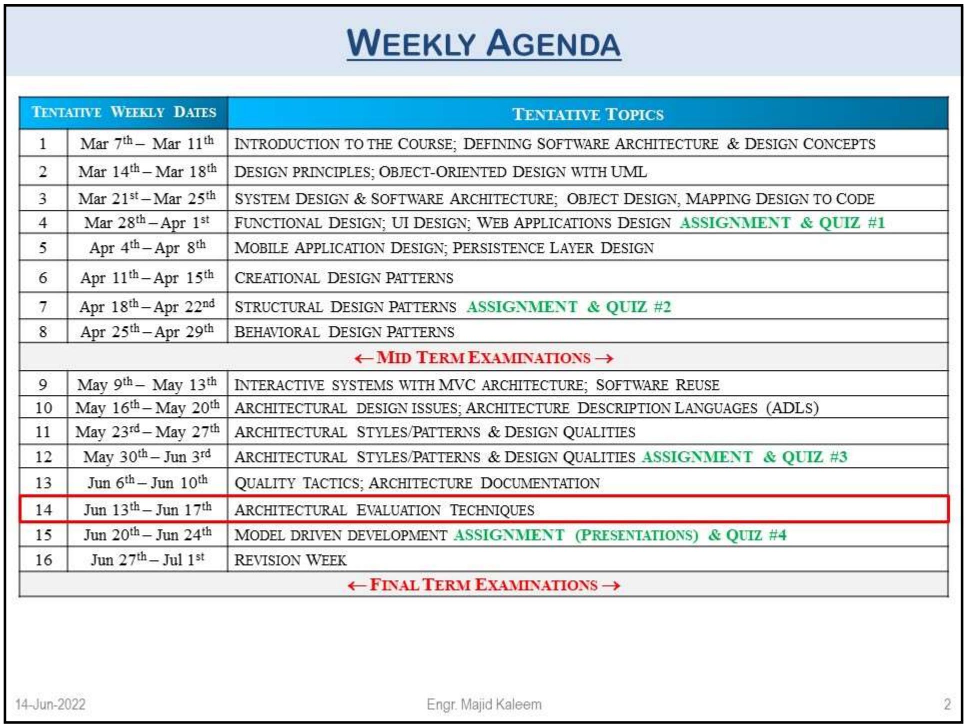
# Software Design & Architecture Spring 2022 - Week-14

