



Designing a Water Slide

What will be the best way to enjoy 20m high water slide?

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The Scorpion's Tail

Height : 55 ft

Starting Angular : 70 deg

Loop height : 27 ft

Loop Angular : 30 deg

Speed : 30 mph

Length : 400 ft

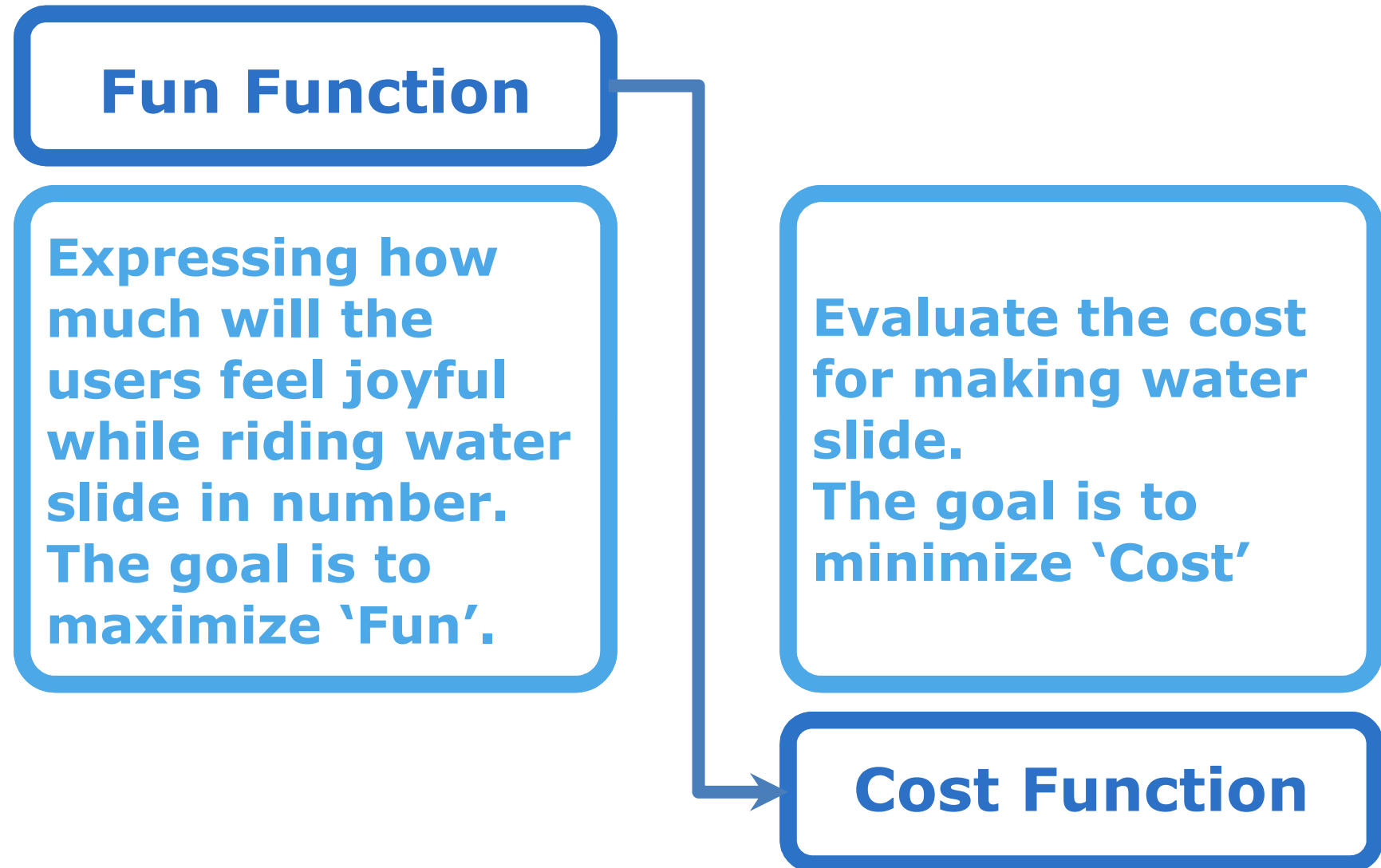
GOAL!!

