

N = Population size n = Sample size μ = Mean of Population \bar{x} = Mean of Sample

\hat{y} = Predicted value v = Degrees of freedom ($n - 1$) r = Correlation coefficient

σ / s = Standard deviation \bar{s} = Standard error r^2 = Coefficient of determination ($\frac{SSR}{TSS}$)

Area Under the Normal Deviation Curve = 1

Standard Deviation: Gives an indication of the width of the distribution of the values around the mean.

$$\sigma = \left[\frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2 \right]^{\frac{1}{2}}$$

Variance = (Standard Deviation)² Total Population

$$\sigma^2 \text{ or } s^2$$

Sample Population $s = \left[\frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2 \right]^{\frac{1}{2}}$

Standard Error : The variation of the means about the estimated mean, using confidence levels.

$$s_{\bar{x}} = \frac{\sigma}{\sqrt{N}} \approx \frac{s}{\sqrt{n}}$$

Z – Statistics: Inaccurate, used for large sample sizes.

$$\mu = \bar{x} \pm z_c s_{\bar{x}}$$

$$Z_{68.26} = 68.25\% = 1\sigma$$

$$Z_{90} = 90\% \text{ confidence level} = 1.645\sigma$$

$$Z_{95} = 1.96 - 95\% \text{ confidence level} = 2\sigma$$

$$Z_{99} = 99\% \text{ confidence level} = 3\sigma$$

T – Statistics: Accurate, used for small sample sizes ($n < 30$)

$$x = \bar{x} \pm z_{v,c} s_{\bar{x}}$$

V: Degrees of Freedom, $v = n - 1$

$$r_{xy} = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{(n-1)s_x s_y}$$

Correlation (r) : How well the line of best fit describes the data set.

$$-1 \leq r \leq 1 \quad -1 = \text{Strong Negative Correlation} \quad 1 = \text{Strong Positive Correlation}$$

$$0 = \text{No Correlation}$$

Regression: Fitting an equation to data (Residual = $\hat{y} - y$, where \hat{y} is the predicted value)

$$\text{Sum of Squared Errors (SSE)} = \sum_{i=1}^n (y_i - \hat{y})^2$$

Linear Square Regression: Minimizes SSE for linear data

$$\text{Coefficient of Determination } (r^2) = \frac{\text{Explained Variation}}{\text{Total Variation}} = \frac{SSR}{TSS} = \text{Accuracy of Prediction}$$

$$\text{Explained Variation} = \text{Sum of Squares from Regression (SSR)} = \sum_{i=1}^n (\hat{y} - \bar{y})^2$$

Total Variation = Total Sum of Squares (TSS) = SSE + SRR

Linear Systems:

One Solution = Meet at a point Infinite Solutions = Planes intersect No Solution = Parallel

Errors:

- Systematic Errors (Consistent Bias):
 - Natural Error (Environmental Causes)
 - Instrumental Error (Imperfect instruments)
 - Personal Error (You fucked up, but that's ok)
- Explicit Uncertainty:
 - Absolute Error: $(343.5 \pm 0.9) \text{ ms}^{-1}$
 - Relative Error: $343.5 (1 \pm 0.26\%) \text{ ms}^{-1}$
- Implicit Uncertainty: ± 5 of the digit right of the least sig. digit
- Addition & Subtraction: $(x \pm y) \pm (\Delta x + \Delta y)$
- Multiplication & Division: $xy (1 \pm \frac{\Delta x}{x} + \frac{\Delta y}{y})$

Common Units (SI & FPS)

	SI	FPS
Force	Newton (N) $= 1\text{kg}\cdot\text{m}/\text{s}^{-2}$	Pound (lb)
Length	Metre (m)	Foot (ft)
Mass	Kilogram (kg)	Slug $= 1\text{lb}\cdot\text{sec}^2/\text{ft}$
Time	s	sec
Pressure	Pascal (Pa) $= 1\text{N}/\text{m}^2$	PSI (lbs/in^2) or lbs/ft^2
Work & Energy	Joule (J) $= \text{N}\cdot\text{m}$	ft·lb
Power	Watt (W) $= \text{N}\cdot\text{m}/\text{s}$	Horsepower (HP) $= 550 \text{ft}\cdot\text{lb}/\text{sec}$
Temperature	K $\text{K} = ^\circ\text{C} + 273.15$	$^\circ\text{F}$ $^\circ\text{F} = 9/5 (^\circ\text{C}) + 32$

