Part I: Design Review

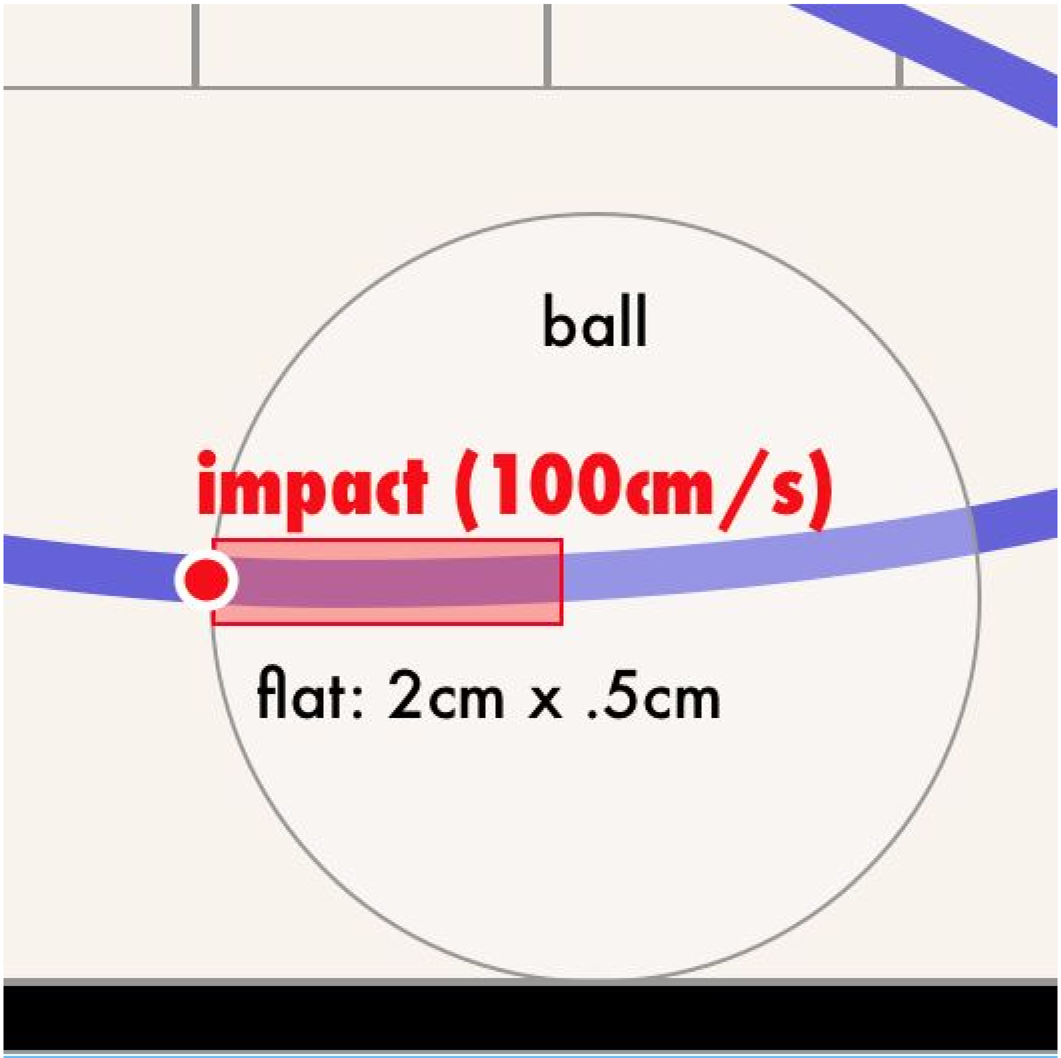
- A Matlab script that plots the trajectory of the coupler point, to-scale (i.e. with undistorted relative x and y scaling).

