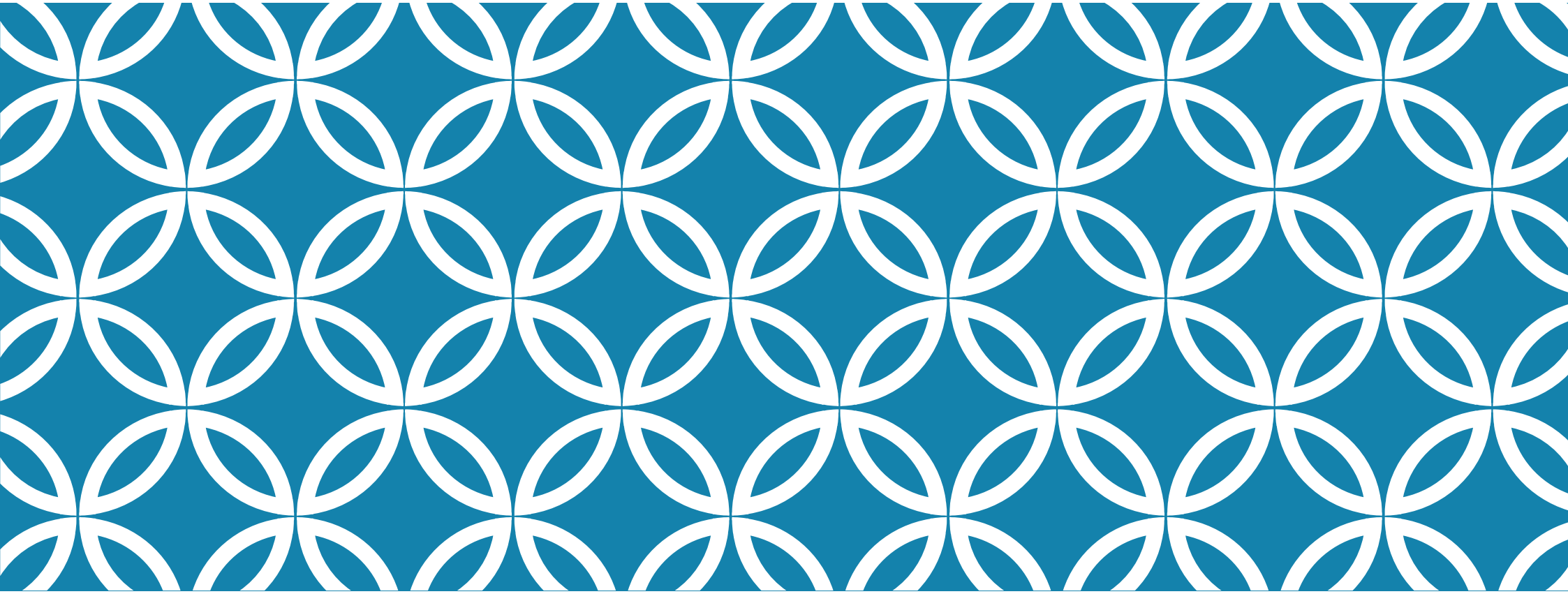


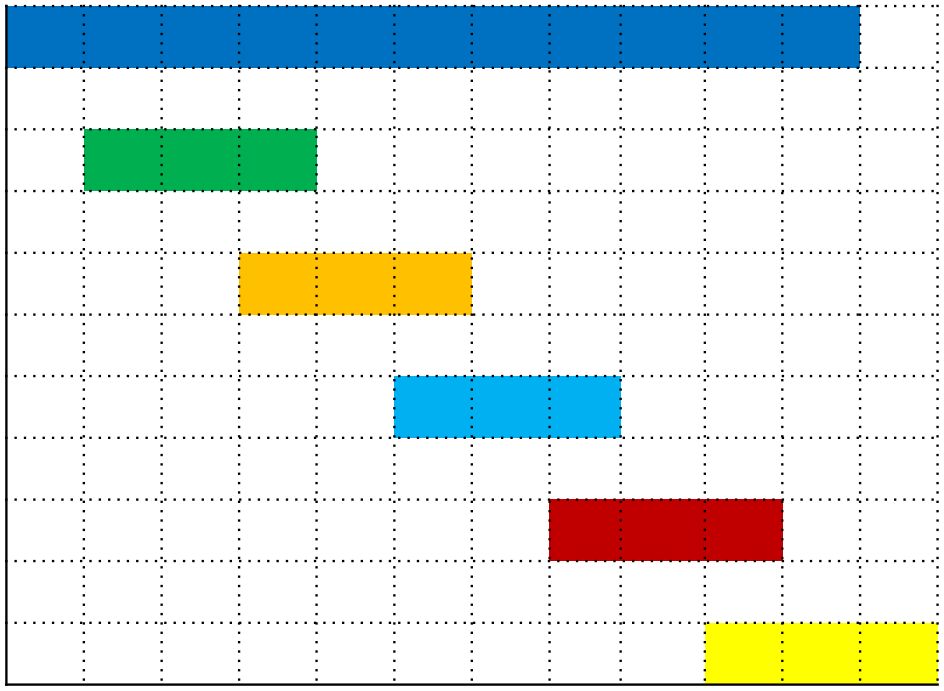
VALUE ENGINEERING LECTURE 5

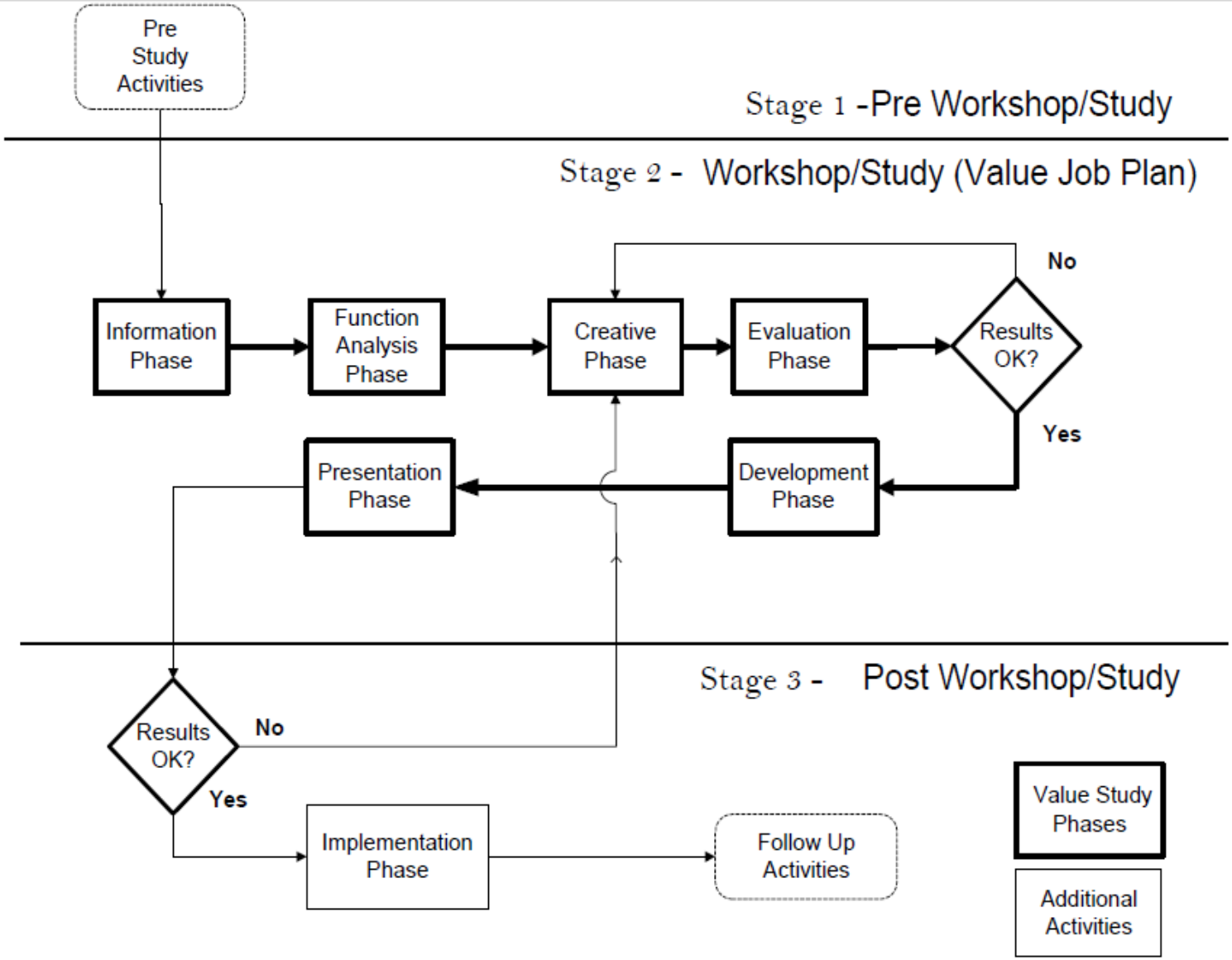
