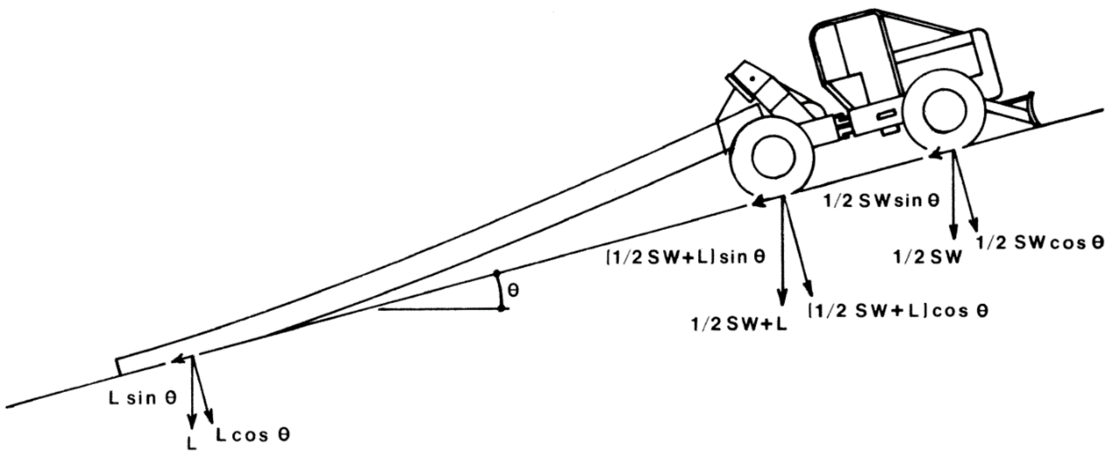
WDSC 422 Lab 2 – Assignment
Skidder Productivity Analysis
Harvesting Forest Products
Fall Semester, 2014



(Source: Phillips, A.P. 1983. Skidder load capacity and fuel consumption HP-41C program. United States Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. Research Paper NE-537. 8pp)

Payload (2L) = SW*((0.28*cos(θ) – sin(θ))/(0.285*con(θ) + sin(θ)))
Where 2L = weight of logs, or payload in pounds;
SW = skidder's weight in pounds;
θ = slope in radians.

Some Excel functions:

=IF(B6>=100, B6*0.10, B6*0.05); Takes three arguments. The first is the logical test. The second argument is the result that you want the function to display if the first argument is true. The third argument is the result if the first argument is false.

=ATAN(number); Returns the arctangent, or inverse tangent, of a number. The arctangent is the angle whose tangent is *number*. The returned angle is given in radians in the range -pi/2 to pi/2.

=MIN(range); Returns the smallest value in a data range.

=SUM(range); Returns the sum of a data range.

=AVERAGE(range); Returns an average value of a data range.

Production machine hours (PMH); Scheduled machine hours (SMH).

In this lab we are going to explore factors that affect skidder productivity in ground based logging systems. More specifically, how terrain impacts skidder payload which in turn affects productivity. Below is a p-line survey for a skid road, the landing is located at station 0+00.

p-Line

	+	-		
Sta.	B.S.	H.I.	F.S.	Elev
T.BM	6.0	1006		1000
0+00	5.8	1008.3	3.5	1002.5
0+25	5.3	1010.2	3.4	1004.9
0+50	5.9	1013.2	2.9	1007.3
0+75	6.2	1015.1	4.3	1008.9
1+00	6.1	1016.7	4.5	1010.6
1+25	5.7	1020.6	1.8	1014.9
1+50	5.9	1025.1	1.4	1019.2
1+75	6.1	1029.9	1.3	1023.8
2+00	6.4	1034.9	1.4	1028.5
2+25	5.8	1037.4	3.3	1031.6
2+50	5.6	1040.3	2.7	1034.7
2+75	6.3	1042.8	3.8	1036.5
3+00	5.2	1043.5	4.5	1038.3
3+25	6.0	1045.4	4.1	1039.4

