Civil and Structural

What and How the Future Engineers will Continue to Learn

Dr. Naveed Anwar

AIT
Asian Institute of Technology

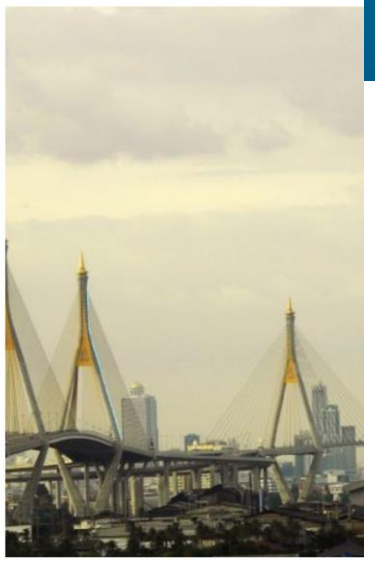
AIT Solutions
Technology • Engineering • Environment • Development • Management

Civil Engineers

Civil engineers serve competently, collaboratively, and ethically as master:

- Planners, designers, constructors, and operators of society's *economic and social engine*, *the built environment*
- Stewards of the *natural environment* and its resources;
- Innovators and integrators of *ideas* and *technology* across the *public, private, and academic sectors;*
- *Managers of risk* and uncertainty caused by natural events, accidents, and other threats; and
- *Leaders in discussions and decisions* shaping public environmental and infrastructure policy.

(Source: ASCE's vision 2025)



The Key Questions?

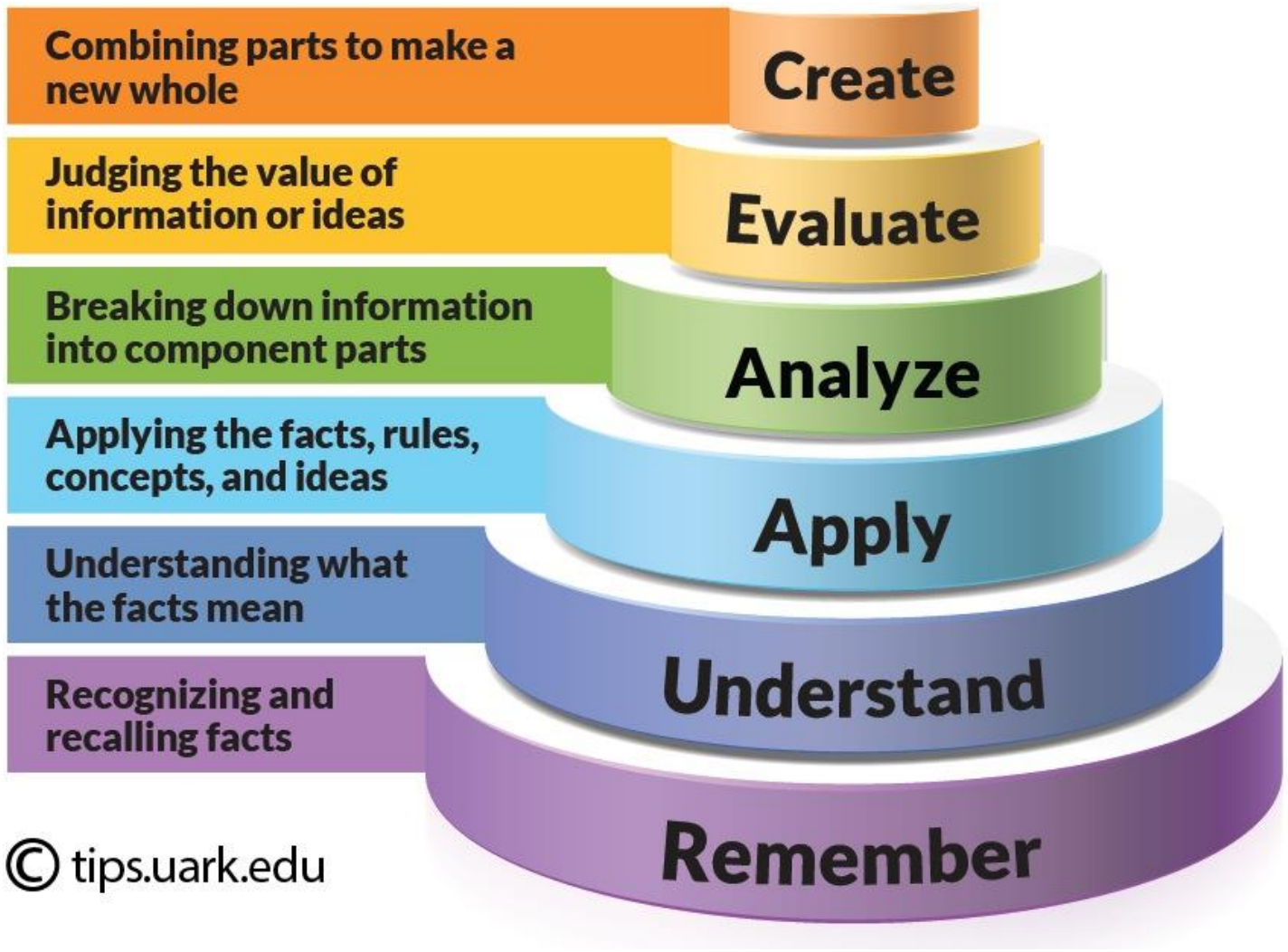
- What is it that the Civil and Structural Engineers should learn?

