BASIC ENGINEERING DESIGN

GEN- N1003

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Lecture 2

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Design

Is a Process	**Involving**	**a designer or more**
	Dealing	**with issue (s) / problem (s)**
	Having	**a start & an end (time frame)**
	Relating	**to time (time to market)**
	Having	**a product**

Engineering Design

Management		
Is a Process	Involving	a designer or more
	Dealing	with issue (s) / problem (s)
	Having	a start & an end
	Relating	to time
	Having	a product
Management		

Problem Description / Typology

		Nature of Variables	
		Calculatable (Complete Understandable)	Incalculatable (Partial Understandable)
Number Of Variables	Specified (all variables)	**1-Simple Problem**	**3-Complex Problem**
	Unspecified (Some variables)	**2-Compound Problem**	**4-Meta Problem**

Problem Description / Typology

Type of problem	Limits of analysis	Limits of action
1- Simple	**Complete** understanding of **all the variables** (Comprehensive analysis)	Maximizing or optimizing
2- Compound	**Complete** understanding of **some variables** (In-depth analysis of sub-problems)	Sub-optimization, Second-best , Satisfying , etc.
3-Complex	**Partial** understanding of **all variables**	Overall improvements
4- Meta	Partial understanding of **some variables** (Points of departure, benchmarks ,etc.	Partial improvements

Example:

Let me take an example from transportation. Suppose that the problem is to plan a trip by car from one city to another.[5] How might this look from the perspective of each different kind of problem?

As a simple problem, getting from one point to another is typically a problem of determining the shortest-distance or least-cost route. To do this, we need to identify all the relevant factors (such as vehicle operating costs, distances and conditions along all the alternative routes, and any other constraints). Then we work out the appropriate distances or costs for each possible route and we choose the optimum: i.e. the shortest-distance or least-cost route. For more involved problems of this type, there are sophisticated mathematical models

Example:

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The 'same' problem typically becomes a compound problem through the addition of a more complicated set of objectives. For example, suppose that we want not only to minimize distances or costs but also to 'have a pleasant trip' on the way. This may mean following a scenic route, not driving too fast, making sure there are convenient places to stop for refreshments, etc.

Example:

Let me take an example from transportation. Suppose that the problem is to plan a trip by car from one city to another.[5] How might this look from the perspective of each different kind of problem?

The 'same' problem typically becomes a complex problem through the addition of more interests. For example, suppose once again that your sole objective is to find the shortest-distance or least-cost route; but this time you have passengers with you whose views must also be considered. Even if you and your passengers agree on the objective of the trip, you may not agree on how to achieve it. For example, you may agree on the objective of minimizing costs but disagree on how to do it (e.g. on the cost of time spent *en route* or the allowance for depreciation of the automobile). So what makes

Example:

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Finally, what makes a problem into a meta-problem is typically a combination of both multiple objectives and multiple interests. For example, suppose that you and your passengers share little more than a willingness to travel together. That leaves unresolved both the objectives of the trip and the means for achieving them. In particular, what makes meta-problems so difficult to deal with is the fact that values (what actually makes the trip 'pleasant' for each of the travellers) may be influenced by the experience of the trip itself (what happens as the trip

PROBLEM SOLVING

- Throughout history, many different people have tried to **map problem solving** as a **process** which individuals and groups could follow to success.

THINKING

- Thinking is the most **complicated** and **advanced brain activities**
- It is a **product of human ability** to process symbols and thoughts, hence using it in solving problems in different situations

THINKING

- Thinking is about using the power of conception, judgment and interference to generate ideas, then to view them as possible or likely **based on** either **information** you receive or perceive.

THINKING TECHNIQUES

- Thinking techniques will help you to use the **learning** you are receiving **more effectively.**
- They allow you a greater understanding of your **ability** to **teach yourself**, and to take ownership of your actions.