Gravity : 3G

Time : 9~14 sec

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www.noahsarkwaterpark.com

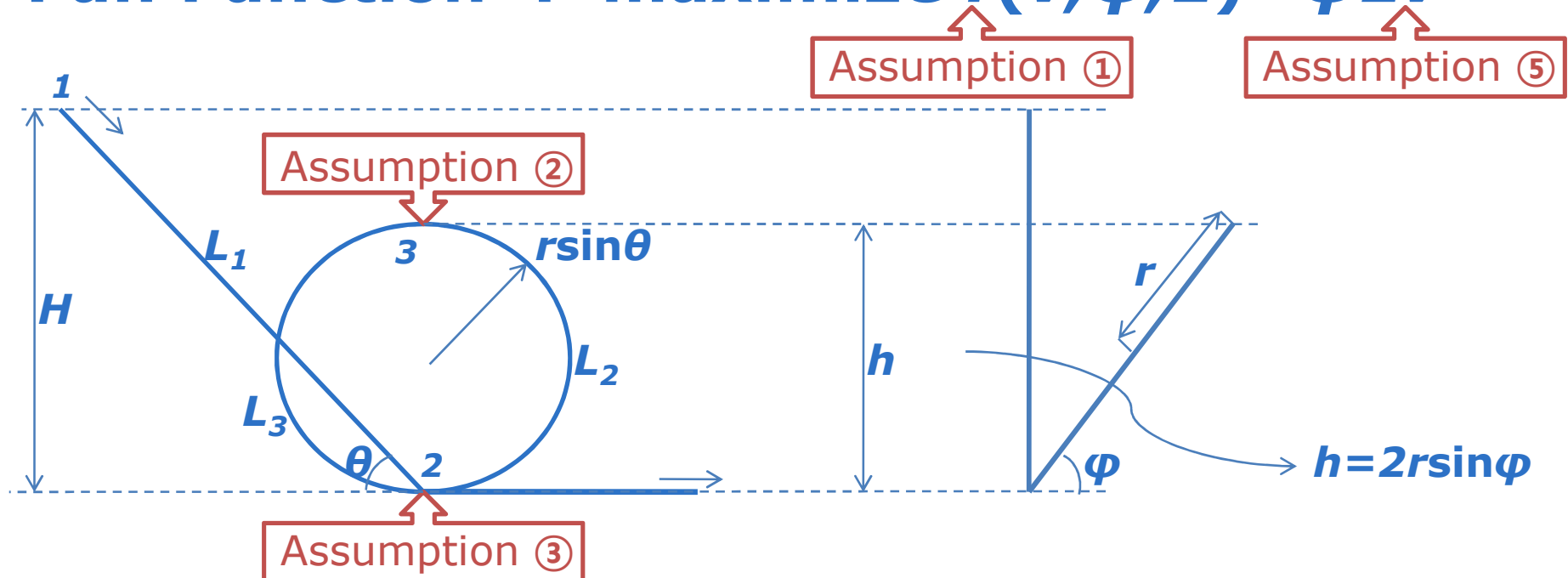




Assumptions for Fun Function

1. People feels joy proportional to ① the speed at the top of the loop, ② looping angular and ③ the total length
2. Looping part of the slide is a circle
3. Part before the looping part of the slide is a straight line and it is connected smoothly to the looping part
4. The total length of the slide is from the beginning to the end of the looping part of the slide
5. A coefficient of fun = 1

Fun Function : maximize $f(v, \phi, L) = \phi L v$



1. Total length L

$$L_1 = H / \sin \theta, \quad L_2 = L_3 = \pi r$$

$$\therefore L = L_1 + L_2 + L_3 = 20 / \sin \theta + 2\pi r \quad \leftarrow \text{Assumption ④}$$

