When three packages have been deposited it is safe for two teams to operate together. When five packages have been deposited it is safe for three teams to operate at once delivering 6 packages per minute.

Subsequent packages can be thrown straight out of the coach front door as the additional counterbalance is not required.

So, the 30 minute limit would break down as follows:

Planning	5 mins
First package	2 min
Second package	30s
Third package	30s
4 th / 5 th packages	30s
6th – 61st packages	10 minutes
Throw out packages 1-5	1 min
Gang leave coach	2 mins
TOTAL	21min 30s

QED

JKS