- How they can learn, and continue to learn effectively?

The What?

Levels of Learning

The Blooms Pyramid



ASCE

Civil Engineering Body of Knowledge for the 21st Century

Preparing the Civil Engineer for the Future

Outcome Number and Title	Level of Achievement					
	1 Knowledge	2 Comprehension	3 Application	4 Analysis	5 Synthesis	6 Evaluation
Foundational						
1. Mathematics	B	B	B			
2. Natural sciences	B	B	B			
3. Humanities	B	B	B			
4. Social sciences	B	B	B			
Technical						
5. Materials science	B	B	B			
6. Mechanics	B	B	B	B		
7. Experiments	B	B	B	B	M/30	
8. Problem recognition and solving	B	B	B	M/30		
9. Design	B	B	B	B	B	E
10. Sustainability	B	B	B	E		
11. Contemp. issues & hist. perspectives	B	B	B	E		
12. Risk and uncertainty	B	B	B	E		
13. Project management	B	B	B	E		
14. Breadth in civil engineering areas	B	B	B	B		
15. Technical specialization	B	M/30	M/30	M/30	M/30	E
Professional						
16. Communication	B	B	B	B	E	
17. Public policy	B	B	E			
18. Business and public administration	B	B	E			
19. Globalization	B	B	B	E		
20. Leadership	B	B	B	E		
21. Teamwork	B	B	B	E		
22. Attitudes	B	B	E			
23. Lifelong learning	B	B	B	E	E	
24. Professional and ethical responsibility	B	B	B	B	E	E

Foundational

Level of Achievement

	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
Mathematics	B	B	B			
Natural sciences	B	B	B			
Humanities	B	B	B			
Social Sciences	B	B	B			

B: Bachelors Degree

Technical

	Level of Achievement					
	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
Materials science	B	B	B			Description
Mechanics	B	B	B	B		
Experiments	B	B	B	B	M	
Problem recognition and solving	B	B	B	M		
Design	B	B	B	B	B	E
Sustainability	B	B	B	E		
Contemp. Issues and hist. perspectives	B	B	B	E		
Risk and uncertainty	B	B	B	E		
Project Management	B	B	B	E		
Breadth in C.E	B	B	B	B		
Technical Specialization	B	M	M	M	M	E

B: Bachelors Degree M: Masters Degree E: Prelicensure Experience

Professional

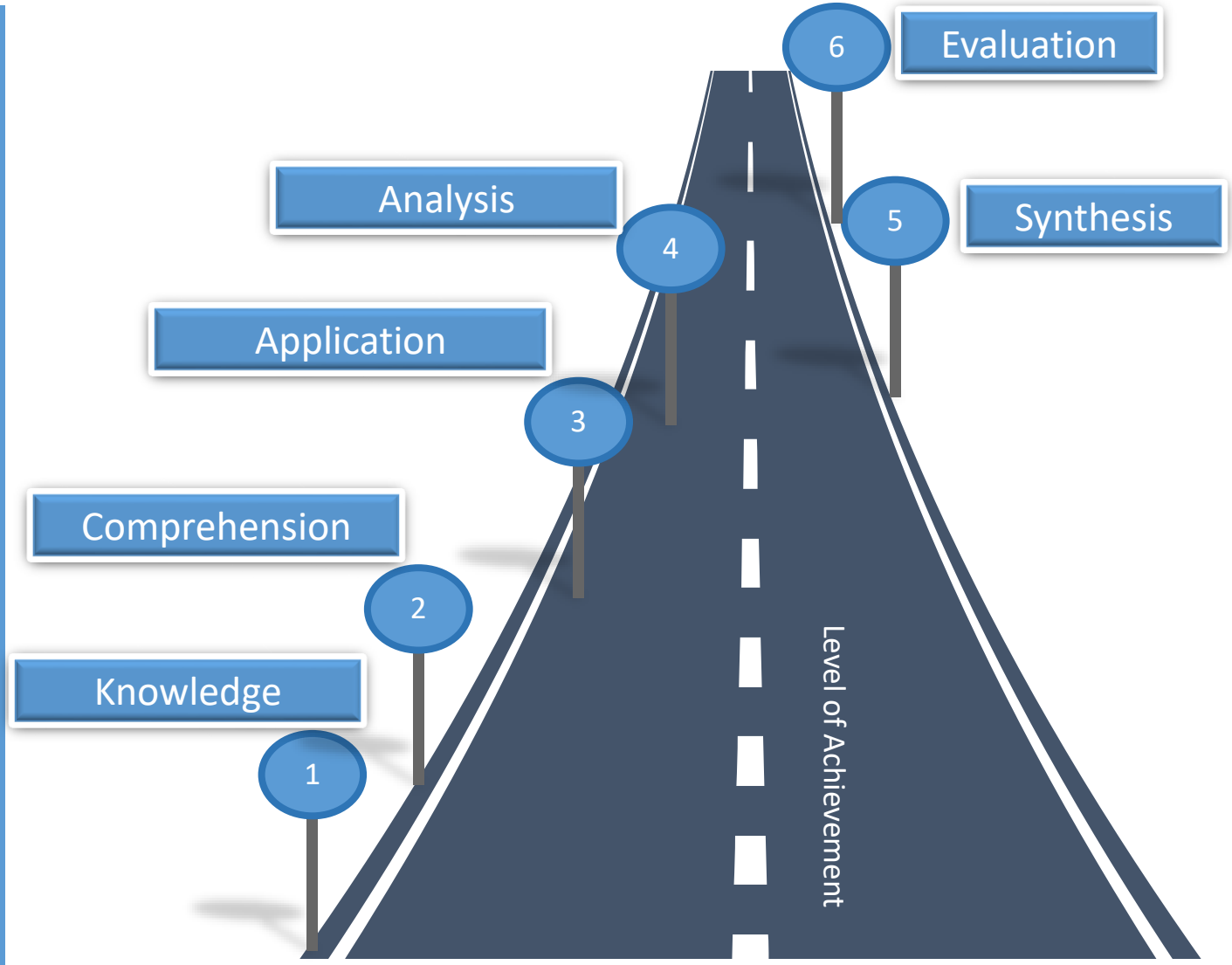
	Level of Achievement					
	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
Communication	B	B	B	B	E	
Public Policy	B	B	E			
Business and Public Administration	B	B	E		M	
Problem recognition and solving	B	B	B	E		
Globalization	B	B	B	E	B	E
Leadership	B	B	B	E		
Teamwork	B	B	B	E		
Attitudes	B	B	E			
Lifelong learning	B	B	B	E	E	
Professional and ethical responsibility	B	B	B	B	E	E