Beat Problem

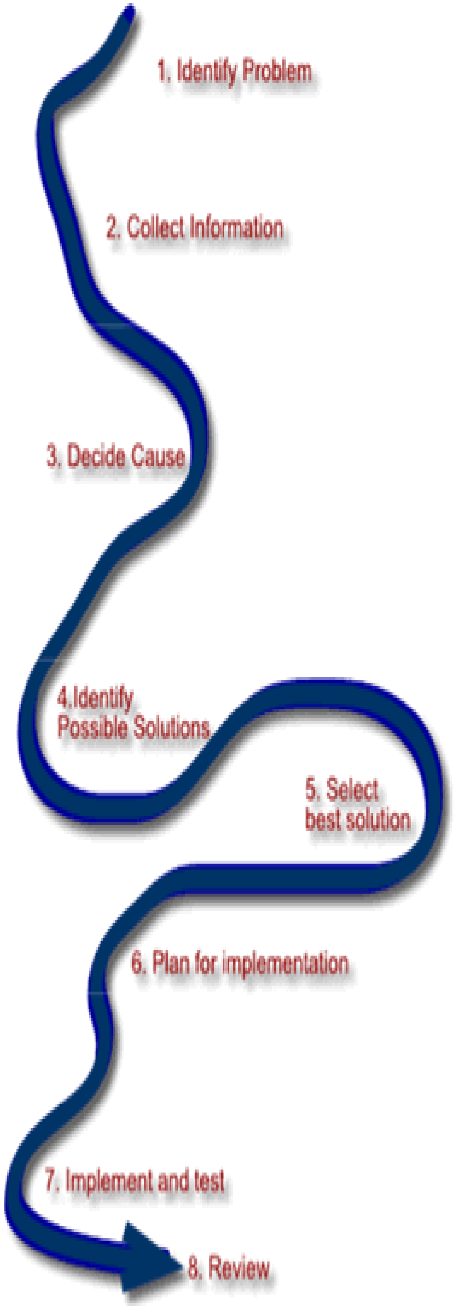
- Two random students: First one should formulate a problem for the second one to find possible solutions.

- My right side, first row, second student from the wall.

- My left side, fourth row, fifth student from the wall.

PROBLEM

The case in which a human has two situations, one is known while the other is relatively unknown.



PROBLEM SOLVING

Ways and methods used to achieve a solution or objective to bridge the gap between the two situations

ALGORITHM

A sequence of steps that can be followed to solve the problem.

HEURISTICS

Direct u to find solutions

A set of actions or activities that can help in finding a solution.

PROBLEM SPACE

Is the **all possible actions** that could be done to achieve a solution.

