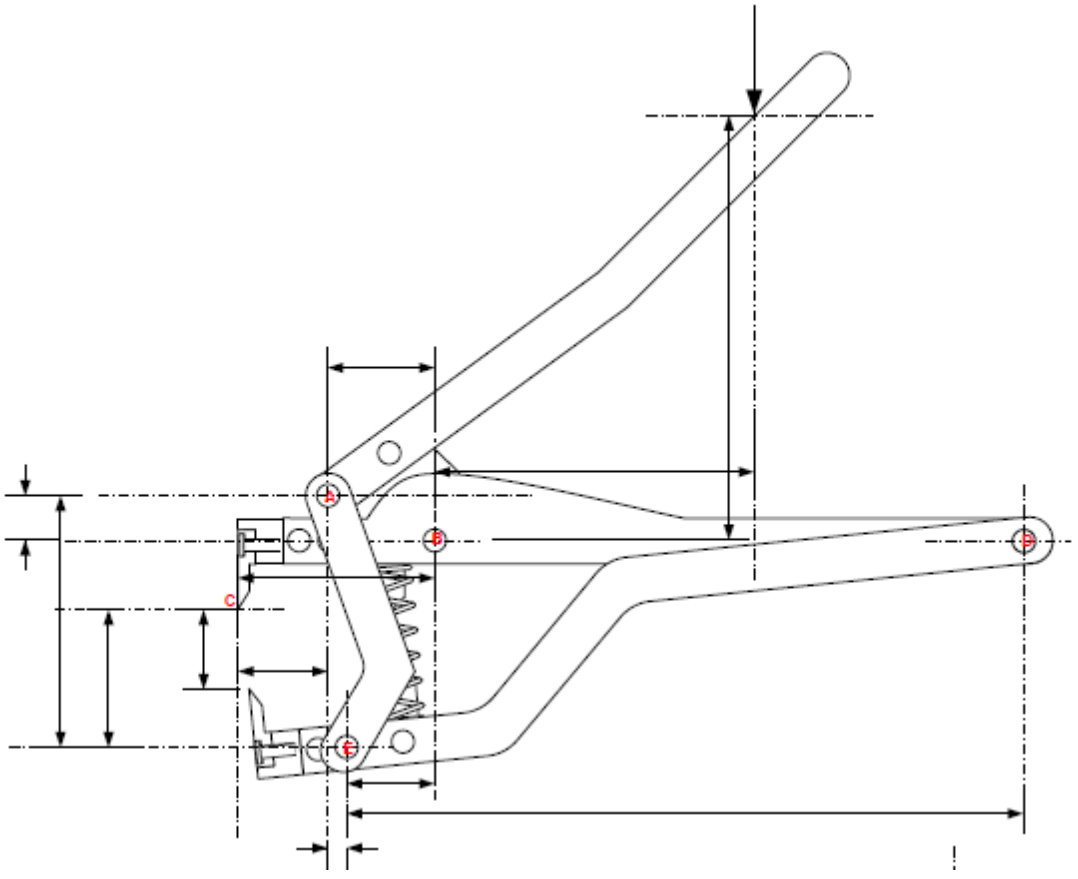
Case Study 9 – New Horse Hoof Trimmer Design

Trimming horse's hooves has been a common and necessary practice by horse owners and farriers ever since horses were domesticated. The tools available to trim a horse hoof are nearly as ancient as the practice itself. The tool typically used is a single fulcrum long handled device that generally requires two hands to provide the cutting power. Many women and older horse owners or farriers cannot perform the task with the existing single fulcrum tool.

To address the leverage problem of the existing tool, this consultant, along with two other partners, designed a double fulcrum tool that can be used with one or two hands (a big advantage when working with a less cooperative horse). The design challenge was to provide a large enough cutting jaw opening within the typical range of closing an open hand. To optimize this design, this consultant assembled a free body diagram force analysis using specific measurements from CAD drawings of the double fulcrum tool. An example of this analysis is described below:



Direction of Force

10 degrees = 0.174533 radians

A_x =	9.39	lbs
A_y =	315.62	lbs
B_x =	-1.89	lbs
B_y =	379.64	lbs
C_x =	0.00	lbs
C_y =	274.22	lbs
D_x =	9.39	lbs
D_y =	41.40	lbs
E_x =	9.39	lbs
E_y =	315.62	lbs
F_x =	11.29	lbs
F_y =	64.01	lbs