B: Bachelors Degree **M: Masters Degree** **E: Prelicensure Experience**

ASCE

Civil Engineering Body of Knowledge for the 21st Century

Preparing the Civil Engineer for the Future



Foundational | Technical | Professional

National Infrastructure
(Transportation planning, roads, highways, railways, bridges, canals, dams, offshore platforms, disaster resilience, …)

Urban Infrastructure
(Smart and resilient cities, traffic, housing, tall buildings, elevated bridges, subway systems, water and solid waste, DRM, …)

Water Cycle
(Water security, water resources, water treatment, water supply, waste water and treatment, irrigation, flood management water-food-energy…)

International Projects
(International bidding, FIDIC Contracts, PPP, International Development Partners, …)

Special Areas
(Integration of technologies in civil engineering, drones, 3D printing, computer vision, data analytics, AI, ML, VR/AR/MR, blockchain, sensing, smart materials, BIM, mobile apps…)

Subjects in statics, dynamics, geology, soil, hydraulics, materials, structures, analysis, design, GIS, FEM, Contracts, PPP…

Strong base in math, statistics, physics, chemistry, material science, computing, economics, …

Knowledge and skills in IT, communication, management, innovation, entrepreneurship, leadership, CAD, …

Exposure to SDG, ER, SR, aesthesis, ethics, law, community development, …

Civil Engineering focus, knowledge base, skills and exposure

Structural Engineering

Backbone of physical infrastructure development

- Buildings
- Bridges
- Tunnels
- Dams
- Transmission
- Communication towers
- Power plants
- Expressways
- Industrial plants
- ….