B. 2.CREATIVE PROBLEM SOLVING

PROBLEM SPACE

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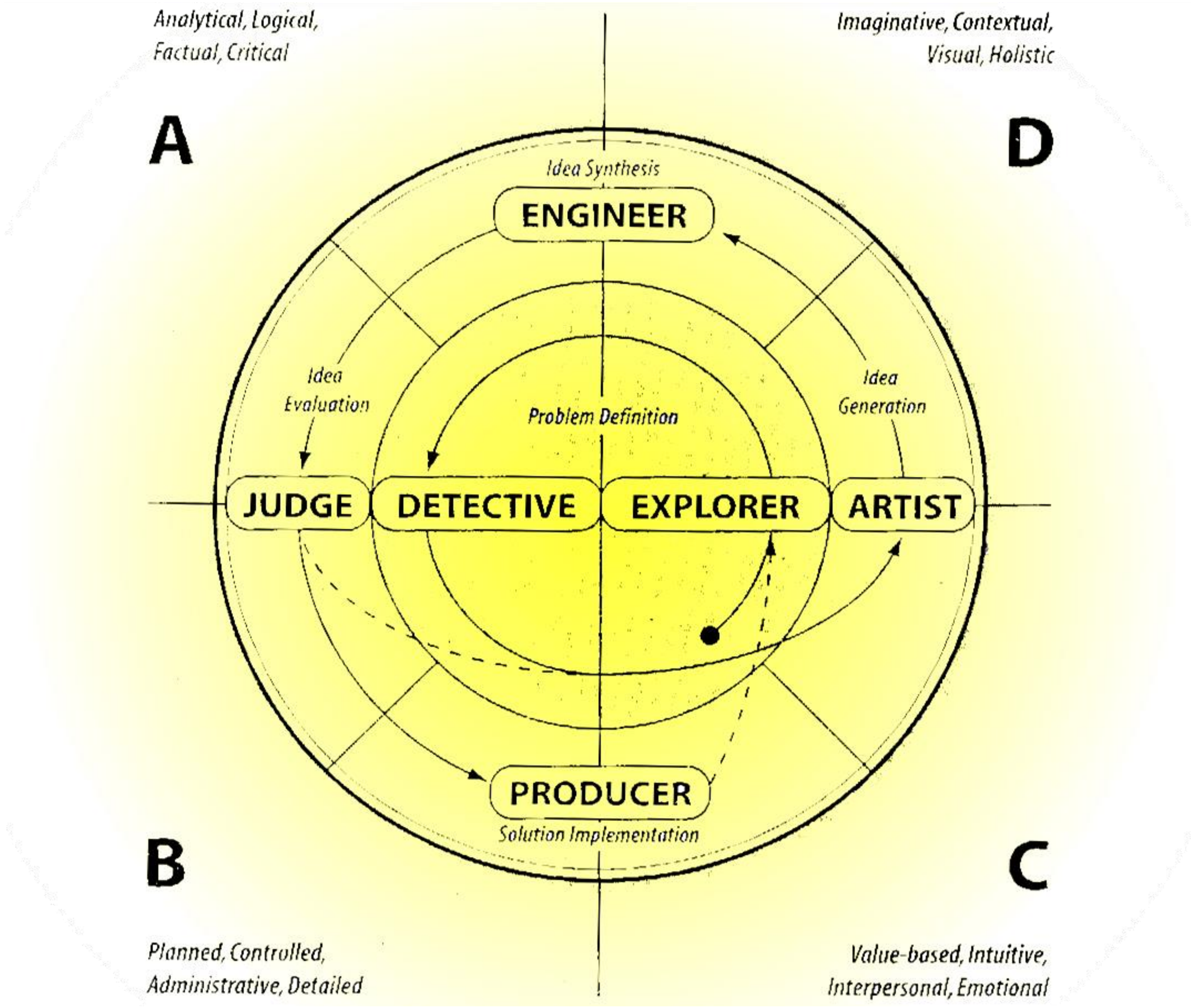


C. PROBLEM DEFINITION

1- FACT FINDING

2- IDEA FINDING

3- SOLUTION FINDING

How to define the problem

❑Thinking up new problems

–Search for problems- Creative success comes also from driving off the deep end in search of unseen problems.

❑Clarification of a problem

- A problem well stated is half-solved.
- Try to express in a clear definite question.
- Try to compose the problem into its different elements.
- Try to examine the nature of the problem.
- Begin with a wide focus and then use a narrow focus to define sub- problems.

How to define the problem

❑Clarification of a problem

- Knowing what you are looking for helps you to recognize it when you see it.
- But in case of innovation how do you know what are you looking for?????
- You don’t know unless you state your problem so broadly so basically and generally.

❑One aim may lead to another

- **As one idea leads to another, one aim leads to another.**

Definition of the problem may lead to:

- ❑ **Factual answer (real life)**
  "How much money do we have to complete this project?"
- ❑ **Answer giving judgment or decision**
  "Should we try to get more money?"
- ❑ **Answer calling for creative ideas**
  "In what ways can we profitably utilize available access funds?"

Problem definition

- **Never define a problem as a solution. You should always go more deeper in understanding the problem.**
- **Example:**
- **Problem: Lack of good trained lecturers**
- **Solution: Train lecturers**
- **Alternative Solutions: --Difficult**

- **However, going deeper in the problem:**
- **Problem: Student learning is not good**
- **Solutions: Train lecturers, teaching methods, teaching environment, teaching materials,….etc.**

1 THE DIFFERENCE REDUCTION METHOD

Reducing the gap between the basic phase and the final phase

This technique is used when the problem is not familiar.