Ahmed Elyamany

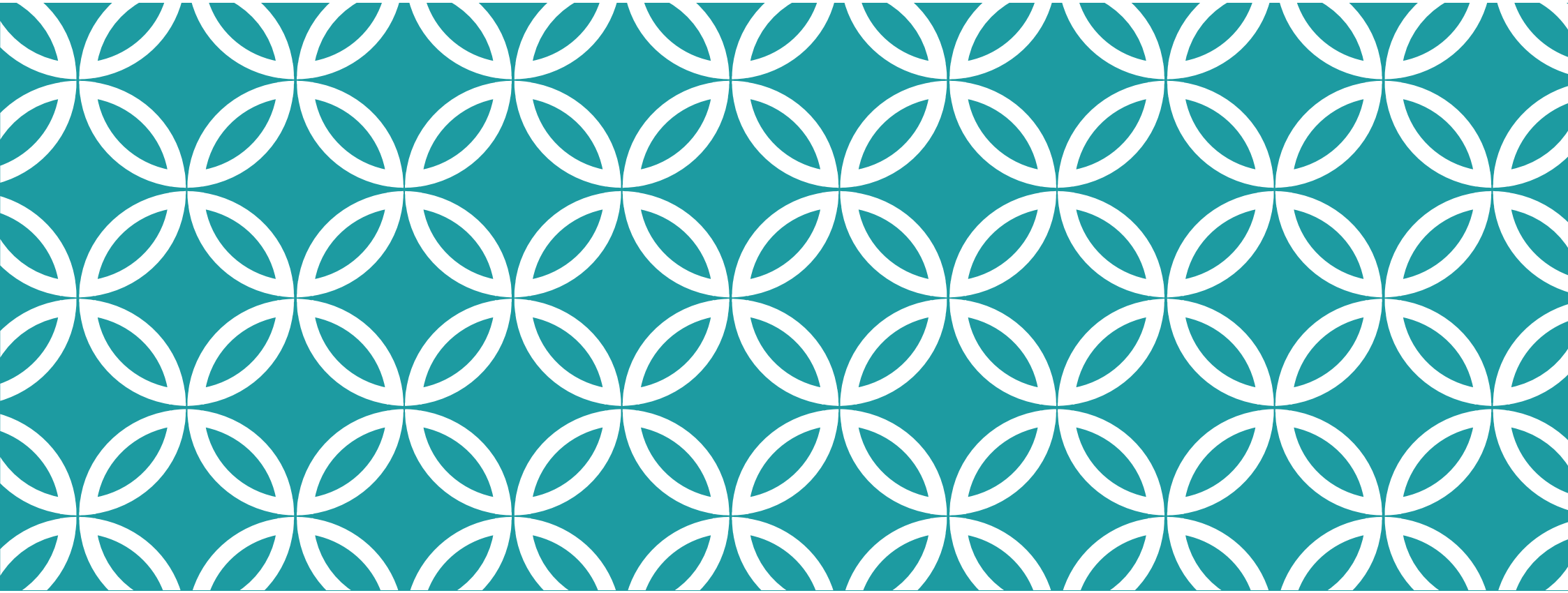
VALUE METHODOLOGY JOB PLAN

The Job Plan consists of the following sequential phases.