10^9 – Giga – g

10^6 – Mega – M

10^3 – Kilo – k

10^{-3} – Milli – m

10^{-6} – Micro – μ

10^{-9} – Nano – n

MATLAB

; c Suppress Output
% – Comment
disp ('words')
A(:, 2) – Selects all elements in col 2
. – Element by Element (period)
& – And
A' – Transpose
inv(A) – Inverse
eye(4) – Identity Matrix
== – Equal to
~= – Not Equal to
| – Or

Z = input('Enter a Value') %prompts user to enter a value for Z

fprintf('The temperature is %8.2f degrees F/n' , temp)

- % is the place holder for the variable
- 8 is the minimum total display
- 2 is the number of decimal places
- Temp is the variable

```
>>if(expression)
    Statements
end

while(expression)
    Statements
end

>>if(expression)
    Statements
else
    Statements
end

>>if(expression)
    Statements
elseif
    Statements
else
    Statements
end
```

>> y = linspace (1,3,5) % Creates a vector from 1 to 3 with 5 equally spaced elements

>> [new_x, new_y] = meshgrid(x,y) % If x = 1:5 and y = 1:3, meshgrid extends to all values:

new_x =

```
1  2  3  4  5
1  2  3  4  5
1  2  3  4  5
```

new_y =

```
1  1  1  1  1
2  2  2  2  2
3  3  3  3  3
```

>> plot(x,y) % Plots x and y

>> title('Put Title Here') % Titles the plot

>> x_label('X') % Labels x-axis

>> y_label ('Y') % Labels y-axis

MAPLE:

; – Terminate and Display
: – Terminate and Suppress Output
:= Assignment (x := 3;)

theta – θ pi – π Pi – 3.14 (numerical value)
– Comment
eval(f) – Evaluates the function
solve(expression, variable) – Solves the expr.
% – Placeholder for previous expression

TSE LECTURES

Life Cycle Analysis (LCA): Manufacture, Transport, Use, End of Life, Disposal (Cradle to Grave) / Recycling (Cradle to Cradle)

Bruntland Report (1987) – Development of Sustainable Design concept

Sustainable Development: Good for present, without hindering future generations

Sustainable Paradox - Efficiency rises, making use less expensive, increasing use exponentially, increasing pollution.

Rachel Carson – Silent Spring (1962) & Club of Rome – Limits of Growth

Montreal Protocol (1987) – CFC Regulation (most successful international enviro. agreement)

Traditional Cultures (ex. Natives) – Meet as many needs as possible with minimal resources

Industrial Capitalism (ex. Western life) – Create wants, abusing resources for economy

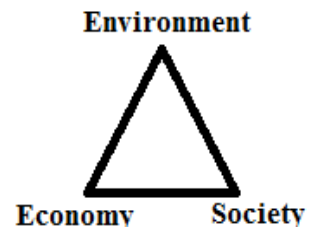
Ideal: Meet all needs without high environmental and social impact

Tips for Sustainability: Prices reflect full cost, Reduce, Reuse, Recycle, Sustainable energy, ~~WANTS~~

Common Pool Resource (CPR): A shared resource source, often difficult to manage

Possible Solutions: Invisible Hand, Public Shame, Vigilante, Mutually Agreed Upon Mutual Coercion

Tragedy of the Commons: When one or more individuals acting independently and rationally in the own self-interest depletes a CPR, even when it is not in anyone's favour.



Externality: An activity by an individual that affects the welfare of the group that is outside the money market system (driving, fishing, etc.)

Cap and Trade: Distribution of carbon credits to companies that can be traded.

The design & engineering stage of product development influence 70% of the final product.

Richest 20% of Population – 80% of Income Poorest 20% of Population – 1.5% of Income

Over the Next 100 Years:

- GDP / person Increases
- Energy / GDP\$ Decreases
- All energies Increase but Oil
- Energy / Person Increases

If you don't know about GHGs and the Greenhouse Effect, gtfo and smb you s.o.b.