2 MEANS –ENDS ANALYSIS

Start with analyzing the main problem into secondary problems (Divide and Conquer)

This technique assumes the following:

- ✓There are two situations: Basic and Final
- ✓Use actions to eliminate or minimize the difference
- ✓This process can be used repetitively as long as there is a progress in finding a solution

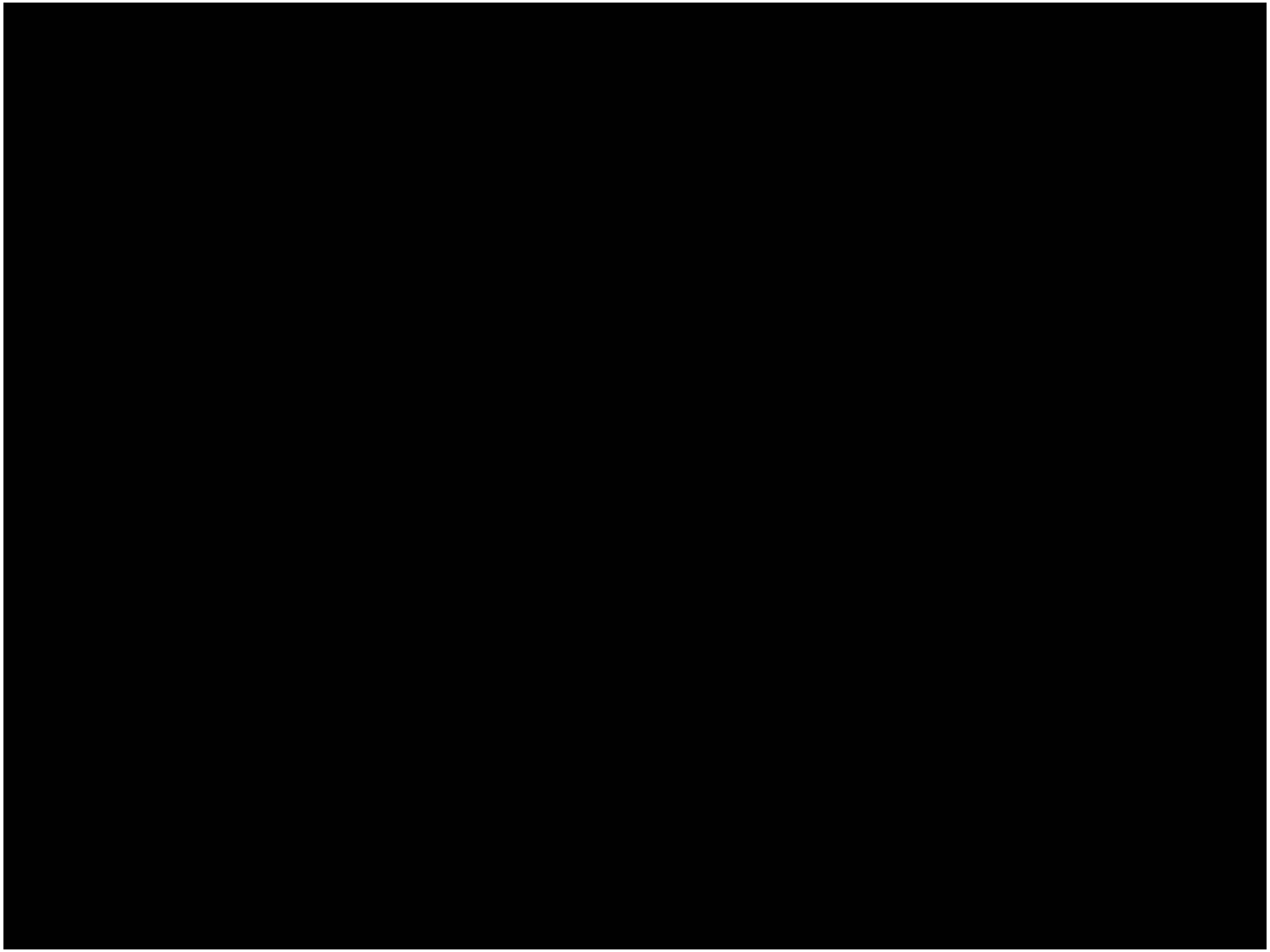
3 WORKING BACKWARD TECHNIQUE

- Start from the End, start from the objective
- Find appropriate sub-objectives to achieve the main objective
- Find appropriate decisions to achieve sub-objectives
- Deal with each sub-objective individually