1) Information Phase
2) Function Analysis Phase
3) Creative Phase
4) Evaluation Phase
5) Development Phase
6) Presentation Phase




Pre Study Activities
Stage 1 -Pre Workshop/Study
Stage 2 - Workshop/Study (Value Job Plan)
Information Phase
Function Analysis Phase
Creative Phase
Evaluation Phase
Results OK?
No
Yes
Development Phase
Presentation Phase
Stage 3 - Post Workshop/Study
Results OK?
No
Yes
Implementation Phase
Follow Up Activities
Value Study Phases
Additional Activities



WORKSHOP (JOB PLAN) ACTIVITIES
EVALUATION PHASE

WORKSHOP (JOB PLAN) ACTIVITIES
EVALUATION PHASE

Purpose:

- Reduce the quantity of ideas that have been identified to a short list of ideas with the greatest potential to improve the project

Fundamental Question:

- Of all these ideas, which are worth spending quality time to further develop?

WORKSHOP (JOB PLAN) ACTIVITIES
EVALUATION PHASE

Common Activities:

- Clarify and categorize each idea to develop a shared understanding
- Discuss how ideas affect project cost, and performance parameters.
  - **Tools:** T- Charts
- Select and prioritize ideas for further development
  - **Tools:** Life Cycle Costing, Choosing by Advantages (CBA)

WORKSHOP (JOB PLAN) ACTIVITIES
EVALUATION PHASE

Typical Outcome:

- The team produces a focused list of concepts that warrant quality time to develop into value-based solutions that can be implemented into a project or a project feature.

EVALUATION

- Creative ideas in themselves are useless.
- Before progressing, think it through.
- **Screen creative ideas**

EVALUATING IDEAS
IDEA SCREENING

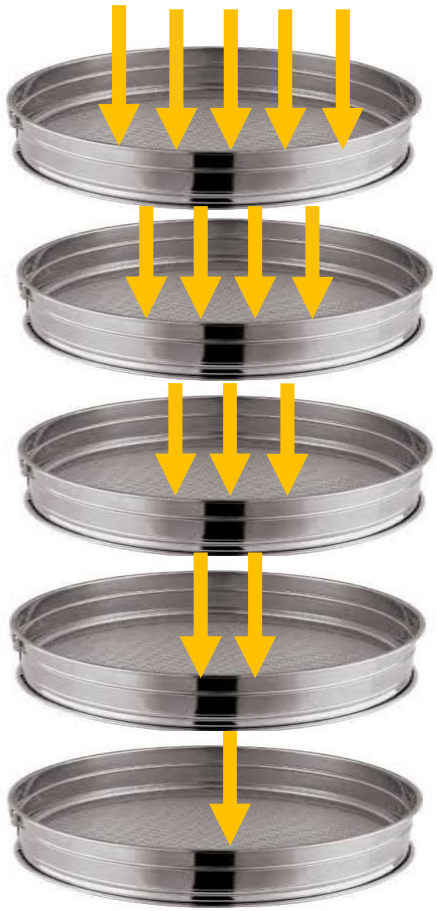
GO, NO-GO 1 st

CHAMPION 2 nd

Go For It 3 rd

TRADE-OFF STUDY 4 th

CUSTOMER ACCEPTANCE 5 th



EVALUATING IDEAS
IDEA SCREENING

- **GO - NO GO**
  - Scratch ideas that hold no interest.

- **CHAMPION**
  - Who will speak for the ideas and support them?

EVALUATING IDEAS
IDEA SCREENING

- **GFI (Go For It)**
  - Discuss pros/cons and vote.
  - GFI is team average.
  - Combine ideas; add new ideas.
  - Record all assumptions when voting.

EVALUATING IDEAS
IDEA SCREENING

- **Trade-Off Study**
  - Quantify performance characteristics.
  - Select top candidates using Pair-wise Comparison, etc.
  - Could use software such as **Expert Choice®**
  - Record all assumptions when voting.

EVALUATING IDEAS
IDEA SCREENING

- **Customer Acceptance**
  - Determine & quantify customer acceptance criteria.
  - Rate surviving ideas against norm & risk.
  - Develop proposal scenarios.

DECISION MAKING TOOLS
T-CHARTS

T-Charts are a type of chart, a graphic organizer in which a student lists and examines two facets of a topic, like the pros and cons associated with it, its advantages and disadvantages, facts vs. opinions, etc.

Advantages	Disadvantages

DECISION MAKING TOOLS
T-CHARTS

For example, a student can use a T-chart to help graphically organize thoughts about:

- Making a decision by comparing resulting advantages and disadvantages,
- Evaluating the pros and cons of a topic,
- Enumerating the problems and solutions associated with an action,
- Listing facts vs. opinions of a theme,
- Explaining the strengths and weaknesses of a piece of writing,
- Listing any two characteristics of a topic.

DECISION MAKING TOOLS
CHOOSING BY ADVANTAGES

- An attribute -- is something we need to know about just ONE alternative. We use nondifference adjectives, e.g. “long”
- An advantage -- is a difference between the attributes of TWO alternatives. We use difference adjectives, e.g. “longer”
- A disadvantage of one alternative -- is an advantage of another alternative, i.e. two names for the same thing.