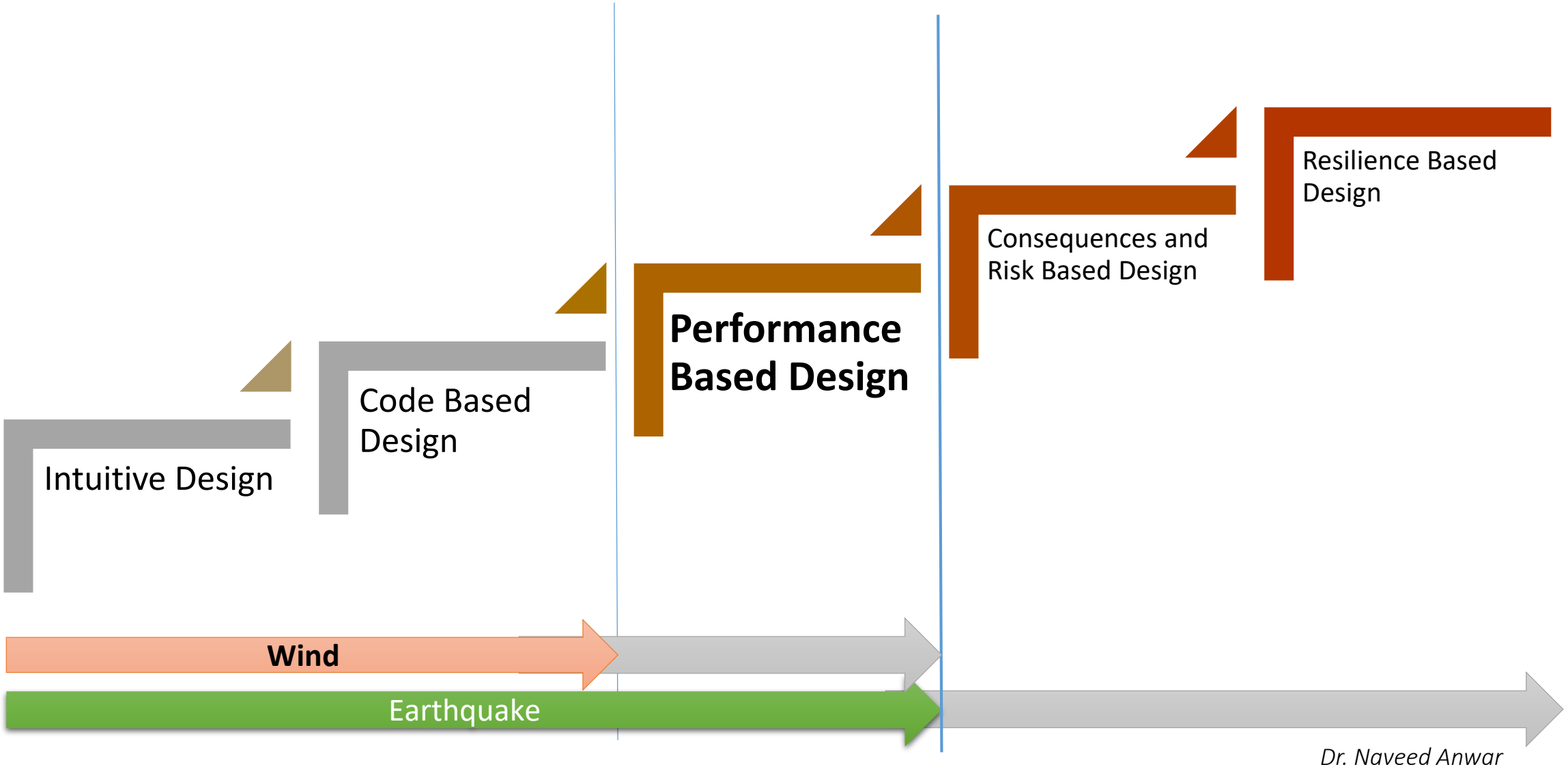
- Cause
  - Natural or man-made hazard
  - Changes with time
- Action
  - Force
  - Displacement
- Effect
  - Deformation
  - Stress

Its all about ..

Is effect acceptable?

- **Difficulty lies in:**
  - How to define causes
  - How to determine actions
  - How to determine effect on structure due to actions
  - How to establish acceptability of effects
  - How to make sure effects are acceptable