4 PROBLEM SOLVING BY ANALOGY

Use a technique that succeeded in solving a similar problem

Break Video



CHARACTERISTICS OF DESIGN PROBLEMS

I. DESIGN PROBLEMS cannot be **COMPREHENSIVELY (totally) STATED**

- Design problems are complicated & require a wide range of information

II. DESIGN PROBLEMS require **SUBJECTIVE EXPLANATION**

- Design problems are subjectively understood

III. DESIN PROBLEMS tend to be **ORGANIZED HIERARCHICALLY**

- Design problems are conflicting yet could be arranged during to priorities

SOURCES OF DESIGN PROBLEMS

Human Sources	Constraints as Problems
▪Client ▪User ▪Designer	▪Functional Problems ▪Context & environment ▪Building regulations & codes ▪Technologies & material available ▪Budget

STEPS to reach the OPTIMUM SOLUTION

1- Specify the PROBLEM (Main – Secondary)

2- Putting the AIMS and GOALS of the Project

3- DATA GATHERING

4- DATA ANALYSIS

5- STRATEGY (Main Concept- Program)

6- ALTERNATIVES (to solve the Problems)

7- ALTERNATIVES EVALUATION best solution

8- IMPLEMENTATION PLAN

9- IMPLEMENTATION

10- TEST & RESULT

Beat Problem

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- My left side, third row, first student from the aisle.

THE ENGINEERING MODEL

ETTER (1995) presented a model used by students to solve engineering problems.

- **Define** the problem - state it clearly
- Gather **information** - describe input and output
- **Generate** and **evaluate** potential **solutions**
- **Refine** and **implement** solutions
- Verify and **test** solution method and **result**

THE ENGINEERING METHOD

- **RECOGNIZE** AND **UNDERSTAND** THE PROBLEM
- GATHER **DATA** (AND **VERIFY** ITS ACCURACY)
- SELECT GUIDING **THEORIES** AND **PRINCIPLES**
- MAKE **ASSUMPTIONS** WHEN NECESSARY
- **SOLVE** THE PROBLEM
- VERIFY THE **RESULTS**
- **PRESENT** THE SOLUTION

ENGINEERING PROBLEM TYPES

❑Create a New Product

- Invention/conceptualization
- New/modified design of existing product

❑Cost Reduction

- Do it faster, cheaper, better
- Example: Personal computers

❑Develop or change a Procedure

- Example: Illumination systems, methods of construction

❑Human Factors

- Make our lives longer, better, easier
- Examples: moving sidewalks, management tools

TYPES OF INFORMATION FOR PROBLEM SOLVING

GIVENS — The initial condition of the problem

OPERATIONS — The various actions we are allowed to perform

GOALS — The desired final condition of the problem

PROBLEM STATE — The state of the problem at any specific point in time

SOLUTION — Completely specified the GIVENS, OPERATIONS, GOALS, and succession of PROBLEM STATES to get to GOAL state

STEPS IN PROBLEM SOLVING

❑IDENTIFY THE PROBLEM

✓YOU CAN'T FIX IT IF YOU DON'T KNOW WHAT IS BROKEN.

❑DETERMINE WHAT IS REQUIRED FOR THE SOLUTION

✓WHAT IS **KNOWN**?

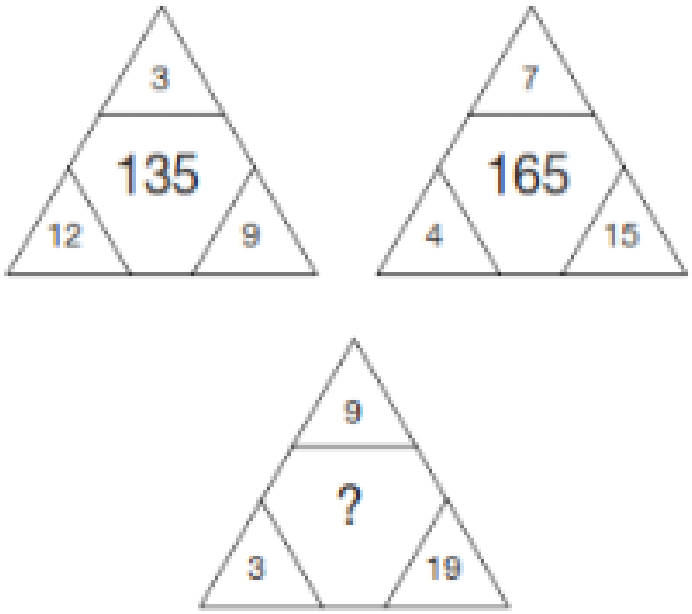
✓WHAT IS **UNKNOWN**?