DECISION MAKING TOOLS
CHOOSING BY ADVANTAGES

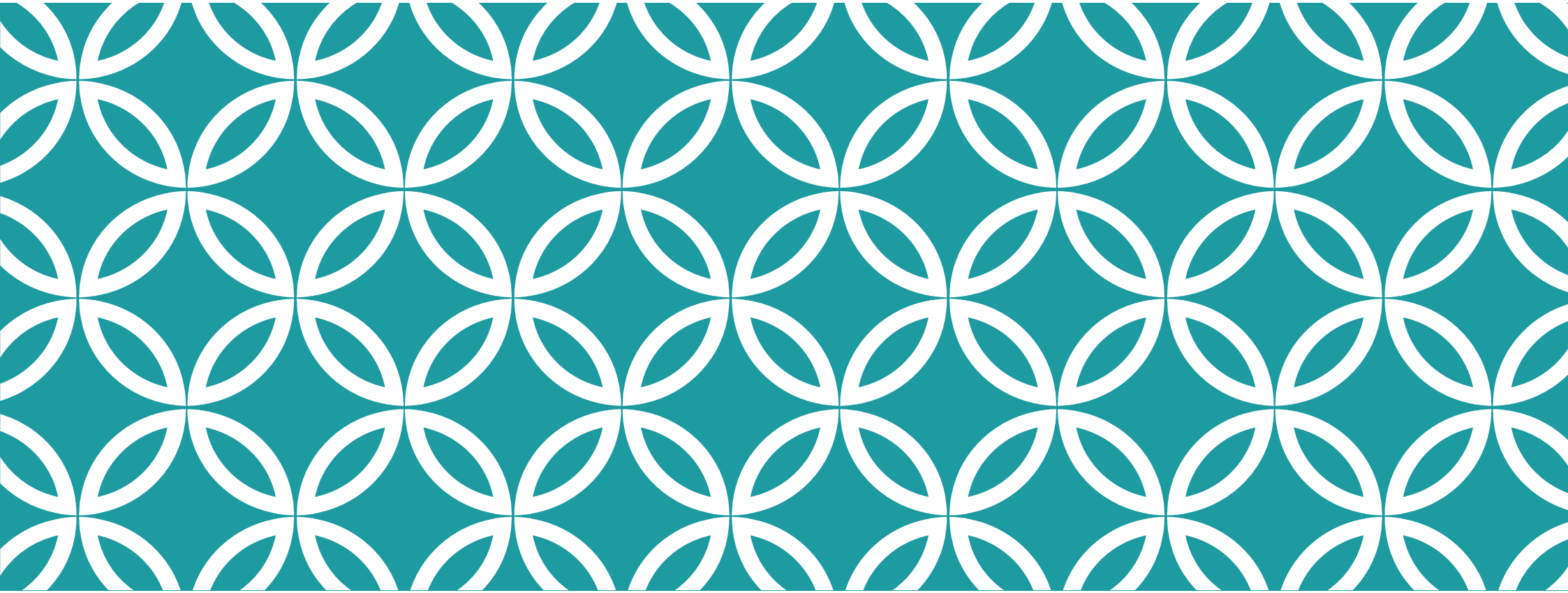
1) Two-List Method
   - List advantages of each attribute (Two List Format).
   - Decide importance of each advantage.
   - Choose alternative with greatest total importance of advantages.

2) Simplified Two-List Method
   - List advantages of each attribute (Two List Format).
   - Choose alternative with most important set advantages.

3) Instant CBA Method
   - Perceive advantages of each attribute in your mind.
   - Choose alternative with most important set advantages.

DECISION MAKING TOOLS
CHOOSING BY ADVANTAGES

- One-Factor Decision-making – Use when differences among the alternatives in only one factor.
- One-Option Situation – Use when only one reasonable option.
- Good Intuition and Good Judgment – Intuitively using correct data and intuitively using data correctly.
- Recognition-Response Method – Recognition of consideration or experienced of similar situation in past. At same time correctly respond to current situation.



DECISION MAKING TOOLS
LIFE CYCLE COST

LIFE CYCLE COST

The Life cycle cost, is the total cost from acquisition of an item to the final disposal of the same after the life of the item.

The elements of Life cycle cost can be narrated as:

1) Acquisition cost
2) Operational cost
3) Maintenance cost
4) Repair and replacement cost
5) Salvage cost

LIFE CYCLE COST
ACQUISITION COST

- It is not only the raw material cost for manufacturing of the item.
- It also includes the drawing and design cost as well as development cost.

LIFE CYCLE COST
OPERATIONAL COST

- Customer, after purchasing the item, may have to spend a certain amount of money to use the item.
- It is like petrol/diesel cost for running a car.
- Such type of costs will fall in this category.

LIFE CYCLE COST
MAINTENANCE COST

- There is always a cost of involvement for the maintenance of the item.
- This is because there may be some need to keep the item in good condition.
- It is like the change of engine oil for the engine of a car.

LIFE CYCLE COST
REPAIR AND REPLACEMENT COST

- The item may have wear and tear, and may need repair after certain period of time.
- There may be some components in the item which have a limited life and need to be replaced.
- These costs will come under this category.
- Re-treading a car tire is a repair cost and providing a new tire is a replacement cost.

LIFE CYCLE COST
SALVAGE COST

- The customer may sell the product and receive some amount in return.
- This amount is called the salvage cost.

VALUE OF MONEY

- Before learning about the Life cycle cost, one is required to understand the appreciation of money.
- If $100 is invested in the bank at the interest rate of 10% on the first day of the year, then at the end of the year, it will become $110.
- In other words, the present value of $110, at the end of the year, is $100.

LIFE CYCLE COST METHODS

There are two methods of calculating the Life cycle cost:

1. Present worth Method
2. Annualized Method

LIFE CYCLE COST ASSUMPTIONS

The calculation of Life cycle cost needs the following assumptions:

1) The alternatives which will be compared through Life cycle cost should be equivalent to each other.
2) The acquisition cost is in the first day of the calendar year.
3) All other costs are presumed to happen in the last day of the calendar year.
4) Discounted rate is valid through out the Life cycle.
5) The cardinal rule is to use the same life span for all the alternatives.

LIFE CYCLE COST LIMITATIONS

1. **Life of the item:** Determining the life of an item is difficult.
2. **Interest rate:** The interest rate may not be same every year.
3. **Annual expenses:** Annually operation and maintenance costs are assumed to occurring at the end of year. Intermediate expenses are not taken into consideration.
4. **Quality/reliability:** Not considering the quality and reliability of the item, since the focus is only on costs. The lowest LCC item may not be a good quality item.

LIFE CYCLE COST LIMITATIONS

5. **Aesthetic:** Not focusing on the esteem value of the item. Hence, the lowest LCC item may fail to add to the esteem of the owner even though it provides the use value.

6. **Safety:** Safety of the customer are not considered. The lowest LCC item may not provide safety resulting in poor value to the customer.

COMPOUND INTEREST

If you have $100 and will be invested using compound interest with 10%

- After 1 year, the $100 will be $110
- After 2 years, the $100 will be $120
- After 5 years, the $100 will be $161

$$F_N = P\,(1+i)^N$$

DISCOUNT INTEREST

- The inverse of compounding is determining a present amount which will yield a specified future sum.
- The equation for discounting is found by:

$$P_N = F\,(1+i)^{-N}$$

SERIES COMPOUND FACTOR

- Given a series of regular payment, what will they be worth at some future time
- A = the amount of a regular end-of-period payment
- Each payment A, is compounded for a different period of time

$$F = A\left[\frac{(1+i)^N - 1}{i}\right]$$

SINKING FUND FACTOR

The process corresponding to the inverse of series compounding is referred to as a sinking fund;

That is, what size regular series payment are necessary to acquire a given future amount?

