[redacted] 93 + 10

Space Systems
Homework #5 103

A.)

Table 1 – Response Matrix

	Responses			
1	588.8877	610.6192	610.6192	571.1305
2	794.517	823.8368	823.8368	770.5594
3	997.8669	1034.6908	1034.6908	967.7775
4	506.9895	525.6987	525.6987	491.7019
5	895.4306	928.4744	928.4744	868.4301
6	1017.3434	1054.8861	1054.8861	986.6668
7	646.9179	670.7909	670.7909	627.4109
8	833.4538	864.2104	864.2104	808.3221
9	1023.7558	1061.535	1061.535	992.8857

✓

Table 2 – Average Signal-to-Noise Ratio

Signal-to-Noise Ratio			
Control Matrix			
X1	**X2**	**X3**	**Average S/N**
1	1	1	55.48470632
1	2	2	58.08612105
1	3	3	60.06550916
2	1	3	54.1840359
2	2	1	59.12469593
2	3	2	60.23340873
3	1	2	56.30104034
3	2	3	58.50168741
3	3	1	60.28798393

✓

B.)

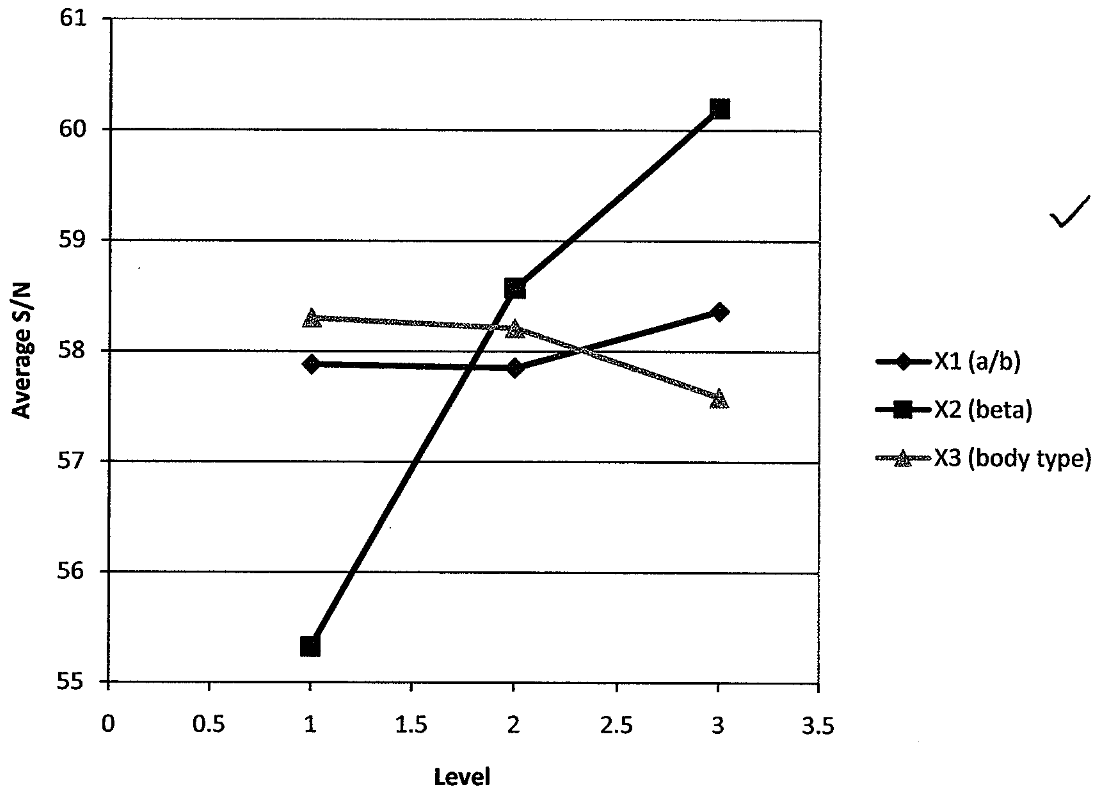

Figure 1 – Average S/N vs. Level Number

Table 3 – Average S/N at Each Level Number

Response Table			
Level	Average S/N		
	X1	X2	X3
1	57.878779	55.3232609	58.29912873
2	57.84738	58.5708348	58.2068567
3	58.363571	60.1956339	57.58374416

C.)