✓ANY **RESTRICTIONS** OR LIMITATIONS?

✓ANY **SPECIAL CASES**?

IQ TESTs

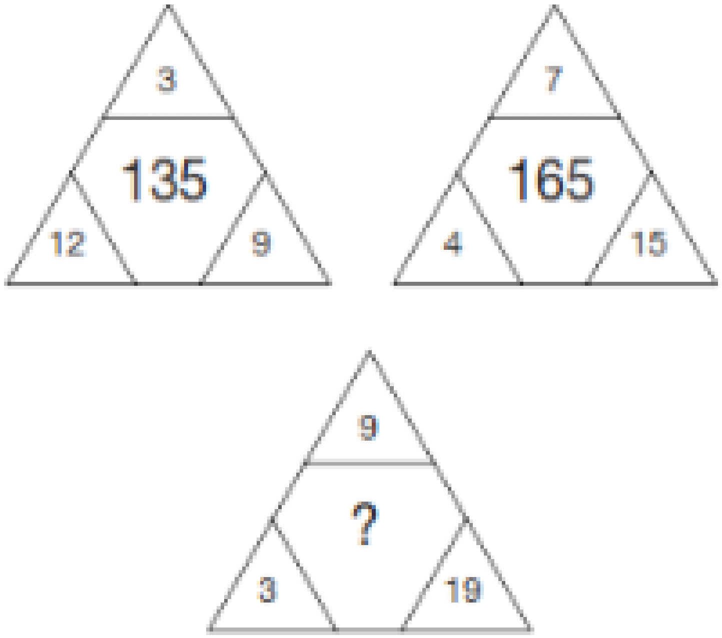
1. What number should replace the question mark? <u>Why?</u>



Answer:

IQ Tests

1. **What number should replace the question mark? Why?**

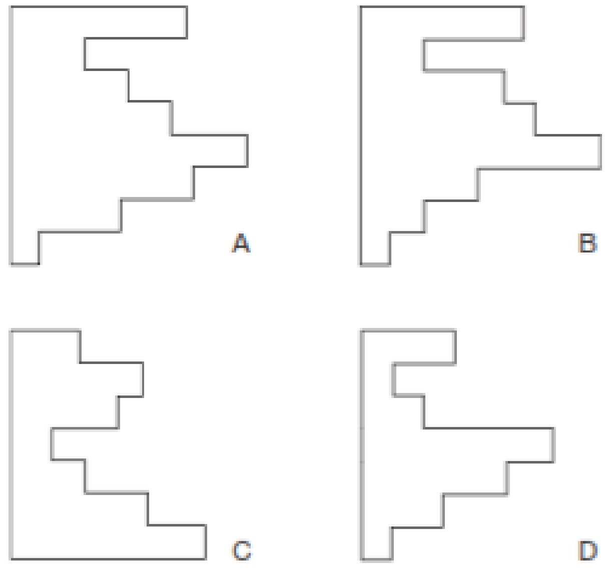


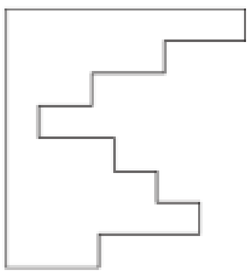
Answer: 228= (9+3)*19

Assignment 2

1 **Which piece of the right side pieces can be fitted to the piece on the left side to form a perfect square? <u>Why?</u>**

Answer:





2 **What is the missing number? <u>Why?</u>**

983 : 75

294 : 22

763 : 45

579 : ?

Answer: