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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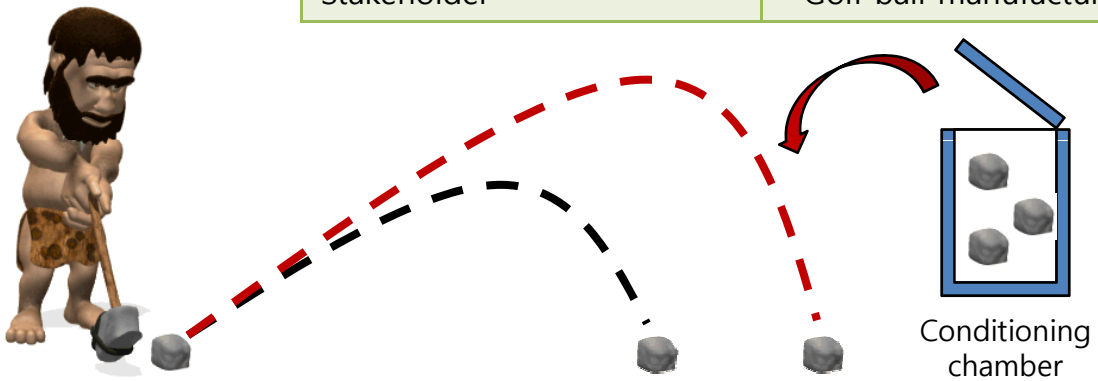
2006-20918 Ji-Seok Kim
2007-20824 Kyung-Tae Lee

Contents

Introduction

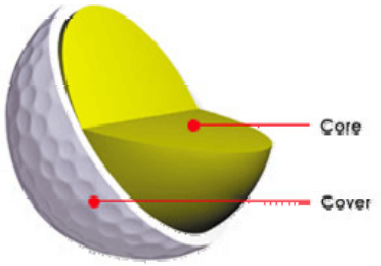
- **Project Objectives**
  - Vision statement
    - Development of portable golf ball case to increase driving distance of golf ball
  - Mission Statement

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

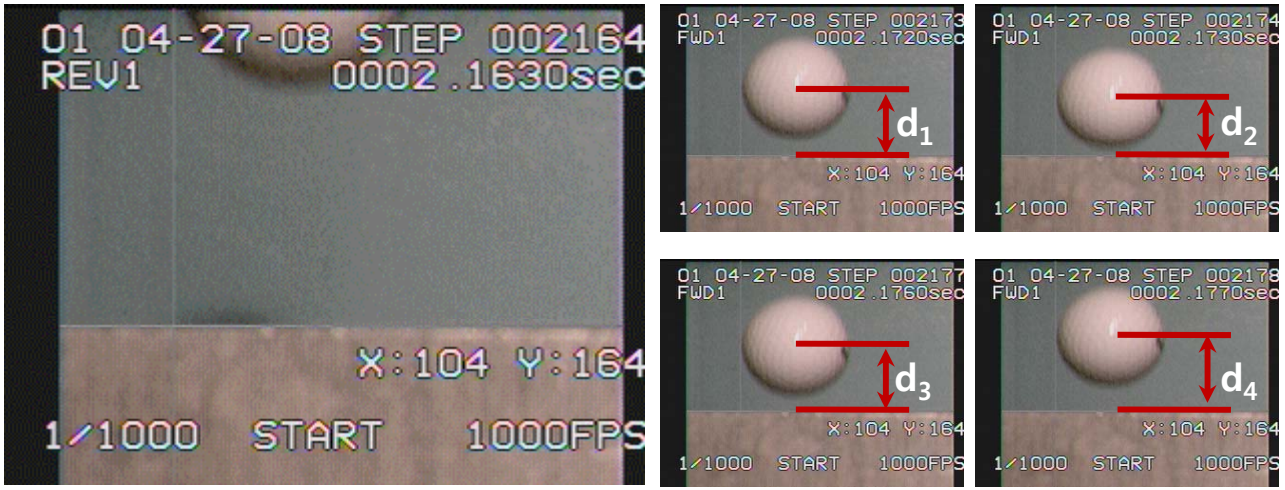
- **System configuration**
  - Conditioning chamber
  - CCD camera
  - Balance
  - Scale
  - Golf ball (Yamazaki 2piece golf ball)
    - Cover: Urethane
    - Core: Surlyn



Drop jig Conditioning chamber

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

- **Estimating initial velocity of golf ball**

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

- **Estimating driving distance***

$$\frac{d^2x_n}{dt^2} = -\frac{\rho A}{2m}\left(\frac{dx_n}{dt}^2 + \frac{dy_n}{dt}^2\right)(C_D\cos\theta + C_L\sin\theta)$$

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

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

$$\frac{d^2y_n}{dt^2} = \frac{\rho A}{2m}\left(\frac{dx_n}{dt}^2 + \frac{dy_n}{dt}^2\right)(C_L\cos\theta + C_D\sin\theta) - g$$

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

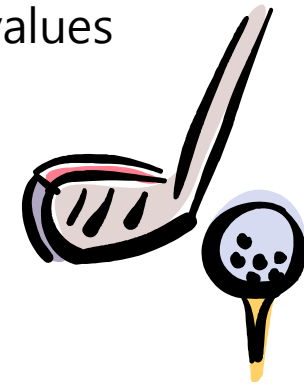
$$\frac{dy_{n+1}}{dt} = \frac{dy_n}{dt} + \frac{d^2y_n}{dt^2}\cdot dt$$

e: Coefficient Of Restitution, COR
m: Mass of golf ball [kg]
M: Mass of club head [kg]
V_1: Initial club head speed [m/s]
v_1: Initial velocity of golf ball [m/s]