Table 4 – Optimal Level and Parameter Settings

Control Parameter	Optimum Level	Parameter Setting
X1	3	3
X2	3	70°
X3	1	Trapezoid

As seen in Table 4, a 3D trapezoid with β = 70° and a/b = 3 is the most robust design parameter combination.

D.)

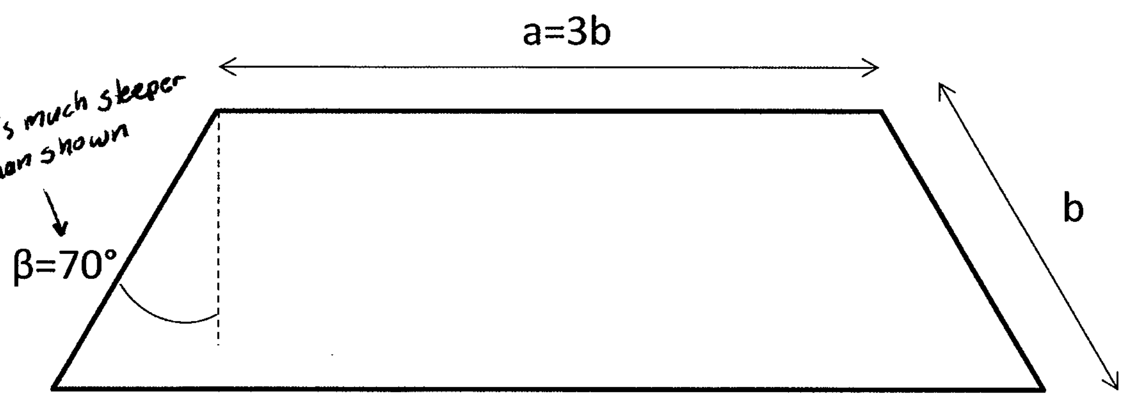

Figure 2 – Optimal Truncated Cone

E.) Yes, the results from the two previous parts make sense. As seen in Figure 2, the width, a, of the truncated cone is three times the length of the slanted height, b. The angle β is 70°, which allows for a large deflection between the top and sides of the trapezoid. In conclusion, I feel that the spacecraft has a geometry that makes physical sense.

F.) Another subsystem that may contribute greatly to the shape of the spacecraft is the communications subsystem. The communications subsystem will perform such tasks as transmission, reception, and routing of attitude telemetry for a spacecraft. Because of this, the communications subsystem will require antennas for command and data handling, which may directly or indirectly affect the power, structural, and GN&C subsystems. I feel that three important design parameters for a communications subsystem are signal strength, accuracy, and reliability. Each of these variables will affect mass, size, and cost. In this situation, I would try to maximize signal strength.

G.) I feel that the Taguchi method is a valuable technique for quality control. Although confusing at first, I understand the reasoning behind performing the Taguchi method instead of trying endless possibilities of design parameters. For our assignment, I found an optimal design from three design parameters at three various levels with three different noise factors. To perform individual studies on each possibility would have proved a waste of time. However, employing the Taguchi method allowed me to focus on a select number of parameter combinations to optimize a spacecraft design. Within a short amount of time, I was able to arrive at a design configuration that maximized each design parameter. For this reason, I feel that the Taguchi method is a useful and practical tool for quality control.