Progression of Design Approaches

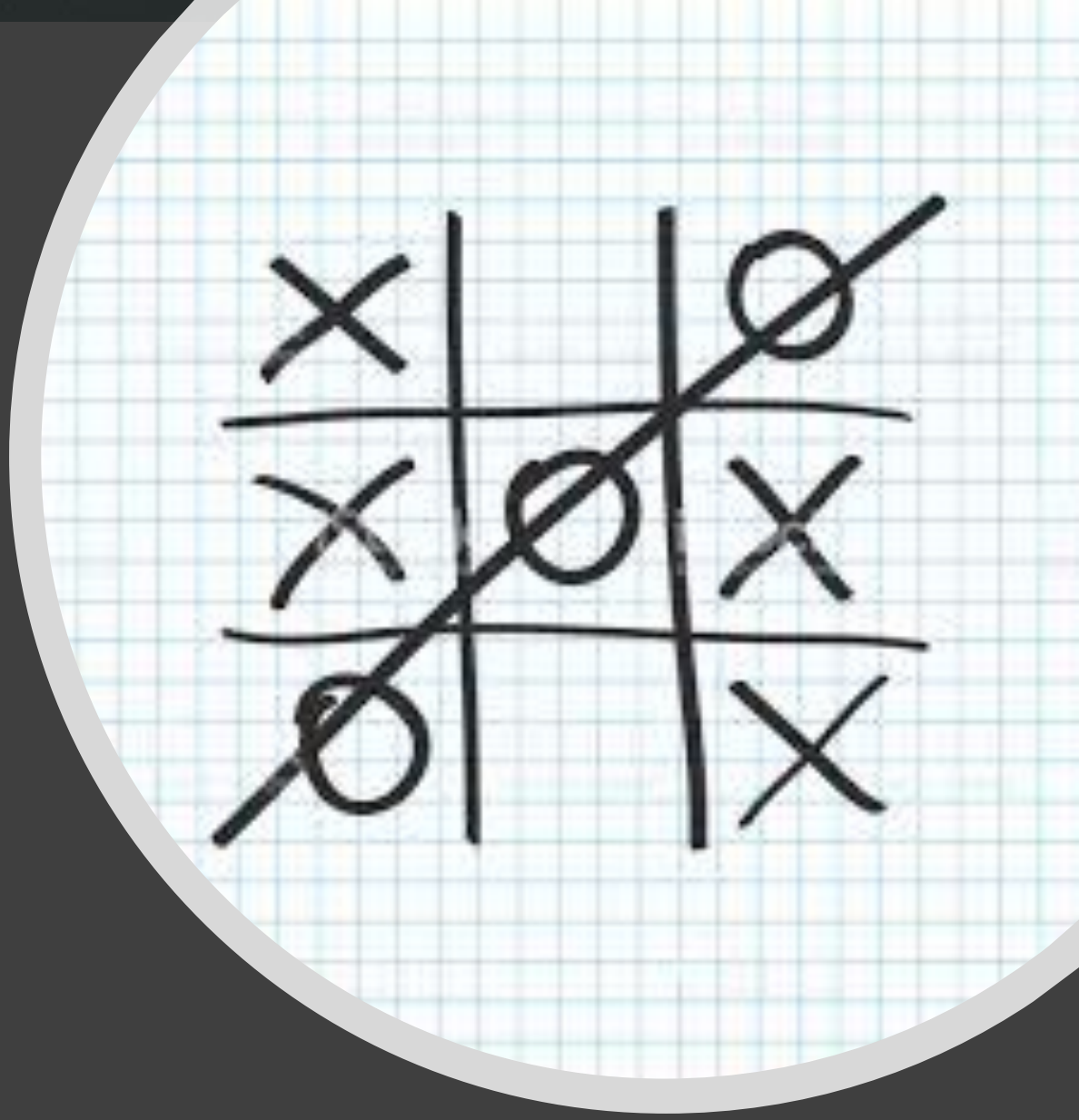


Dr. Naveed Anwar

A game played between a few basic quantities

- **Length, Mass, Force**
- **Time, Displacement**
- **Stiffness, Damping, Energy**
- **Resources**

- (Deformation, Velocity, Acceleration)
- (Stress, Strain, Moment, Strength, Ductility, …)



1. Research on the development and implementation of real-time structural monitoring of completed tall buildings (including the creation of a database of results, comparison with design assumptions, determining actual performance such as in-situ natural frequency, damping, vertical shortening, acceleration, creep, etc.

2. Research on the validation of modelling assumptions for wind and seismic loading.

3. Research to improve tall building protection from multi-hazard events such as seismic and wind events, blast, plane impact, tornadoes, etc. (including robustness, structural optimization, etc.)

4. The development of design criteria to determine the appropriate level of safety for tall buildings in extreme events(such as seismic and wind events, blast, plane impact, tornadoes, etc.)

5. Research on the development of holistic performance-based multi-hazard design and analysis of tall buildings across multiple disciplines.

The How

Develop Key Skills

Understand

- Understand physical meanings of the quantities

Establish

- Establish relations between the quantities

Simulate and visualize

- Simulate and visualize of the cause and effect cycle

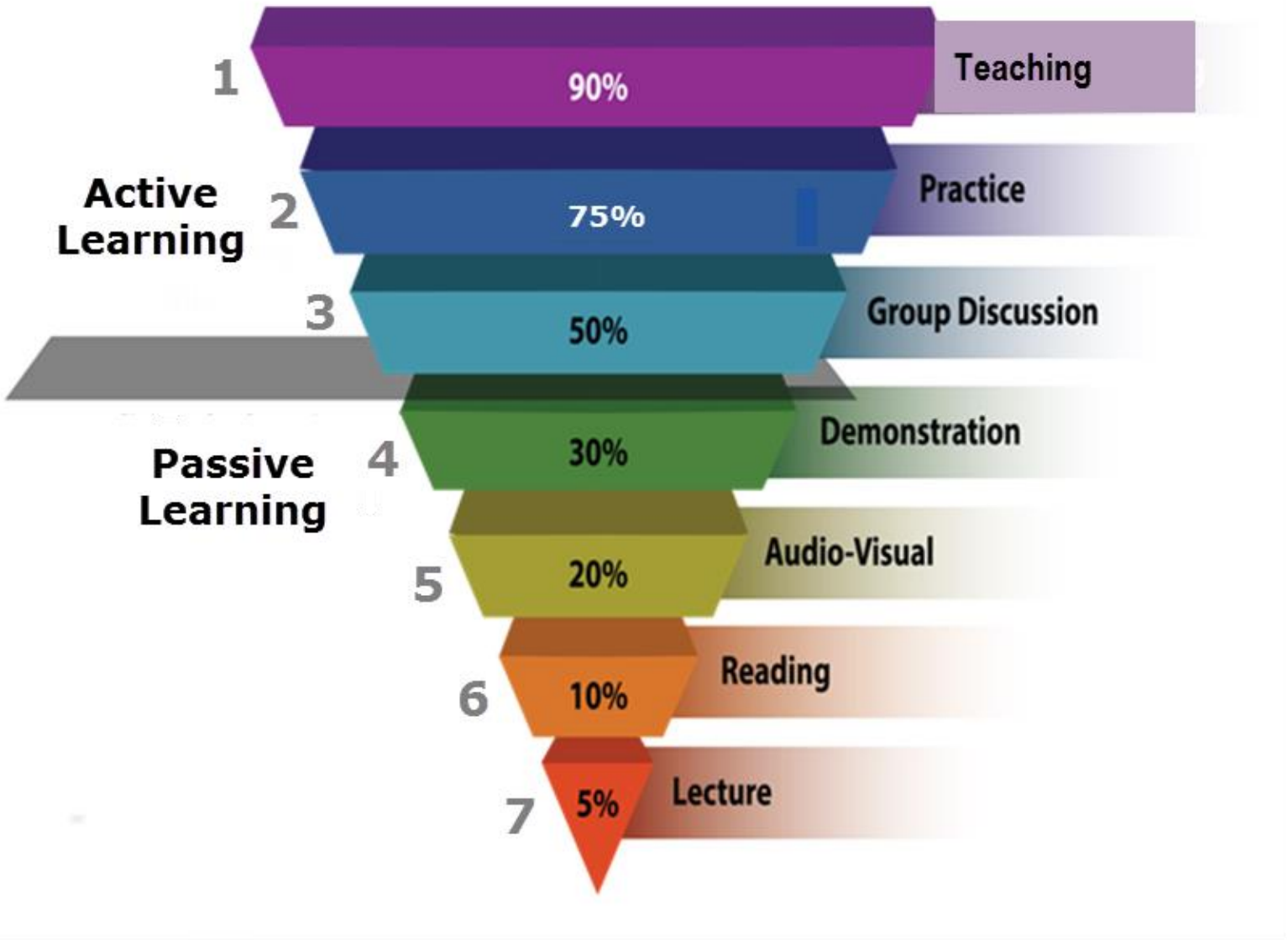
Create

- Create efficient configuration and proportioning

Communicate

- Communicate the outcome effectively

Learning Retention



Dr. Naveed Anwar

Simulation – A Tool for Learning

Some Initiatives

There is a demand of Ecosystems for Connecting Learning with Employment

Life Long Learning

Continued Professional Development

AIT's Experience in Structural Engineering

Structural Lab
Shake table, Cyclic Actuator, strong floor

Teaching, Research
Tall Buildings, Wind and Earthquake Engineering

Practical Experience
of over 100 PBD Projects

Development and application of Integrated PBD for Wind and Earthquake

CSi
Software Developer

Partners
Structural Engineers

AIT Share

AIT Share

A knowledge platform that provides access to the knowledge generated at AIT through online lecture videos and related courses offered in AIT

An Example: Professional Masters in Civil Engineering

Advisory Board and Experts for PMCE

Marshall Strabala
Design Partner
S T R A B A L A + Architecture
Chicago- Shanghai

Goman Ho
Arup Fellow, Global Leader of Tall Building, Skills Network, Adjunct Professor of Hong Kong Polytechnic University

C. V. R. Murty
Director
Indian Institute of Technology Jodhpur
India

Ron Klemencic
Chairman and C.E.O.
Magnusson Klemencic Associates
USA

Antonino 'Jojo' S. Aligaen
Head, Construction Management Department
Real Estate Division
OCLP Holdings, Inc.

Sinéad C. Mac Namara
Associate Professor
School of Architecture
College of Engineering
Honors Core Faculty

Karoon Chandrangsu
President
K.C.S. & Associates Co., Ltd
Thailand

Jose A. Sy
President
SY^2 + Associates Inc.
Philippines

Pennung Warnitchai
Professor
Asian Institute of Technology
Thailand

Naveed Anwar
Executive Director
AIT Solutions, Asian Institute of Technology

CSi Initiatives

- **Tools and Platform for Engineering Education and Learning**
- With a view to help produce next generation of engineers that have greater understanding, skills and tools to design and construct a safer build environment

CSi CLOUD

Your models on the go.

CSi Mobile

Structural engineering on the go.