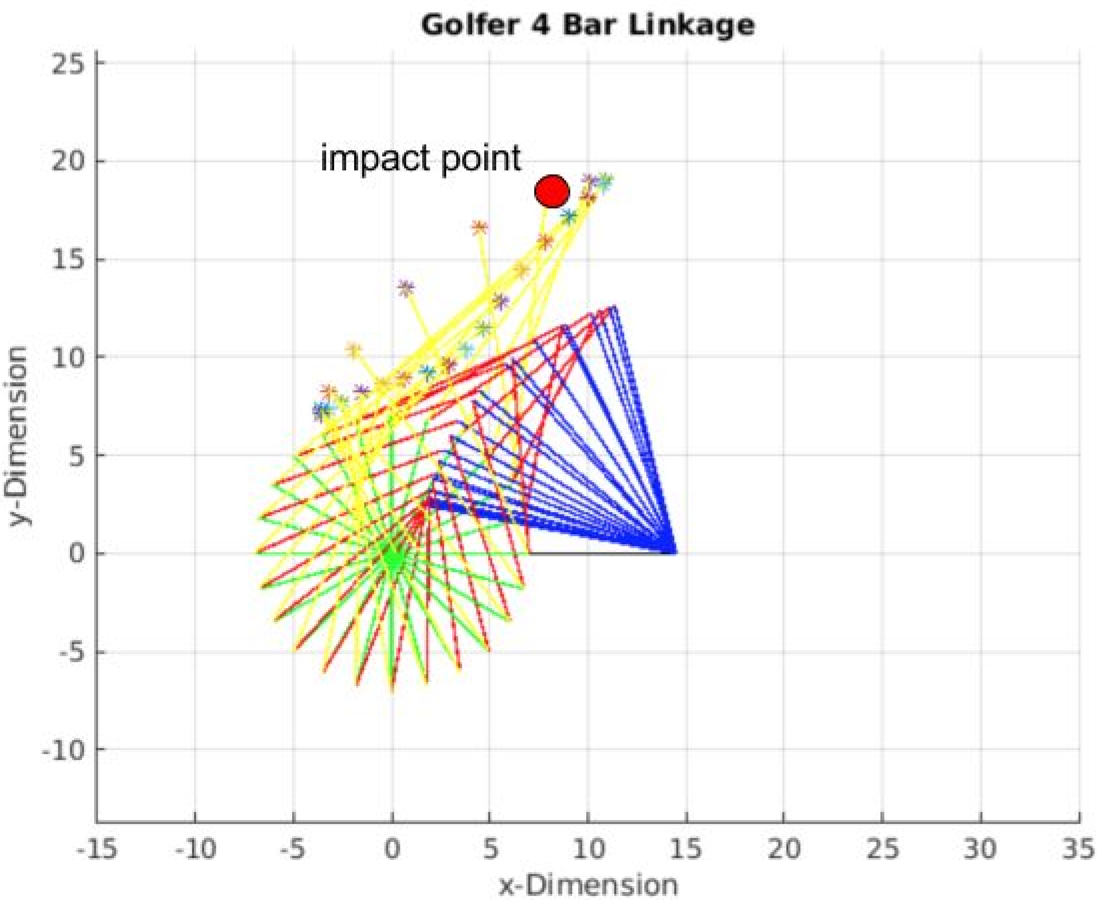
```
clear all; close all; clc;

% Length of Linkages:
frame = 14.5;
crank = 7;
coupler = 10;
rocker = 13;
toCouplerPoint = 15;
gammac = pi*(20/180);

%Define range of angles to plot and step size

theta2start = 0;
theta2end = 2*pi;
numsteps = 24;
theta2step = (theta2end-theta2start)/numsteps;
theta2s = [theta2start:theta2step:theta2end];
velocities = zeros(numsteps,1);  %empty array

%Guess a reasonable plot area (may need to tweak these)
leftlim = -15;
rightlim = 35;
bottomlim = -15;
toplim = 15;
axis([leftlim rightlim bottomlim toplim],'equal');
grid('on')

%The fixed ground link
X1 = 0;
Y1 = 0;
X4 = frame;
Y4 = 0;
line([X4;X1],[Y4;Y1],'Color','k','LineWidth',1);

hold on;

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
%% Main loop for each crank angle
for i=1:length(theta2s)

cosq2 = cos(theta2s(i));
sinq2 = sin(theta2s(i));

% Define some substitutions (9.29-9.31)
A = 2*rocker*(frame - crank*cosq2);
B = -2*crank*rocker*sinq2;
C = coupler^2 - crank^2 - rocker^2 - frame^2 + 2*crank*frame*cosq2;

%Solve for the roots of half angle equation (9.35)
%If general
u41 = (B + sqrt(A^2 + B^2 - C^2))/(A+C);
q4 = 2*atan(u41);

%Solve for theta3 (9.37-9.39)
%range = -PI to +PI
cosq3 = (-crank*cosq2 + rocker*cos(q4) + frame)/coupler;
sinq3 = (-crank*sinq2 + rocker*sin(q4))/coupler;
q3 = atan2(sinq3,cosq3);  %don't really need it for plotting

%Compute locations of joints 2,3
X2 = crank * cosq2;
Y2 = crank * sinq2;
X3 = X2+coupler*cosq3;
Y3 = Y2+coupler*sinq3;
%Now plot the linkage...
line([X1;X2],[Y1;Y2],'Color','g','LineWidth',1);
line([X2;X3],[Y2;Y3],'Color','r','LineWidth',1);
line([X3;X4],[Y3;Y4],'Color','b','LineWidth',1);

%Coupler location
xca1(i) = crank*cos(theta2s(i))+toCouplerPoint*cos(q3+gammac);
yca1(i) = crank*sin(theta2s(i))+toCouplerPoint*sin(q3+gammac);

%Compute coupler velocities.
dtheta2dt = 5.55; % in rad/s for 2.5V input

if(i>1)
   dx = xca1(i)-xca1(i-1);
   dy = yca1(i)-yca1(i-1);
   velocities(i) = dtheta2dt.*sqrt(dx^2 + dy^2)/theta2step;
```

