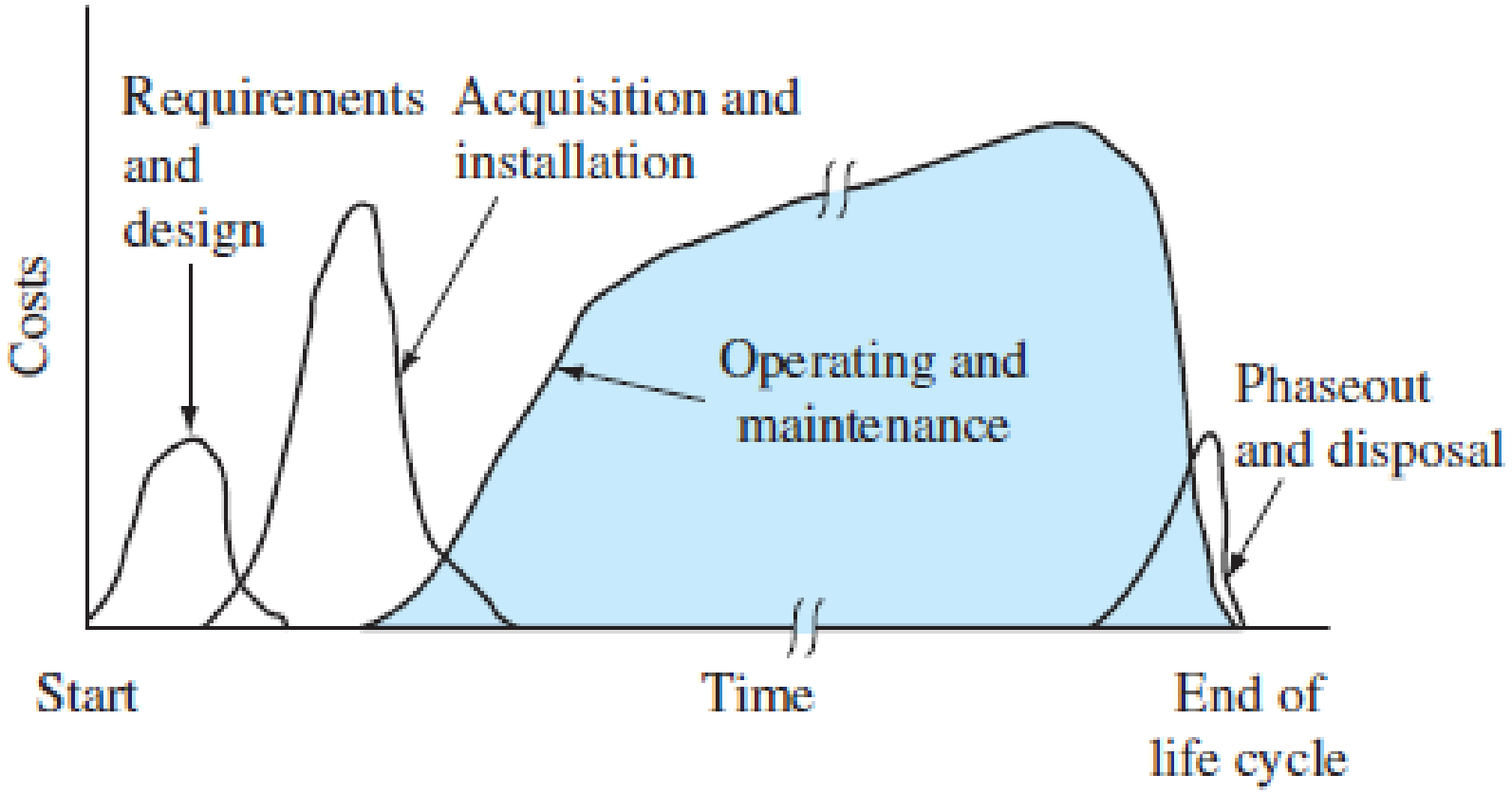
- **Course Title:** Engineering Cost Analysis & Economy (ENGR 222)
- **Session:** Fall 2024
- **Instructor:** Sudipta Chowdhury (chowdhurys@marshall.edu)
- **Class Time: TR 9.30 PM-10.45 AM**
- **Office hours: TR 1.00 PM-2.30 AM**

Typical Life-Cycle Cost Distribution by Phase



Example 6

An international aerospace contractor has been asked by a municipal police department to estimate and analyze the life cycle costs for a proposed drone surveillance system to monitor traffic patterns and congestion within the central thoroughfares of the city. The list of items include the following general categories: R&D costs (R&D), nonrecurring investment costs (NRI), recurring investment costs (RI), scheduled and unscheduled maintenance costs (Maint), equipment usage costs (Equip), and disposal costs (Disp). The costs (in $ million units) for the 20-year life cycle have been estimated. Calculate the annual LCC at an interest rate of 7% per year.