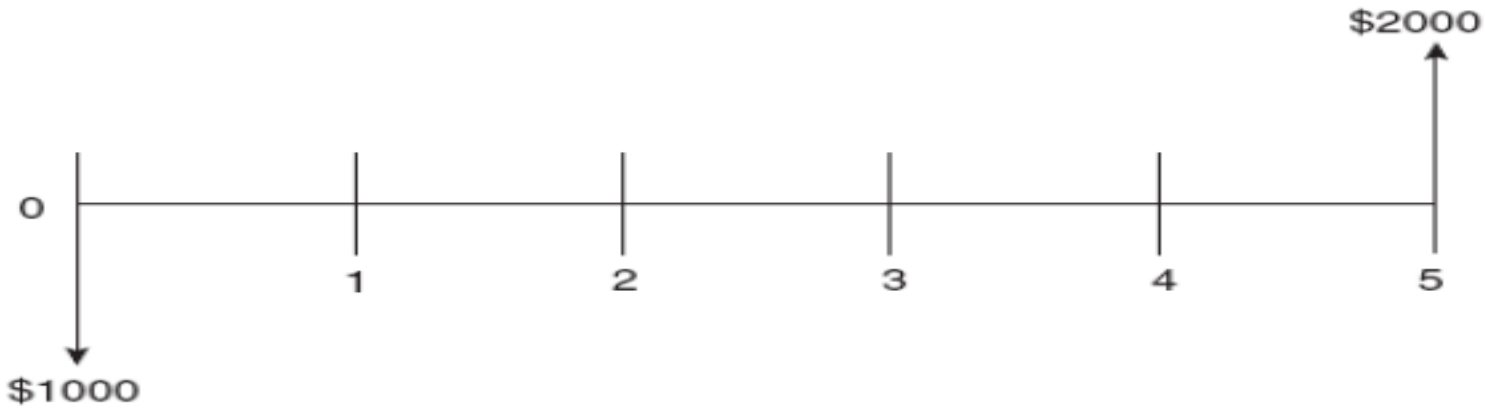
$$A = F\left[\frac{i}{(1+i)^N - 1}\right]$$

SERIES PRESENT WORTH

$$P = A\,\frac{[(1+i)^N - 1]}{[i(1+i)^N]}$$

CASH FLOW REPRESENTATION

- It is difficult to solve a problem if you can not see it.
- The easiest way to approach problems in economic analysis is to draw a picture:
  - Time interval divided in equal periods
  - All cash outflows
  - All cash inflows



EXAMPLE 1

what present sum will yield $ 1000 in 5 years with interest 10%

Solution:

$P = 1000\ (1.1)^{-5} = \$620.92$

Depositing $620.92 at 10% compounded annually will yield 1,000 in 5 years

EXAMPLE 2

what interest rate is required to triple $1,000 in 10 years.

Solution:

$3000 = 1000\,(1+i)^{10}$

$i = 11.6\%$

EXAMPLE 3

Given that a $40,000 pile jacketing will be required on a bridge in year 20 of its 50 year life, find the Present Worth of that expenditure (Interest 7%).

Solution:

Find P given F.

$P = 40{,}000[1/(1.07)^{20}] = \$10{,}337$ or

$P = 40{,}000 \times (P/F, 7\%, 20 \text{ yrs})$

$= 40{,}000 \times (0.2584) = \$10{,}336.$

EXAMPLE 4

As a check on Example 1, fine the Future Worth in year 20 of an initial outlay of $10,337 (Interest 7%).

Solution:

Find F given P.

$F = 10{,}337 \times (1 + 0.07)^{20} = \$40{,}001$ or

$F = 10{,}337 \times (F/P, 7\%, 20)$

$= 10{,}337 \times (3.8697) = \$40{,}001$

EXAMPLE 5

A new roadway project costs $2,100,000. What is the Annual Worth of this initial cost? Assume a 40 year life. (Interest 7%).

Solution:

Find A given P:

$A = 2{,}100{,}000\{[0.07(1.07)^{40}]/[1.07^{40} - 1]\} = \$157{,}519$ or

$A = 2{,}100{,}000 \times (A/P, 7\%, 40)$

$= 2{,}100{,}000 \times (0.0750) = \$157{,}500$

EXAMPLE 6

As a check of Example 3, find the Present Worth of an annual outlay of $157,519. (Interest 7%).

Solution:

Find P given A.

$P = 157{,}519\{[(1.07)^{40} - 1]/[0.07(1.07)^{40}]\} = \$2{,}099{,}997$ or

$P = 157{,}519 \times (P/A, 7\%, 40)$

$= 157{,}519 \times (13.3317) = \$2{,}099{,}997$

EXAMPLE 7

Find the Annual Worth of a $750,000 bridge widening project in year 50 of a bridge's life. (Interest 7%).

Solution:

Find A given F.

$A = 750{,}000\{(0.07)/[(1.07)^{50} - 1]\} = \$1{,}845$ or

$A = 750{,}000 \times (A/F, 7\%, 50)$

$= 750{,}000 \times (0.0025) = \$1{,}875$

EXAMPLE 8

As a check on Example 5, find the Future Worth of an annual outlay of $1,845. (Interest 7%).

Solution:

Find F given A.

$F = 1{,}845[(1.07^{50} - 1)/(0.07)]$ or

$F = 1{,}845 \times (F/A, 7\%, 50$

$= 1{,}845 \times (406.5289) = \$750{,}046$

EXAMPLE 9

A construction company is comparing between 2 machines:

- The price of the first machine is 100,000 and will be sold after 5 years by 20,000
- The price of the other machine is 150,000 and will be sold after 5 years by 40,000

Which machine is more feasible to purchase? (i=10%)

EXAMPLE 9

Solution

- PW [Machine (1)] = -100,000 + 20,000/(1+0.1)^5 = **-87,581.5**
- PW [Machine (2)] = -150,000 + 40,000/(1+0.1)^5 = **-125,163.1**

Machine 1 is better since its cost is less

EXAMPLE 10

Two alternative plans are available for increasing the capacity of existing water transmission line. discount ratio =12%

	Plan A Pipeline	Plan B Pumping station
Construction cost	$1,000,000	$200,000
Life	40 years	40 years (structure) 20 years (equipment)
Operating cost	$1,000/year	$50,000/year
Cost of replacing equipment at the end of year 20	0	$75,000

EXAMPLE 10

Solution:

Present Worth (Plan A) =

$= P + A(P/A, 12\%, 40) = \$1{,}000{,}000 + \$1000(8.24378) =$ **$1,008,244**

Present Worth (Plan B) =

$= P + A(P/A, 12\%, 40) + F(P/F, 12, 20\%)$

$= \$200{,}000 + \$50{,}000(8.24378) + \$75{,}000(0.10367) =$ **$619,964**

EXAMPLE 11

- The construction of a sewerage system is estimated to be $30,000,000.
- The annual operation, maintenance and repair (OMR) is $1,000,000/year.
- The annual income (benefit) from users is $3,500,000/year.
- The life of the system is 30 years and the discount rate is 5%.
- Determine if the project is *feasible or not*.