CSi Mobile Apps

RELEASED

ETABS Cloud Viewer

SAP2000 Cloud Viewer

CSi Sections

CSi Units

FOR REVIEW / TESTING

Frame 2D

RC Beam

Section Stresses

PS Stresses

PM Interaction

Stress-Strain

Steel Sections

Rebar Selector

Material Library

Faculty Assistant

Student Assistant

IN DEVELOPMENT STAGE

Section MØ

RC Column

Isolated Footing

Steel Beam

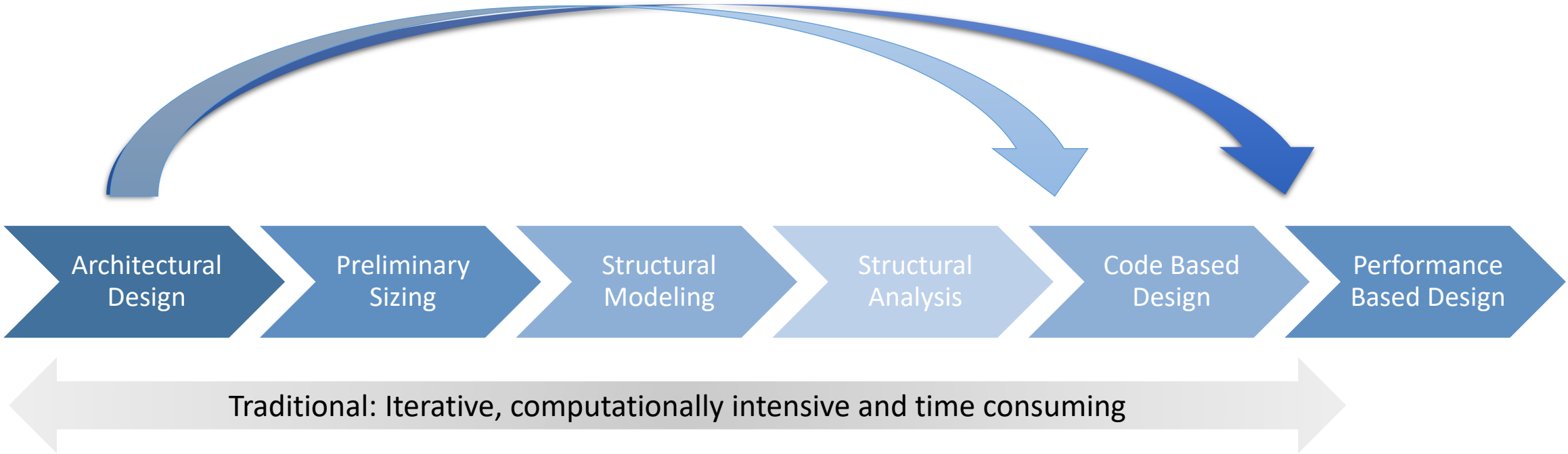