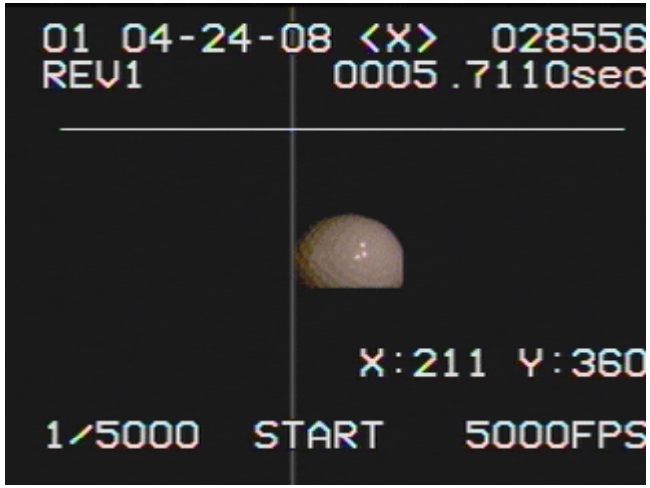
* P. W. Bearman and J. K. Harvey
– Golf ball aerodynamics, Aeronautical Quarterly, pp. 112-122, May 1976

Future works

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

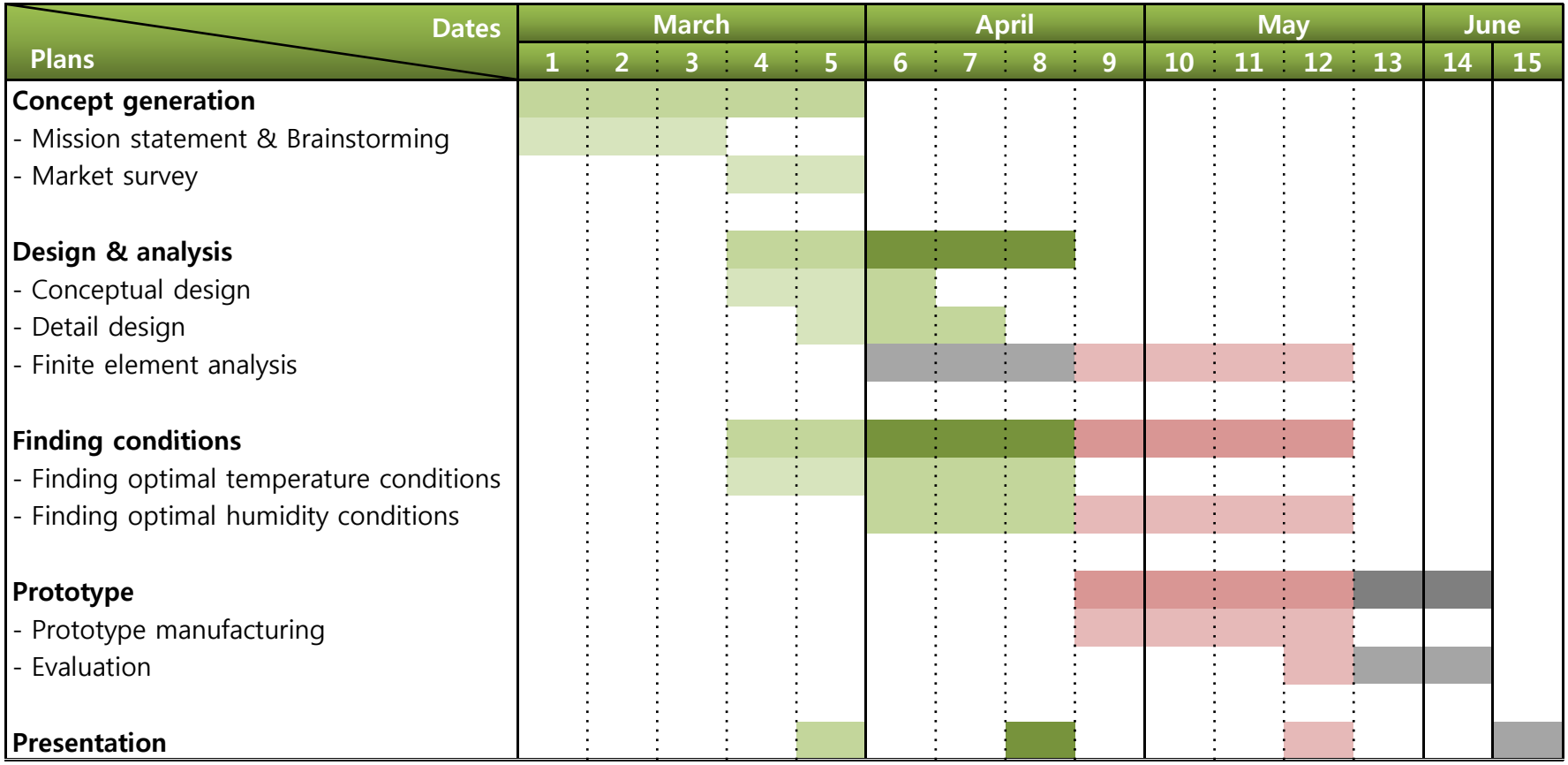


- **Prototype fabrication**



Future works (cont.)

- **Plans**



Thank You !