Member	Moment Balance	Force Balance
1	0	0.00
2	0	0.00
3	0	0.00
4	0	0.00

F Position 8.71 inches right of **C**

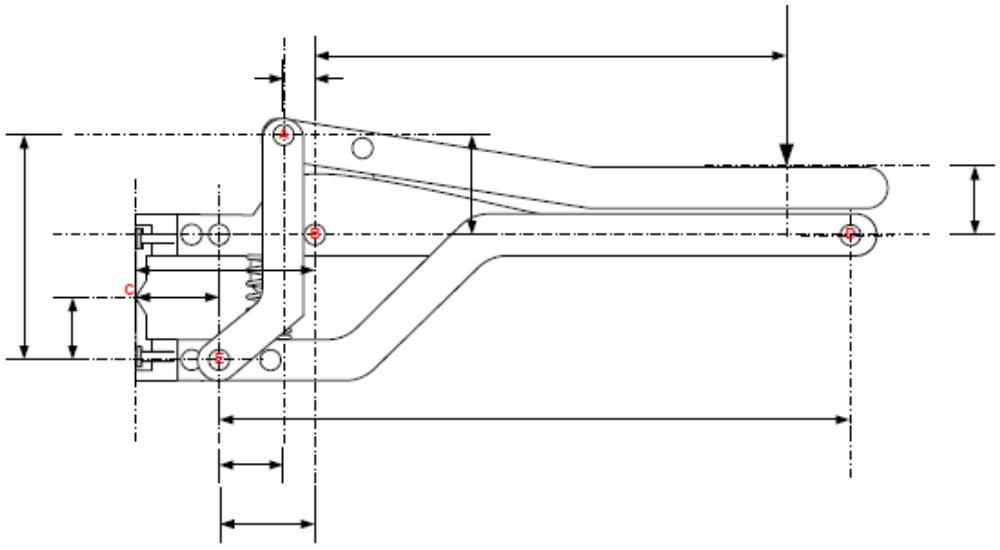
A_y determined by simultanous equation:

$0.22A_y - 2.76A_x = 0$
$0.54A_y + 0.59A_x = 58.576$

derived from 4 balance equations:

$B_y - A_y - P\cos(x) = 0$ where x is the angle counterclockwise from vertical; P = force (lbs)
$A_x - B_x - P\sin(x) = 0$
$aA_y + bA_x - cP[\sin(x)] - dP[\cos(x)] = 0$ where a,b,c, and d are moment lengths around point **B**
$eA_y - fA_x = 0$ where e and f are moment lenghts

The leverage magnification starting from the fully open position is 4.22. Using the same force and moment balance equations, this consultant determined that the leverage increases as the tool closes:



Direction of Force			
0	degrees	=	0 radians

A_x =	157.75	lbs
A_y =	653.26	lbs
B_x =	157.75	lbs
B_y =	718.26	lbs
C_x =	0.00	lbs
C_y =	563.26	lbs
D_x =	157.75	lbs
D_y =	90.00	lbs
E_x =	157.75	lbs
E_y =	653.26	lbs
F_x =	0.00	lbs
F_y =	65.00	lbs

Member	Moment Balance	Force Balance
1	0	0.00
2	0	0.00
3	0	0.00
4	0	0.00

F Position 17.21 inches right of **C**

The leverage magnification as the tool approaches its fully closed position is 8.67, resulting in the extra power to complete the clipping motion.

With the force and moment balances provided with the equations embedded in a Microsoft Excel spreadsheet, the positions of certain fulcrums and pivot points were experimentally moved to maximize leverage magnification while maintaining the minimum cutting jaw opening and maximum range of motion of a normal sized hand. With the equations, shear and moment diagrams for each tool piece and pivot pin locations can also be determined (necessary for tool part design).

The tool has become very popular with horse owners and farriers, particularly those that manage miniature horses. The tool has also been used to maintain the hooves of other domesticated livestock (like sheep, goats, and dairy cattle). A patent has been issued for this tool design.