Year	R&D	NRI	RI	Maint	Equip	Disp
0	5.5	1.1				
1	3.5					
2	2.5					
3	0.5	5.2	1.3	0.6	1.5	
4		10.5	3.1	1.4	3.6	
5		10.5	4.2	1.6	5.3	
6–10			6.5	2.7	7.8	
11–20			2.2	3.5	8.5	
18–20						2.7

7%	Compound Interest Factors								7%
	Single Payment		Uniform Payment Series				Arithmetic Gradient		
n	Compound Amount Factor Find F Given P F/P	Present Worth Factor Find P Given F P/F	Sinking Fund Factor Find A Given F A/F	Capital Recovery Factor Find A Given P A/P	Compound Amount Factor Find F Given A F/A	Present Worth Factor Find P Given A P/A	Gradient Uniform Series Find A Given G A/G	Gradient Present Worth Find P Given G P/G	n
1	1.070	.9346	1.0000	1.0700	1.000	0.935	0	0	1
2	1.145	.8734	.4831	.5531	2.070	1.808	0.483	0.873	2
3	1.225	.8163	.3111	.3811	3.215	2.624	0.955	2.506	3
4	1.311	.7629	.2252	.2952	4.440	3.387	1.416	4.795	4
5	1.403	.7130	.1739	.2439	5.751	4.100	1.865	7.647	5
6	1.501	.6663	.1398	.2098	7.153	4.767	2.303	10.978	6
7	1.606	.6227	.1156	.1856	8.654	5.389	2.730	14.715	7
8	1.718	.5820	.0975	.1675	10.260	5.971	3.147	18.789	8
9	1.838	.5439	.0835	.1535	11.978	6.515	3.552	23.140	9
10	1.967	.5083	.0724	.1424	13.816	7.024	3.946	27.716	10
11	2.105	.4751	.0634	.1334	15.784	7.499	4.330	32.467	11
12	2.252	.4440	.0559	.1259	17.888	7.943	4.703	37.351	12
13	2.410	.4150	.0497	.1197	20.141	8.358	5.065	42.330	13
14	2.579	.3878	.0443	.1143	22.551	8.745	5.417	47.372	14
15	2.759	.3624	.0398	.1098	25.129	9.108	5.758	52.446	15
16	2.952	.3387	.0359	.1059	27.888	9.447	6.090	57.527	16
17	3.159	.3166	.0324	.1024	30.840	9.763	6.411	62.592	17
18	3.380	.2959	.0294	.0994	33.999	10.059	6.722	67.622	18
19	3.617	.2765	.0268	.0968	37.379	10.336	7.024	72.599	19
20	3.870	.2584	.0244	.0944	40.996	10.594	7.316	77.509	20
21	4.141	.2415	.0223	.0923	44.865	10.836	7.599	82.339	21
22	4.430	.2257	.0204	.0904	49.006	11.061	7.872	87.079	22
23	4.741	.2109	.0187	.0887	53.436	11.272	8.137	91.720	23
24	5.072	.1971	.0172	.0872	58.177	11.469	8.392	96.255	24
25	5.427	.1842	.0158	.0858	63.249	11.654	8.639	100.677	25
26	5.807	.1722	.0146	.0846	68.677	11.826	8.877	104.981	26
27	6.214	.1609	.0134	.0834	74.484	11.987	9.107	109.166	27
28	6.649	.1504	.0124	.0824	80.698	12.137	9.329	113.227	28
29	7.114	.1406	.0114	.0814	87.347	12.278	9.543	117.162	29
30	7.612	.1314	.0106	.0806	94.461	12.409	9.749	120.972	30

Rate of return (RoR) analysis using AW or PW relation: One project

Interpretation of ROR

Rate paid on *unrecovered balance* of borrowed money such that final payment brings balance to exactly zero with interest considered

ROR equation can be written in terms of PW, AW, or FW

Use trial and error solution by *factor* or *spreadsheet*

Interpretation of ROR

Example 1

To get started in a new telecommuting position with AB Hammond Engineers, Jane took out a \$1000 loan at $i = 10\%$ per year for 4 years to buy home office equipment. From the lender's perspective, the investment in this young engineer is expected to produce an equivalent net cash flow of \$315.47 for each of 4 years.

$$A = \$1000(A/P,10\%,4) = \$315.47$$

This represents a 10% per year rate of return on the unrecovered balance. Compute the amount of the unrecovered investment for each of the 4 years using (*a*) the rate of return on the unrecovered balance (the correct basis) and (*b*) the return on the initial \$1000 investment. (*c*) Explain why all of the initial \$1000 amount is not recovered by the final payment in part (*b*).

Interpretation of ROR

Interpretation of ROR

To determine ROR, find the *i value in the relation**

$$PW = 0 \quad \text{or} \quad AW = 0 \quad \text{or} \quad FW = 0$$

Alternatively, a relation like the following finds i*

$$PW_{outflow} = PW_{inflow}$$

For evaluation, a project is economically viable if

$$i^* \geq MARR$$

Steps to use for Trial and Error Method

1. Draw a cash flow diagram
2. Set up a rate of return equation
3. Select values of i by trial and error until the equation is balanced
    1. Try to bring all the cash flows into P/F, P/A, A/F factors. This can be done in the following manner:
        1. Convert all disbursements into either single amounts (P or F) or uniform amounts (A) by neglecting time value of money.
        2. Confirm all receipts into either single or uniform values
        3. Use the interest tables to find the approximate interest rate at which the into P/F, P/A, A/F value is satisfied

ROR Calculation Using PW, FW or AW Relation

ROR is the unique i* rate at which a PW, FW, or AW relation equals exactly 0

Example

Applications of green, lean manufacturing techniques coupled with value stream mapping can make large financial differences over future years while placing greater emphasis on environmental factors. Engineers with Monarch Paints have recommended to management an investment of $200,000 now in novel methods that will reduce the amount of wastewater, packaging materials, and other solid waste in their consumer paint manufacturing facility. Estimated savings are $15,000 per year for each of the next 10 years and an additional savings of $300,000 at the end of 10 years in facility and equipment upgrade costs. Determine the rate of return using hand solution.

QUESTIONS?