GG & Co. *Fly, babe fly*

446.686A Design For Manufacturing

2nd Presentation

Development of portable golf ball case to increase driving distance

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Contents

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Introduction

Project Objectives

- Vision statement
 - Development of portable golf ball case to increase driving distance of golf ball

Mission Statement

Product description	• Development of portable golf ball case to increase driving distance of golf ball
Key business goal	New, cheap method to increase driving distance
Target market for the product	• US, Japan, and Korea golf clubs
Assumptions and constraints	• Using same ball, same driver
Stakeholder	Golf ball manufacturing companies, golfers





Finding conditions

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- System configuration
 - Conditioning chamber
 - CCD camera
 - Balance
 - Scale
 - Golf ball (Yamazaki 2piece golf ball)
 - Cover: Urethane
 - Core: Surlyn



Finding conditions (cont.)

Test method

- Keep in conditioning chamber for certain time
- Take out and measure mass, diameter
- Drop the ball and measure time, height and calculate COR



$$COR = \frac{v_{2}' - v_{1}'}{v_{1} - v_{2}} = \frac{v_{2}'}{-v_{2}} = \frac{\frac{d_{4} - d_{3}}{\Delta t}}{\frac{d_{1} - d_{2}}{\Delta t}} = \frac{d_{4} - d_{3}}{d_{1} - d_{2}}$$

* COR: Coefficient of Restitution



Estimation of driving distance

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Estimating initial velocity of golf ball

$$v_1 = \frac{(1+e) \cdot V_1}{1+\frac{m}{M}}$$

Estimating driving distance*

$$\frac{d^{2}x_{n}}{dt^{2}} = -\frac{\rho A}{2m} \left(\frac{dx_{n}}{dt}^{2} + \frac{dy_{n}}{dt}^{2}\right) (C_{D} \cos \theta + C_{L} \sin \theta)$$

$$x_{n+1} = x_{n} + \frac{dx_{n}}{dt} \cdot dt + \frac{1}{2} \frac{d^{2}x_{n}}{dt^{2}} \cdot dt^{2}$$

$$\frac{dx_{n+1}}{dt} = \frac{dx_{n}}{dt} + \frac{d^{2}x_{n}}{dt^{2}} \cdot dt$$

$$\frac{d^{2}y_{n}}{dt^{2}} = \frac{\rho A}{2m} \left(\frac{dx_{n}}{dt}^{2} + \frac{dy_{n}}{dt}^{2}\right) (C_{L} \cos \theta + C_{D} \sin \theta) - g$$

$$y_{n+1} = y_{n} + \frac{dy_{n}}{dt} \cdot dt + \frac{1}{2} \frac{d^{2}y_{n}}{dt^{2}} \cdot dt^{2}$$

$$\frac{dy_{n+1}}{dt} = \frac{dy_{n}}{dt} + \frac{d^{2}y_{n}}{dt^{2}} \cdot dt$$
* P. W. Bearmar – Golf ball aer

e: Coefficient Of Restitution, COR
m: Mass of golf ball [kg]
M: Mass of club head [kg]
V₁: Initial club head speed [m/s]
v₁: Initial velocity of golf ball [m/s]

* P. W. Bearman and J. K. Harvey – Golf ball aerodynamics, Aeronautical Quarterly, pp. 112-122, May 1976



Future works

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- Hit test
 - Measure velocity at the moment of hit
 - Estimate driving distance based on measured values
- Prototype fabrication





Future works (cont.)

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Plans

Dates	March					April				Мау				June	
Plans	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Concept generation		:	-								-	:			
- Mission statement & Brainstorming		:						:			÷	-			
- Market survey		:										-			
		:										:			
Design & analysis		-	÷								÷	-			
- Conceptual design		-										-			
- Detail design		:	:									:			
- Finite element analysis		:	÷	-	-			:				÷			
		:	÷												
Finding conditions		:	-									÷			
- Finding optimal temperature conditions		:	÷					:			-	:			
- Finding optimal humidity conditions		-	÷	-	-							:			
		:	÷									:			
Prototype			-						-			:			
- Prototype manufacturing		÷	÷	-								;			
- Evaluation		:	÷												
		-	÷	-							÷				
Presentation		:	:								:				



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Thank You !