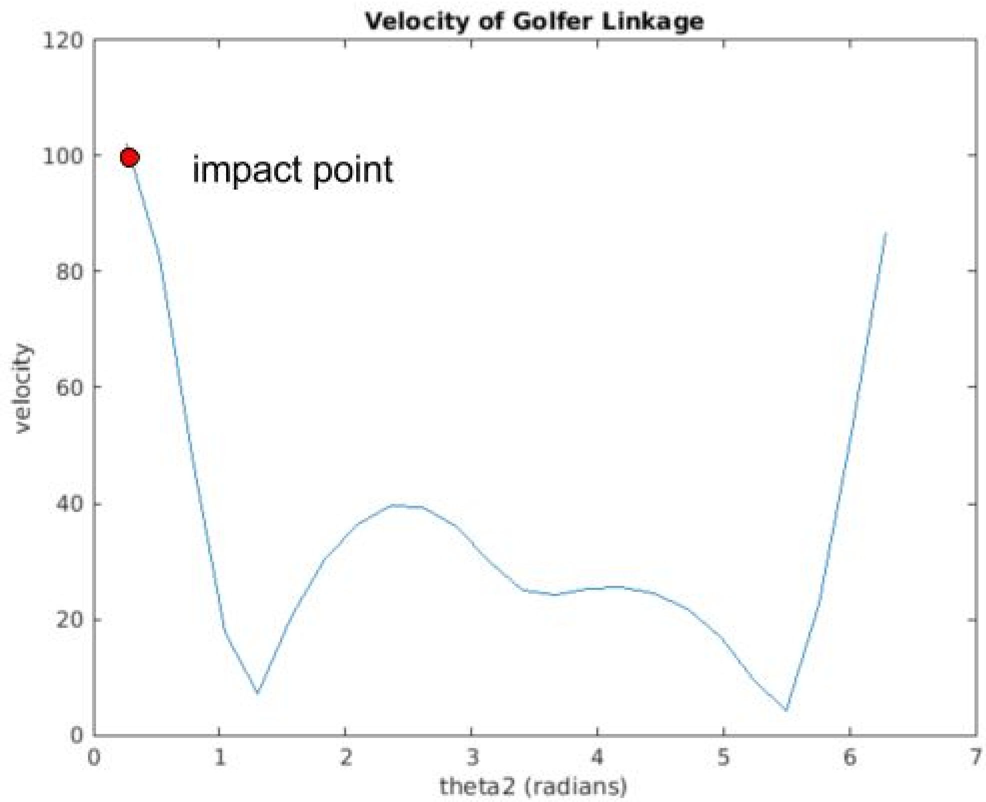
```
end

%Plot Coupler
plot(xca1(i),yca1(i),'*');
line([X2;xca1(i)],[Y2;yca1(i)],'Color','y','LineWidth',1);

end    %end for i
xlabel('x-Dimension');
ylabel('y-Dimension');
title('Golfer 4 Bar Linkage');
%% Plot the coupler velocities
%We can't really say what velocity is for the 1st element
%(but one can always move theta2start earlier)
figure;
plot(theta2s(2:end),velocities(2:end));
xlabel('theta2 (radians)') % x-axis label
ylabel('velocity') % y-axis label
title('Velocity of Golfer Linkage');
```

- A zoomed-in plot of the coupler trajectory in the vicinity of the impact point, so that we can see that it is appropriately flat and centered on the impact.