EXAMPLE 11

Solution

- Annual Benefits = 3,500,000
- Annual OMR = -1,000,000
- Annual cost of construction = -30,000,000 (0.06505) = -1,951,500
- **Net annual benefits (AW)**= 3,500,000 - 1,000,000 - 1,951,500 = (+**548,500**)
- **The positive means that the project is profitable**

EXAMPLE 12

Repeat Example 11 using the present Worth Method

Solution

- PW(Annual Benefits) = 3,500,000 x 15.3724 = 53,803,400
- PW(Annual OMR) = -1,000,000 x 15.3724 = -15,372,400
- PW(Annual cost of construction) = -30,000,000
- **Net PW= 8,431,000**

The positive means that the project is profitable

ALTERNATIVES WITH DIFFERENT LIFE TIME

- Alternatives with unequal life times may be compared by assuming replacement at the end of the shorter life, thus maintaining the same level of uniform payment
- OR, all cash flows are changed to series of uniform payments

EXAMPLE 13

- A company is investigating the installation of two alternative systems.
- Given the purchase price and the annual insurance and life, which system should be chosen, considering discount ratio =10%?

	System Cost	Insurance Premium	Life
Partial System	$8,000	$1,000	15 yr
Full system	$15,000	$250	20 yr

EXAMPLE 13

Solution:

Annual cost (partial system) $= A + P(A/P, 10\%, 15)$

$= -\$1000 - \$8000(0.13147) \quad = -\$2051.75$

Annual cost (Full system) $= A + P(A/P, 10\%, 20)$

$= -\$250 - \$15000(0.11746) \quad = -\$2011.90$

The **Full system** is more economical

EXAMPLE 14

A new piece of equipment costs L.E.100,000. The life of the equipment is estimated to be 15 years. During the first five years, there will be no maintenance cost. After that, L.E.20,000 is the annual maintenance cost. The equipment is assumed useless at the end of its life. Compute the equivalent annual cost of owing the machine by taking i=10%

EXAMPLE 14

Solution:

- PW of the annual maintenance at year (5)
  $=20{,}000\,(P/A,10\%,10)= 20{,}000 \times 6.1455 = \text{L.E.}122{,}890$
- PW of the annual maintenance at year (0)
  $= 122{,}890\,/(1+0.1)^5 = 122{,}890 \times 0.62092 = \text{L.E.}76{,}305$
- Total PW $= 100{,}000 + 76{,}305 = \text{L.E.}176{,}305$
- Equivalent annual worth $= 176{,}305\,(A/P,10\%, 15) = 176{,}305 \times 0.1314 =$ L.E.**23,166.47**

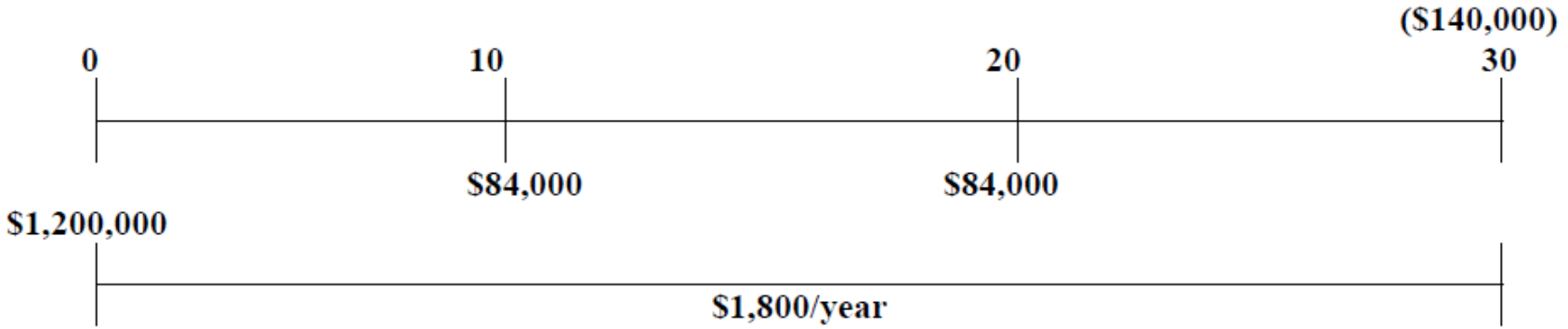
EXAMPLE 15

	Alternative 1 PCC Pavement	Alternative 2 HMA Pavement
Initial Construction Cost (year 0)	$1,200,000	$900,000
Stage II Construction (year 10)		$350,000
Stage III Construction (year 20)		$290,000
Joint Sealing (year 10 & 20)	$84,000	
Routine Annual Maintenance	$1,800	$1,000
Salvage (year 30)	($140,000)	($280,000)

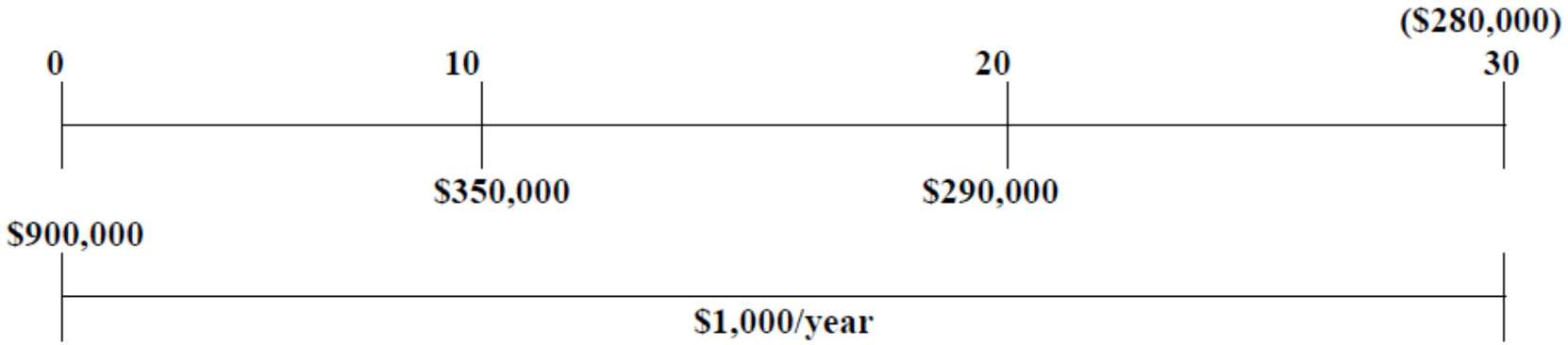
The estimated life of each alternative is **30 years**.