	+	-		
Sta.	B.S.	H.I.	F.S.	Elev
3+50	5.7	1046.2	4.9	1040.5
3+75	5.4	1049.6	2.0	1044.2
4+00	6.5	1054.4	1.7	1047.9
4+25	6.1	1051.5	9.0	1045.4
4+50	2.7	1045.5	8.7	1042.8
4+75	2.1	1041.2	6.4	1039.1
5+00	2.2	1038.5	4.9	1036.3
5+25	1.2	1033.1	6.6	1031.9
5+50	2.2	1029.9	5.7	1027.4
5+75	1.3	1025.9	5.0	1024.6
6+00	1.2	1024.1	3.0	1022.9
6+25	0.9	1019.7	5.3	1018.8
6+50	2.1	1016.9	4.9	1014.8
6+75	1.9	1011.3	7.5	1009.4
7+00	1.5	1005.4	7.4	1003.9

	+	-		
Sta.	B.S.	H.I.	F.S.	Elev
7+25	1.4	1002.7	4.1	1001.3
7+50	1.6	1000.3	4.0	998.7
7+75	1.9	998.8	3.4	996.9
8+00	1.8	997	3.6	995.2
8+25	1.3	995.5	2.8	994.2
8+50	1.7	995.4	1.8	993.7
8+75	1.6	992.7	4.3	991.1
9+00	1.2	989.8	4.1	988.6
9+25	2.4	987.9	4.3	985.5
9+50	2.2	984.6	5.5	982.4
9+75	1.6	981.2	5.0	979.6
10+00	2.3	979.1	4.4	976.8
10+23			6.6	972.5

Using the information in the survey and the payload equation that we derived for skidder payload and some Excel functions and formulas (Table 1) to develop an Excel sheet to answer the following questions:

A. What is the maximum payload for a skidder that weighs 23,485 lbs.?

B. Assuming that the maximum safe working payload is 95% of the maximum payload what is the maximum safe working payload?

C. What is the maximum payload for this skidder on a 12% adverse slope? (**Work this calculation by hand and show all work**)

D. What is the maximum payload that can be brought to the landing from Sta. 10+23?

E. Which section of the skid trail limits the maximum payload?

F. What is the maximum payload that can be brought to the landing from Sta. 4+00?

G. Assuming a loaded speed of 12.6 ft/sec and an unloaded speed of 20 ft/sec and hook and unhook time of 100 sec/turn. If the skidder were to work at maximum capacity what would the average hourly production be for the entire skid trail in **tons/hour**? Assuming an hourly rate for a skidder of $145.77/SMH, what cost would be needed at the landing to break even (Give answer in **$/ton**).

The Excel worksheet can be downloaded at www.wdscapps.caf.wvu.edu/jxwang/courses/WDSC422/Labs/Lab2_SkidderPayload_Analysis.xlsx.

Please submit a summary report containing the answers to the above questions before the beginning of next lab. If you would like to be considered for partial credit, please consider to submit your calculations (in a neat and organized manner).

Table 1. Excel cell formulas in this assignment.

Description	Cell Name	Formula
Slope	D3	=IF(C3="",(C4-C2)/25,"")
Inverse slope	E3	=IF(D3<>"",D3*-1,"")
Payload	F3	=IF(E3<>"",((0.28*COS(ATAN(E3))-SIN(ATAN(E3)))/(0.285*COS(ATAN(E3))+SIN(ATAN(E3))))*23485,"")
Payload to landing	G3	=IF(F3<>"",IF(F3>21919.33,21919.33,MIN(F3:F3)),"")
Unloaded time	H3	=IF(G3<>"",B4/20,"")
Loaded time	I3	=IF(G3<>"",B4/12.6,"")
Hook and unhook time	J3	=IF(G3<>"",100,"")
Total productive turn time (sec)	K3	=IF(G3<>"",SUM(H3:J3),"")
Scheduled machine time per turn (sec)	L3	=IF(G3<>"",K3/0.65,"")
Scheduled machine time per turn (hours)	M3	=IF(G3<>"",L3/3600,"")
Skidding productivity (tons/SMH)	N3	=IF(G3<>"",(G3/2000)/M3,"")
Skidding hourly cost ($/SMH)	O3	=IF(G3<>"",147.77/N3,"")