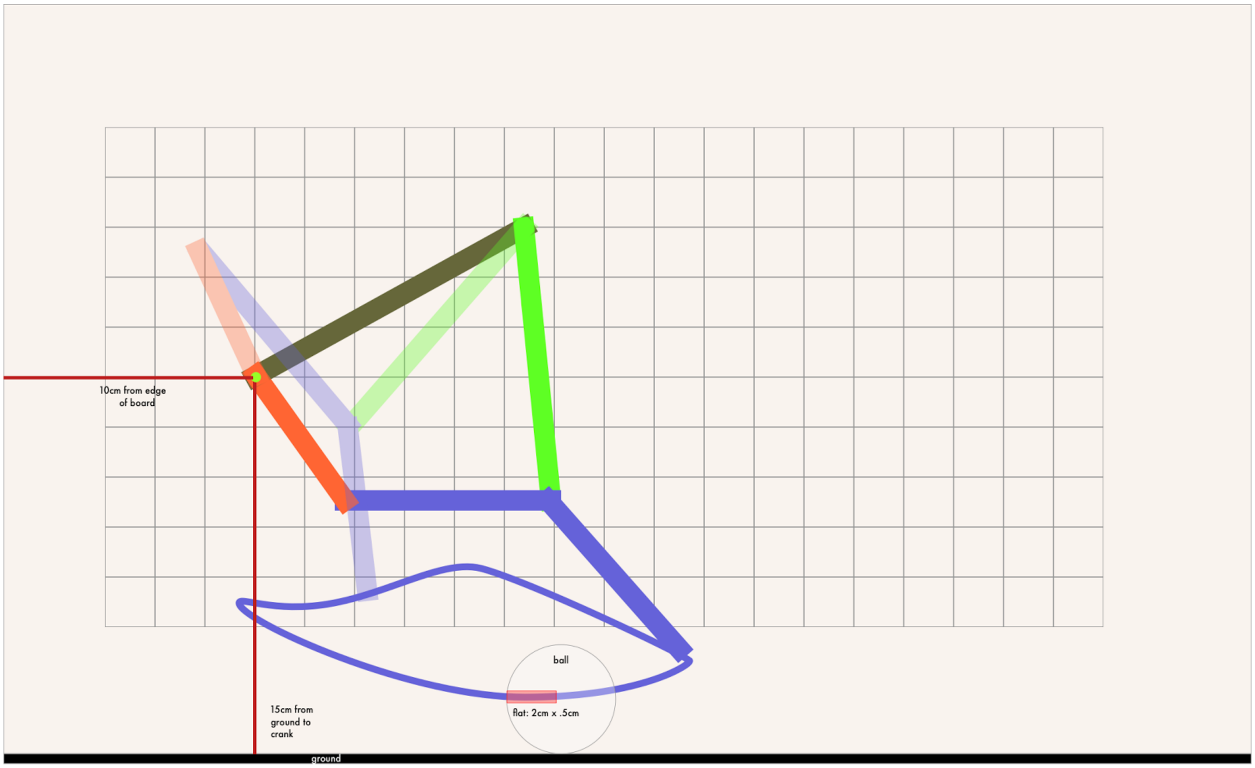



Golfer 4 Bar Linkage
impact point
y-Dimension
x-Dimension
25
20
15
10
5
0
-5
-10
-15
-10
-5
0
5
10
15
20
25
30
35

- A plot of the velocity of the coupler point around its curve, including the velocity at the impact point with the golf ball. **Desired Crank Angular Velocity: 5.55 rad/second**



- Coordinates of any grounded links showing which of the candidate mounting holes they fit into.
    - The frame is located on the board as follows (x,y): first point: (10,14.5), second point: (23, 20.5)
- To-scale sketches showing that none of the links in the mechanism go outside the bounding volume provided in Fig. 1. Sketch the mechanism in a few different crank locations to convince us of this assertion.



*This is just an image of our to-scale diagram; this particular image is not to scale.
Our to scale diagram will be presented on another piece of paper or on computer.