H.)

```
% Mike Alonzo
% Space Systems
% HW #5

clear all
close all
clc

% Table of Variables
% P = power
% S = specific power
% An = adjusted solar array surface area
% d = solar array degradation
% y = number of years
% R = distance from the sun
% SA = surface area
% a = trapezoid length
% b = trapezoid slanted height
% B = beta, angle b/w a and b

% Known Values
S = 302;
y = 5;
R = 148107600;
SA = 3;

% Input Parameters
fprintf('Control Factor Levels\n\n');
x1 = input('Please input a/b (1, 2, 3):       ');
x2 = input('Please input Beta (1, 2, 3):    ');
x3 = input('Please input body type (1, 2, 3): ');

fprintf('\nNoise Factor Levels\n\n');
n1 = input('Please input theta (1, 2):        ');
n2 = input('Please input phi (1, 2):          ');
n3 = input('Please input gamma (1, 2): ');

% Determine Input Parameters
```

```
if (x2==1)
    x2 = 20*pi/180;
elseif (x2==2)
    x2 = 45*pi/180;
elseif (x2==3)
    x2 = 70*pi/180;
end

if (n1==1)
    n1 = 0;
elseif (n1==2)
    n1 = 10*pi/180;
end


if (n2==1)
    n2 = 0;
elseif (n2==2)
    n2 = 10*pi/180;
end

if (n3==1)
    n3 = 0.025;
elseif (n3==2)
    n3 = 0.035;
end

% 3D Trapezoid
if (x3==1)
    b = sqrt(SA/(x1^2+2*x1));
    a = (-2*b+sqrt((2*b)^2+(4*SA)))/2;
    An = (a^2)*cos(n1)*cos(n2)...
        +a*b*cos(pi/2-x2-n1)*cos(n2)...
        +a*b*cos(pi/2-x2+n1)*cos(n2);
end

% Truncated Pyramid
if (x3==2)
    b = sqrt(SA/((x1^2)+(4*x1*cos(x2))+(4*sin(x2)*cos(x2))));
    a = (-4*b*cos(x2)...
        +sqrt((4*b*cos(x2))^2-4*(4*(b^2)*sin(x2)*cos(x2)-SA)))/2;
    An = (a^2)*cos(n1)*cos(n2)...
        +(a*b*cos(x2)+(b^2)*sin(x2)*cos(x2))*cos(pi/2-x2-n1)*cos(n2)...
        +(a*b*cos(x2)+(b^2)*sin(x2)*cos(x2))*cos(pi/2-x2+n1)*cos(n2)...
        +(a*b*cos(x2)+(b^2)*sin(x2)*cos(x2))*cos(n1)*cos(pi/2-x2-n2)...
        +(a*b*cos(x2)+(b^2)*sin(x2)*cos(x2))*cos(n1)*cos(pi/2-x2+n2);
end

% Truncated Cone
if (x3==3)
    b = sqrt(SA/(((pi*x1^2)/4)+(2*pi*x1)-(pi*sin(x2))));
    a = ((-2*pi*b)...
        +sqrt(((2*pi*b)^2)-4*((pi/4)*(-pi*b*b*sin(x2)-SA))))/(pi/2);
    An = pi*((a/2)^2)*cos(n1)*cos(n2)...
        +pi*b*(2*a-b*sin(x2))*sin(x2)*cos(n1)*cos(n2);
end
```

```
P = (S*((1.4959787e8/R)^2)*An)/((1-n3)^y);

% Print results
fprintf('\na  = %0.4f\n', a);
fprintf('b  = %0.4f\n', b);
fprintf('An = %0.4f\n', An);
fprintf('P  = %0.4f\n', P);
```

[redacted]
Space Systems
Extra Credit #1

+10

The Taguchi Method in Advertising

Since its inception nearly fifty years ago, the Taguchi method has been applied to various fields spanning from engineering to business and everything in between. The Taguchi method allows a user to test multiple variables in a design process at once instead of painstakingly conducting each experiment one at a time. The ultimate goal of the Taguchi method is quality control, the ability to optimize design parameters within one's control and minimize noise factors that are out of one's control.

An interesting field where the Taguchi method has been recently applied is in advertising. Traditionally, advertisers relied on the One-Factor-at-a-Time (OFAT) approach for testing new ideas. This concept was considered a breakthrough in the field of advertising in the early 1920's. Claude Hopkins, the creator of OFAT, tested small changes to a design one at a time. With this method, Hopkins claimed that advertisers could study and focus on the relative effect of each change individually. Over time, a larger picture could be assembled from the data collected from the many smaller experiments. However, this method was long and drawn out, consisting of many consecutive tests in order to gain an accurate portrait of a parameter's impact.

However, the Taguchi method allows advertisers to measure the impact of changes in multiple variables at once. Under this method, an advertisement can be optimized by controlling the right variables. For instance, the right combination of headline, pictures, and price information can deliver a strong response from a particular audience. With the Taguchi method, marketers can select optimal advertisements for their audiences and save more time and money than with the OFAT method.