2. Speed at the top of the loop v

$$PE_1 = PE_3 + KE_3 + FE_3$$

$$mgH = mgh + mv^2/2 + \mu mg(L_1 + L_2)$$

$$v^2/2 = 20g - 2g\sin\phi - \mu g(20/\sin\theta + \pi r)$$

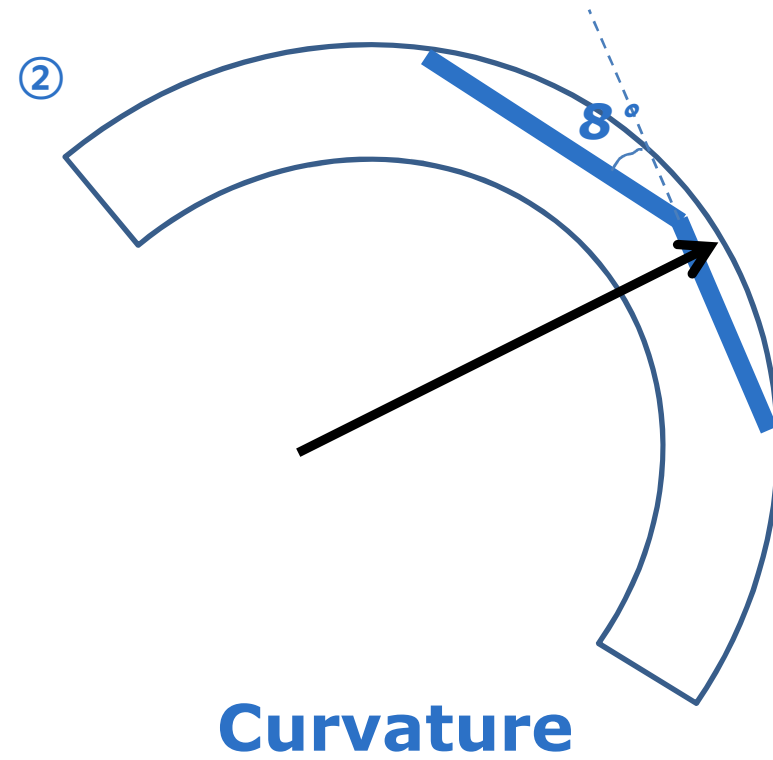
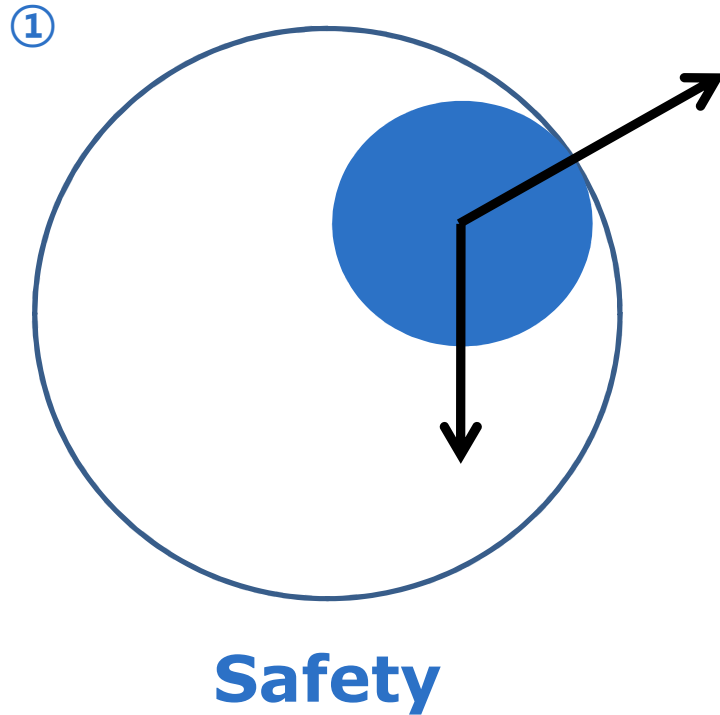
$$\therefore v = \text{SQRT}(40g - 4g\sin\phi - 2\mu g(20/\sin\theta + \pi r))$$

Therefore, Fun Function

maximize $f(v, \phi, L)$

$$= \phi(20/\sin\theta + 2\pi r) * \text{SQRT}(40g - 4g\sin\phi - 2\mu g(20/\sin\theta + \pi r))$$

Constraints for Fun Function



Constraints for Fun Function

1. $H=20\text{m}, \theta=70^\circ, \mu=0.09, g=9.81\text{m/s}^2$

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2. $0 \leq \varphi \leq 90^\circ$

3. $6.6 \text{ m} \leq r < 10 \text{ m}$

from constraint ②

4. $(40-40\mu/\sin\theta)\sin\varphi-r-4r(\sin\varphi)^2-2\mu nrs\sin\varphi \geq 0$

from constraint ①

Summary of Fun Function

Fun Function

maximize $f(v, \varphi, L) = \text{maximize } f(r, \varphi)$

$$= \varphi(20/\sin 70^\circ + 2\pi r) * \text{SQRT}(392.4 - 39.24\sin\varphi - 19.62\mu (20/\sin\theta + \pi r))$$