Steel Column

Base Plate

Project Manager

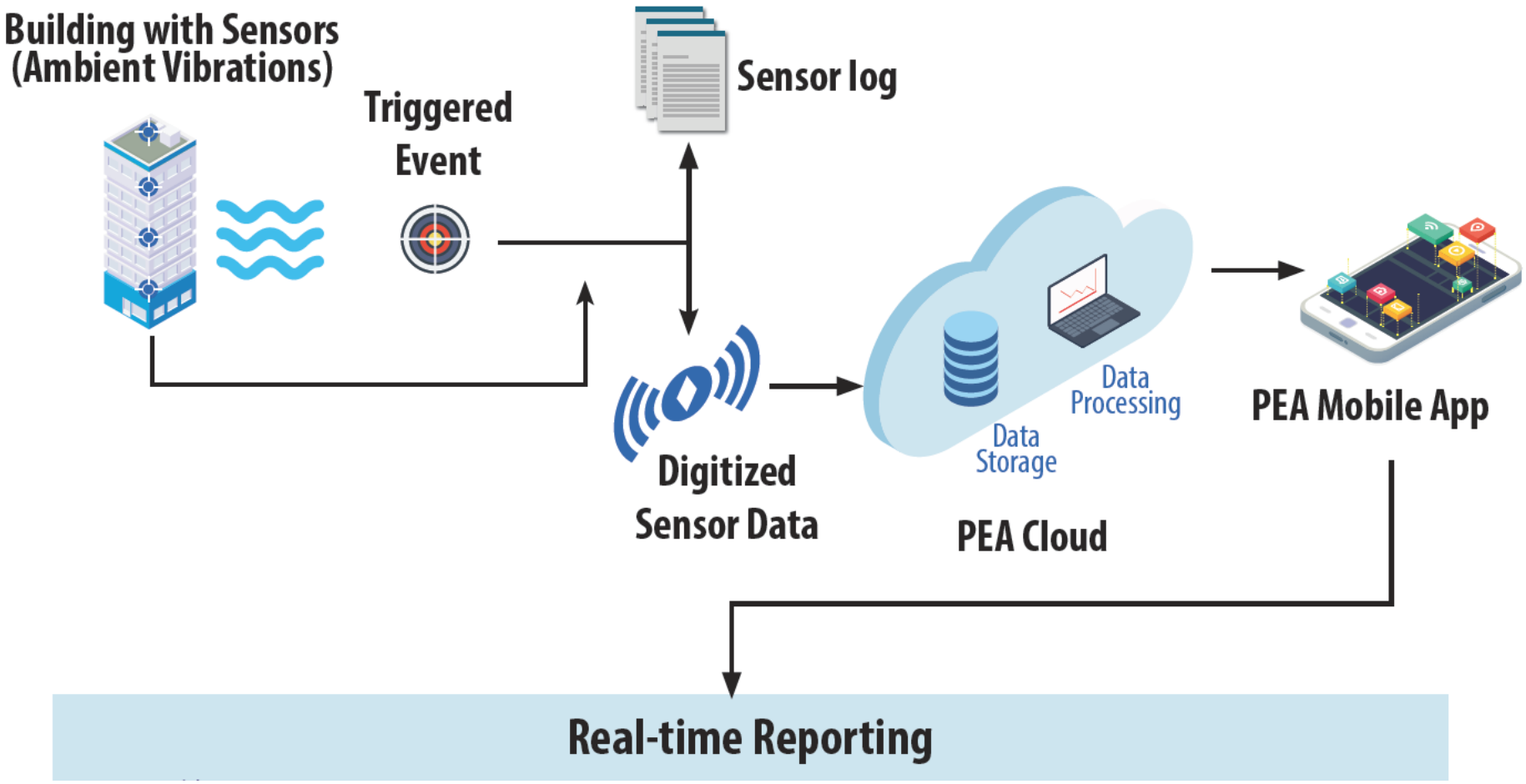
Report Manager

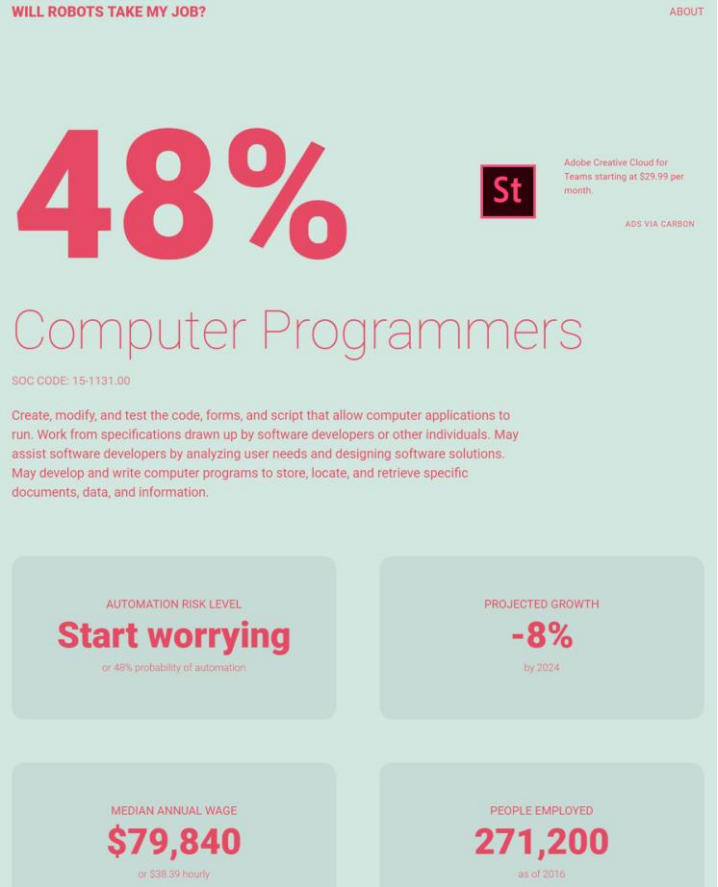
Machine Learning and AI as Learning Tool



Dr. Naveed Anwar

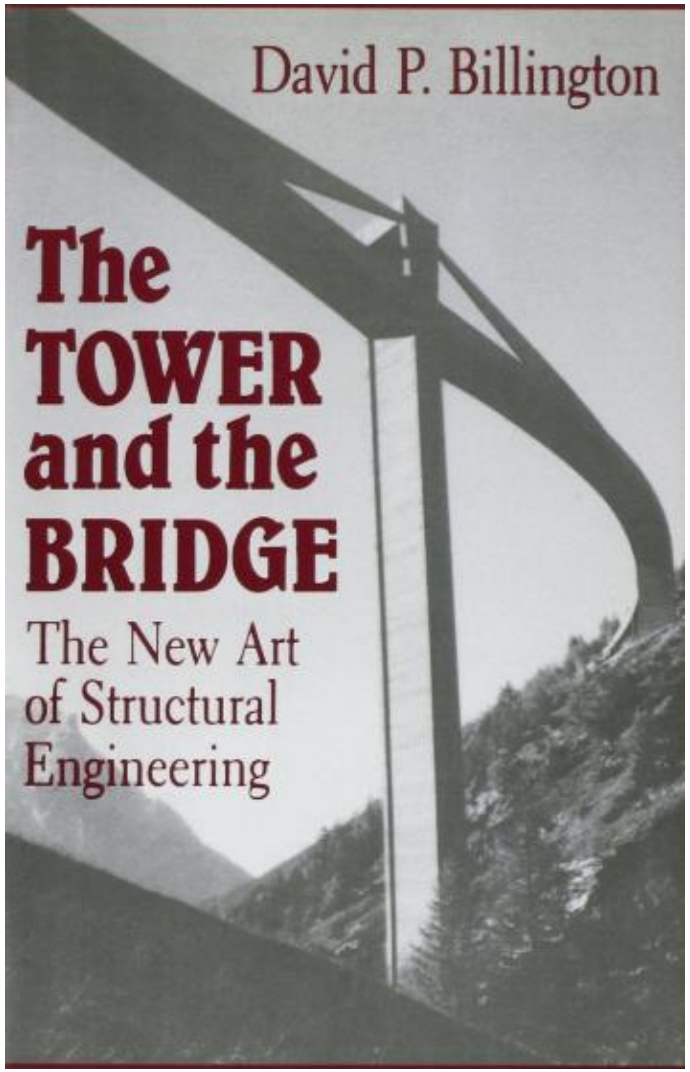
Learning from Instrumented Structures





Will Robots take my Job!

Thank you



Most recommended for civil and structural engineers