Temperature will rise 1.8°C - 4°C, Sea Levels will rise 18-59+cm before 2100.

1971 – Greenpeace Founded

1985 – Antarctic Ozone Hole Found

1997 – Kyoto Protocol

$$I = \frac{P \times A}{T}$$

I = Enviro. Impact	P = Population
A = Affluence	T = Technology

Nature supports Society. Society develops the Economy.

OHSA – Occupational Health and Safety Act

Ontario Ministry of Labour regulates OHSA

Health and Safety Committee – If 20+ Employees

Right to Know (about hazards)

Right to Participate (Prevent Hazards)

Right to Refuse Work (will be investigated)

Right to Stop Work (H&S committees can stop work)

Use safety equipment supplied by employer.

Report all hazards and injuries.

OHSA must be posted in the workplace

WHMIS – MSDS Sheets – Safety Education

Anyone who contravenes with OHSA is guilty (not necessarily employer) 25,000 – 500,000\$ Fines

Engineering failures are caused by decisions made by managers disconnected with workers

Make Safety Reviews when equipment, machines or devices are altered or installed.

K so I've left out some details, like what a proposal is, but really, think about it. Durrrip.

Space between value and unit symbol, and every 3 digits. 1 000 km.

CEAB – Canadian Engineering Accreditation Board – Engineering Programs

CEQB – Canadian Engineering Qualification Board – P. Eng certification, ethics, standards.

Perspective Projection – 1, 2 or 3 point perspective – Lines intersect at one or more vanishing points

Oblique Projection – Drawn like a Cube – Front face has proper dimensions – Indicates depth

Isometric Projection – Start 30° above X-axis – Lines 120° apart – Includes Axonometric Projection

Orthographic Projection – Shows three perpendicular sides – Front (best) in bottom left

Text must be readable

1st Dimension x3 letter height

2nd + Dimension x2 letter height

Dimension between views

Dimension most descriptive view

Dimension from Visible lines

Omit last dimension in a series

Organize – No clutter

No Duplicates

Avoid crossing dimension lines

Extension lines can cross, leave a space

Dimension outside objects

Dimension cylinders in rect. view

Dimension circles in circular view

Top	Iso. Proj.
Front	Right

CIM – Computer Integrated Manufacturing (complete process, design to production)

CAD – C.A.Design CADD – C.A.Designing & Drafting CAM – C.A. Manufacturing

Systems Design: An entire system created by the assembly of several modules or parts.

Product Design: Design, testing, manufacture, sale, etc. of mass-produced goods.

DESIGN PROCESS

1. Recognition of need

2. Definition of the design problem

3. Definition of the design criteria

4. The design loop (Synthesis, Analyze, Decide)

5. Optimization

6. Evaluation

7. Communication

Code: Set of specifications for the creation of things, to maintain safety and quality.

Standard: Set of specification for parts, materials, processes, etc. for uniformity.

Standard Organizations: ISO, ANSI, CSA

Visible – Hidden – Center & Cutting Plane – Break – Dimension & Extension – Crosshatch & Section

Protrusion – Add. Cut – Remove. Round & Fillet – Think. Holes – Holes.

ARP – Additive Rapid Prototyping. SRP – Subtractive Rapid Prototyping

Stereolithography (.stl) – Laser + Sensitive Liquid 3D Ink-Jet Printing – Like We Did

Selective Laser Sintering – Fuse with Laser Fused Deposition Modeling – Solidify Liquids

Solid Ground Curing – Layer applied, Object outline UV'ed into it.

Nomography – Alignment Chart, uses scales with 3+ variables – Think resistance nomograph,

Empirical Equations – Derived from experimental data – Think machine heat equation

Interpolation – Determine data point within the data range. Extrapolation – Find data outside the range.



P.Eng

Be 18. Good guy. Have B. Eng. Work for 4 years. Pass PPE Exams. Don't have an Opinion

Experience: Max 12 month of Grad studies count, Thesis counts if it's related and externally funded

Misconduct: Make sure everybody's safe. Don't be an ass. Remember safety reviews.

Certificate Of Authorization

Required for any firms or engineers acting as individuals. Chief Engineer must have 5 yrs experience.

Be Safe. Trust the Engineer's Touch.