Constraints

1. $0 \leq \varphi \leq 90^\circ$

2. $6.6 \text{ m} \leq r < 10 \text{ m}$

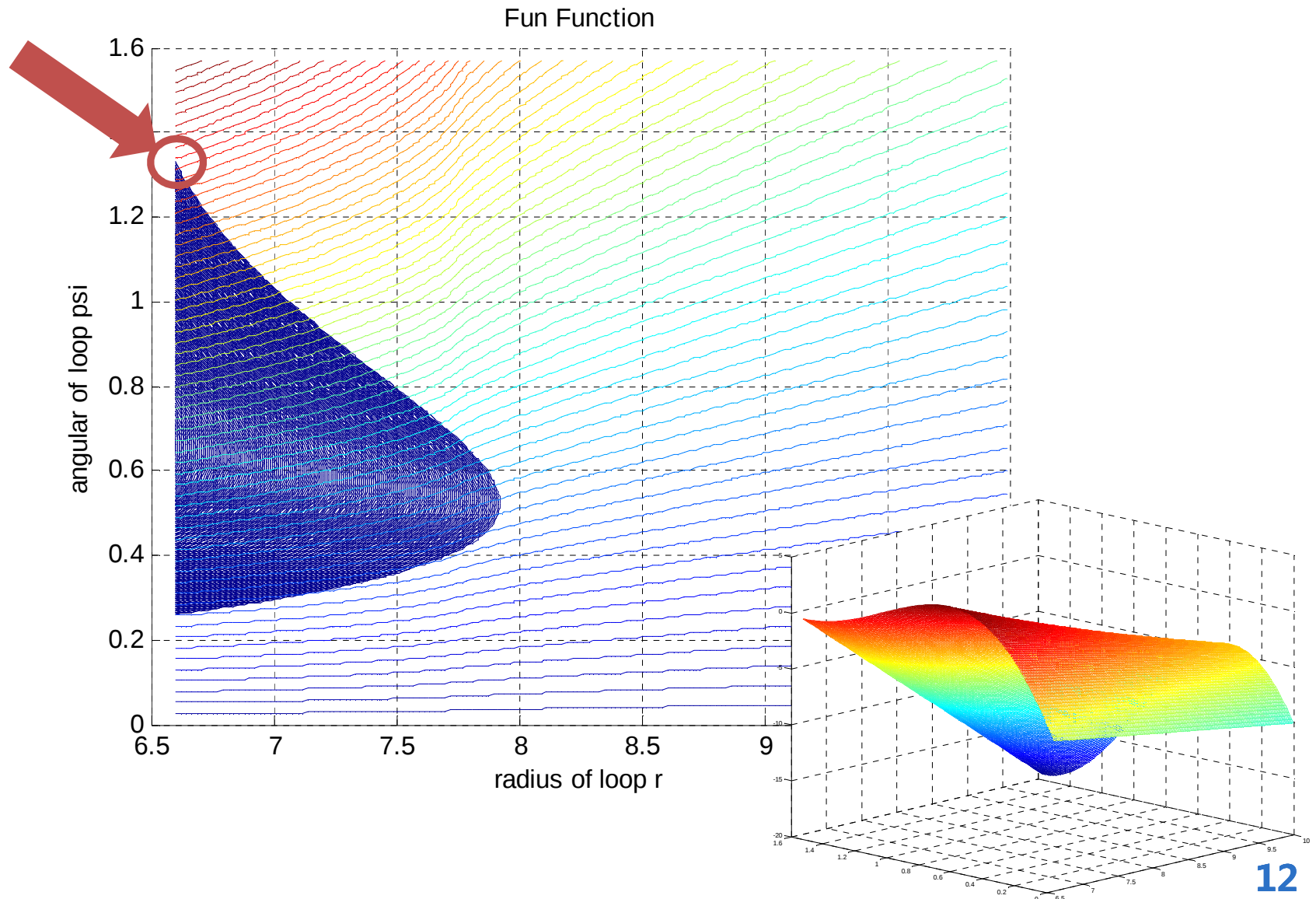
3. $(40 - 3.6/\sin 70^\circ)\sin\varphi - r - 4r(\sin\varphi)^2 - 0.18\pi r \sin\varphi \geq 0$

Result of Fun Function by Excel

	theta	phi	r	mu
Variable	70	76.23	6.6	0.09
Fun	681.7			

Constraints					
g1	70	<=	70	<=	70
g2	0	<=	76.23	<=	90
g3	6.6	<=	6.6	<=	10
g4	9.81	<=	9.81		

Result of Fun Function by Matlab



Result of Fun Function

	Before	After
r	-	6.6 m
ϕ	30°	76.23°
L	-	62.75 m
v	13.4 m/s	18.83 m/s
h	8.2 m	12.8 m
f	-	681.7

Thank You