مدرس: مہندس ماجد کلیم

جامعہ بحریہ، واقعگاہ کراچی

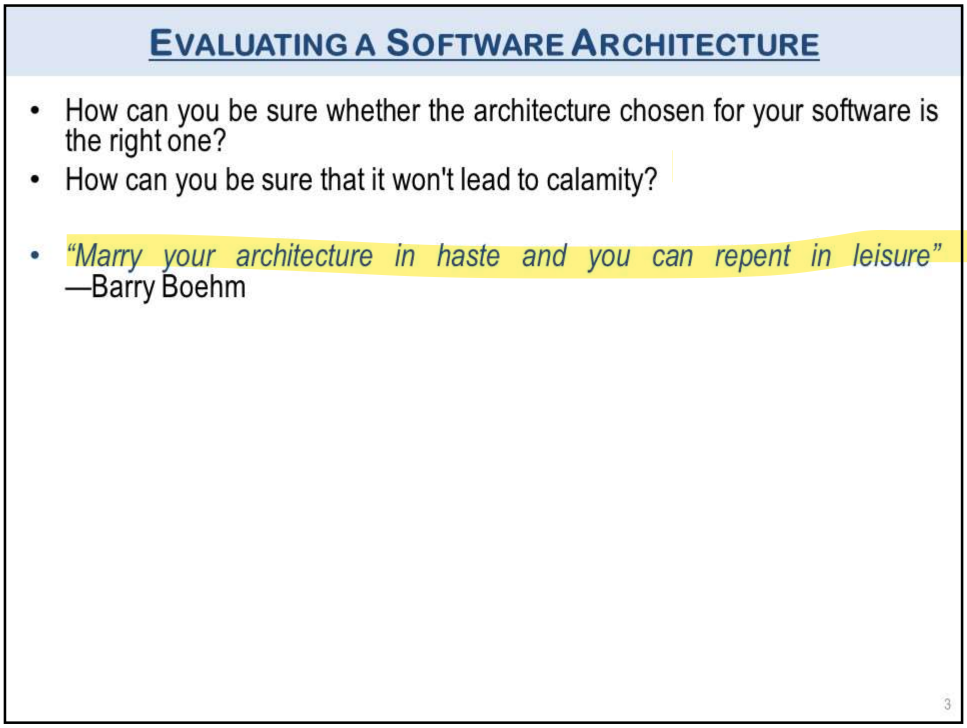
Engr. Majid Kaleem



## Weekly Agenda

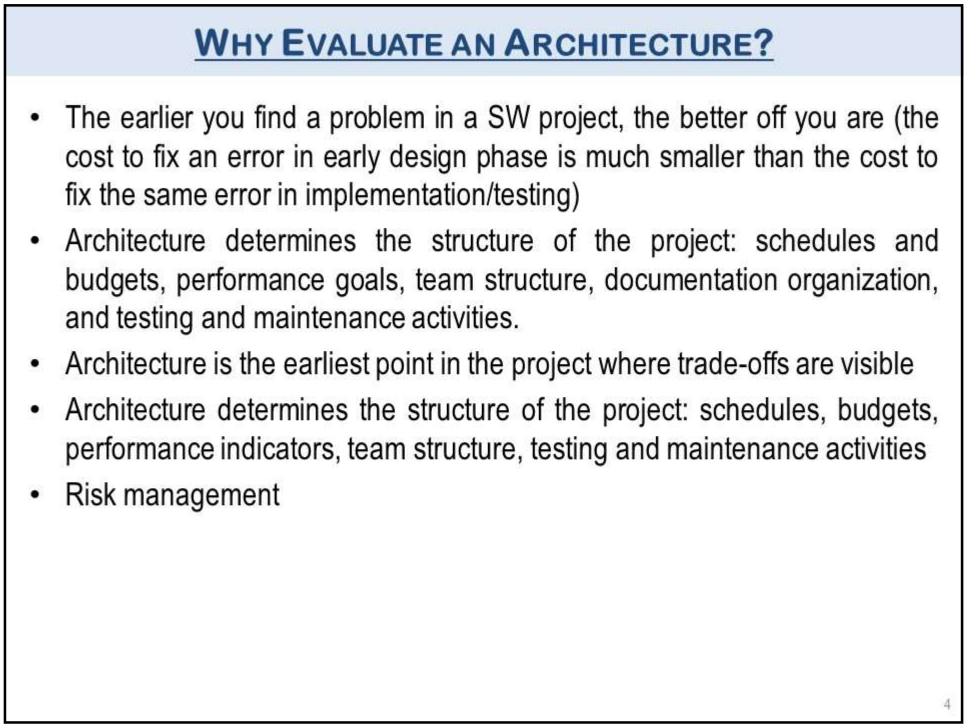
| Tentative Weekly Dates | | Tentative Topics |
|---|---|---|
| 1 | Mar 7th – Mar 11th | Introduction to the Course; Defining Software Architecture & Design Concepts |
| 2 | Mar 14th – Mar 18th | Design principles; Object-Oriented Design with UML |
| 3 | Mar 21st – Mar 25th | System Design & Software Architecture; Object Design, Mapping Design to Code |
| 4 | Mar 28th – Apr 1st | Functional Design; UI Design; Web Applications Design ASSIGNMENT & QUIZ #1 |
| 5 | Apr 4th – Apr 8th | Mobile Application Design; Persistence Layer Design |
| 6 | Apr 11th – Apr 15th | Creational Design Patterns |
| 7 | Apr 18th – Apr 22nd | Structural Design Patterns ASSIGNMENT & QUIZ #2 |
| 8 | Apr 25th – Apr 29th | Behavioral Design Patterns |
| ← Mid Term Examinations → | | |
| 9 | May 9th – May 13th | Interactive systems with MVC architecture; Software Reuse |
| 10 | May 16th – May 20th | Architectural design issues; Architecture Description Languages (ADLs) |
| 11 | May 23rd – May 27th | Architectural Styles/Patterns & Design Qualities |
| 12 | May 30th – Jun 3rd | Architectural Styles/Patterns & Design Qualities ASSIGNMENT & QUIZ #3 |
| 13 | Jun 6th – Jun 10th | Quality Tactics; Architecture Documentation |
| 14 | Jun 13th – Jun 17th | Architectural Evaluation Techniques |
| 15 | Jun 20th – Jun 24th | Model driven development ASSIGNMENT (PRESENTATIONS) & QUIZ #4 |
| 16 | Jun 27th – Jul 1st | Revision Week |
| ← Final Term Examinations → | | |