Use a 4% discount rate to find the best alternative.

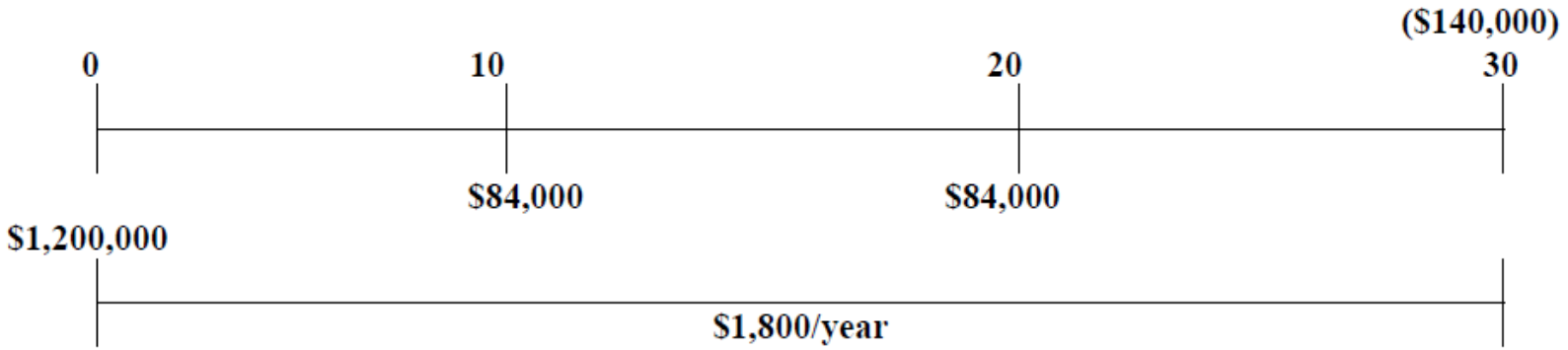
Alternative 1



Alternative 2



Alternative 1



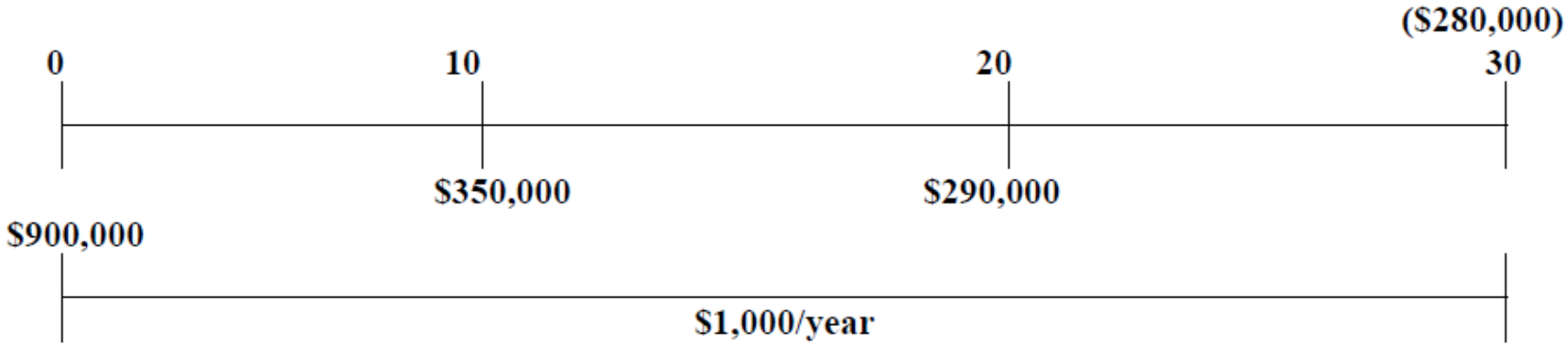
Present Worth Method

- P = $1,200,000 + $84,000 (P/F, 4%, 10) + $84,000 (P/F, 4%, 20) + $1,800 (P/A, 4%, 30) - $140,000 (P/F, 4%, 30)
- P = 1,200,000 + 84,000 (0.6756) + 84,000 (0.4564) + 1,800 (17.2920) - 140,000 (0.3083)= $1,283,045 **ANSWER**

Annual Worth Method

- A = $1,200,000 (A/P, 4%, 30) + $84,000 (P/F, 4%, 10) (A/P, 4%,30)+ $84,000 (P/F, 4%, 20) (A/P, 4%, 30) + $1,800 - $140, 000 (A/F, 4%, 30)
- **A** = 1,200,000 (0.0578) + 84,000 (0.6756) (0.0578) + 84,000 (0.4564) (0.0578)+ 1,800 - 140,000 (0.0178)= $74,199 **ANSWER**

Alternative 2



Present Worth Method

- P = $900,000 + $350,000 (P/F, 4%, 10) + $290,000 (P/F, 4%, 20) + $1,000 (P/A, 4%, 30) - $280,000 (P/F, 4%, 30)
- **P** = 900,000 + 350,000 (0.6756) + 290,000 (0.4564) + 1,000 (17.2920) - 280,000 (0.3083) = $1,199,762 **ANSWER**

Annual Worth Method

- **A** = $900,000 (A/P, 4%, 30) + $350,000 (P/F, 4%, 10) (A/P, 4%,30) + $290,000 (P/F, 4%, 20) (A/P, 4%, 30) + $1,000 - $280, 000 (A/F, 4%, 30)
- **A** = 900,000 (0.0578) + 350,000 (0.6756) (0.0578) + 290,000 (0.4564) (0.0578) + 1,000 - 280,000 (0.0178) = $69,382 **ANSWER**

EXAMPLE 15

Comparison of Alternatives:

	Alternative 1	Alternative 2
Present Worth	$1,283,045	$1,199,762
Annual Worth	$74,199	$69,382

Alternative 2 is the least expensive alternative.

This example also illustrates that the use of either the annual worth or present worth method leads to the **same conclusion**.

CRITERIA WEIGHTING
PAIRED COMPARISON

CRITERIA	A	B	C	D	E	F	G	H	I	CRITERIA
A. Safety		B 4	A 5	A 5	A 5	F 3	A 5	A 5	I 2	A
B. Reliability			B 5	D 4	B 4	B 4	G 4	B 5	B 5	B
C. Portability				C 2	E 4	C 3	G 3	C 3	I 5	C
D. Machineabilty					E 5	D 4	G 3	D 4	D 4	D
E. Constructabilty						F 3	E 1	E 0	I 2	E
F. Frangability							F 5	F 4	I 0	F
G. Maintainability								H 0	H 1	G
H. Serviceability									I 3	H
I. Ergonomic Compatibility										I
										TOTAL

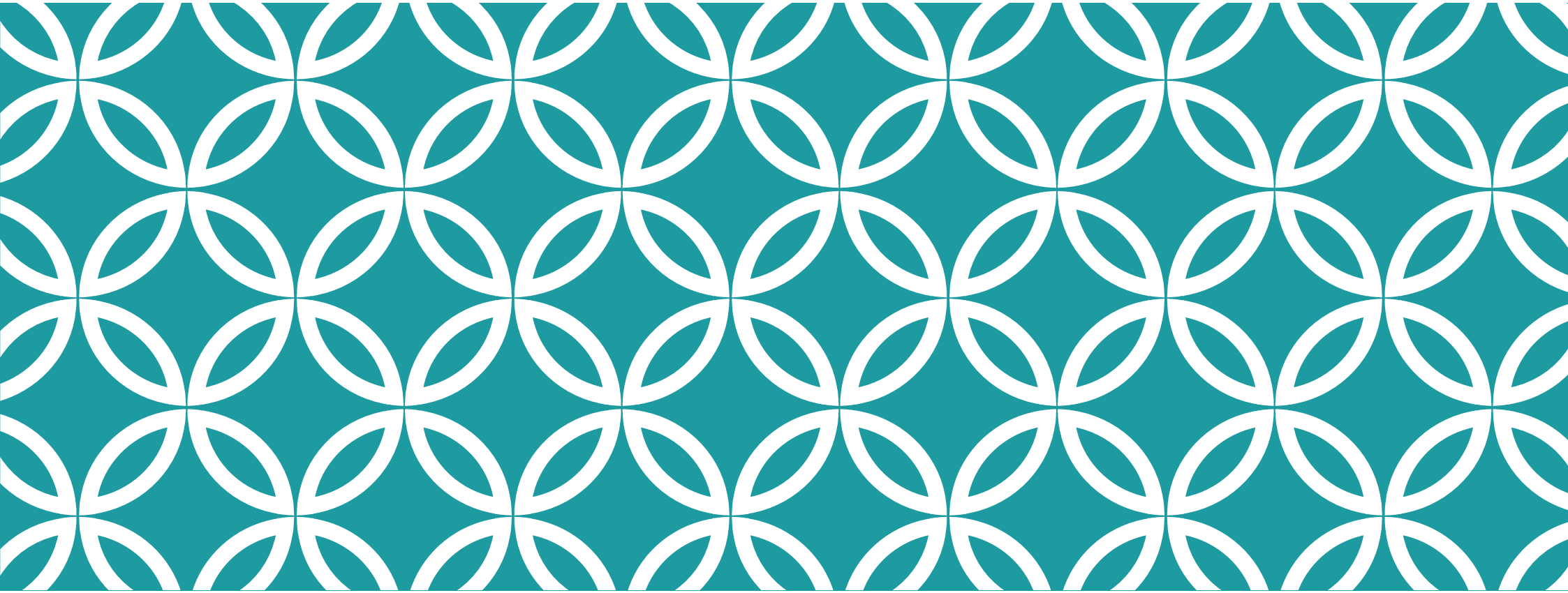
The team arrives at consensus on the scores for each criteria. For example, the team decides which is better, A - Safety, or B - Reliability. In this case, B - Reliability wins by 4 points. Next, which is better A, or C- Portability. Winner - A by 5,

SCORING

scale - 0 to 5
0 = No Differen
5 = Major Diffe

RATE AND RANK OF ALTERNATIVES						
		ALTERNATIVES				
CRITERIA	WEIGHT	A	B	C	D	E
A. Safety	20.3	5 / 101.6	4 / 81.3	2 / 40.7	3 / 61.0	5 / 101.6
B. Reliability	22.0	4 / 87.8	5 / 109.8	2 / 43.9	4 / 87.8	5 / 109.8
C. Portability	6.5	2 / 13.0	4 / 26.0	1 / 6.5	2 / 13.0	3 / 19.5
D. Machineabilty	13.0	3 / 39.0	2 / 26.0	2 / 26.0	3 / 39.0	4 / 52.0
E. Constructabilty	7.3	4 / 29.3	1 / 7.3	4 / 29.3	4 / 29.3	5 / 36.6
F. Frangability	12.2	5 / 61.0	2 / 24.4	5 / 61.0	3 / 36.6	3 / 36.6
G. Maintainability	8.1	5 / 40.7	5 / 40.7	3 / 24.4	4 / 32.5	2 / 16.3
H. Serviceability	0.8	4 / 3.3	3 / 2.4	2 / 1.6	3 / 2.4	5 / 4.1
I. Ergonomic Compatibility	9.8	3 / 29.3	1 / 9.8	2 / 19.5	3 / 29.3	4 / 39.0
TOTAL	100	404.9	327.6	252.8	330.9	415.4
COST		$ 1,450.00	$ 1,711.00	$ 1,000.00	$ 1,250.00	$ 2,100.00
Value Index		0.28	0.19	0.25	0.26	0.20
		best value				

Each alternative is scored against how well it satisfies the various criteria. Once the scores are assigned, they are multiplied by the weight of the criteria and summed for a total score. Then, a value Index is calculated by dividing the total score by the implementation cost.



THANKS FOR LISTENING