14-Jun-2022 Engr. Majid Kaleem 2



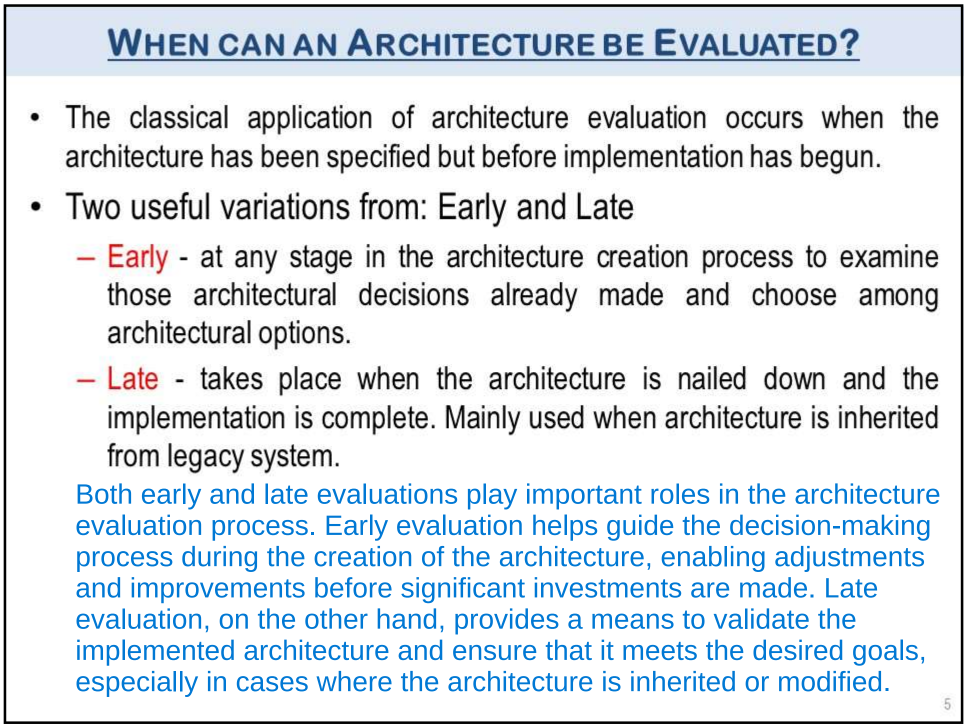
## Evaluating a Software Architecture

- How can you be sure whether the architecture chosen for your software is the right one?
- How can you be sure that it won't lead to calamity?
- *“Marry your architecture in haste and you can repent in leisure”* —Barry Boehm



## Why Evaluate an Architecture?

- The earlier you find a problem in a SW project, the better off you are (the cost to fix an error in early design phase is much smaller than the cost to fix the same error in implementation/testing)
- Architecture determines the structure of the project: schedules and budgets, performance goals, team structure, documentation organization, and testing and maintenance activities.
- Architecture is the earliest point in the project where trade-offs are visible
- Architecture determines the structure of the project: schedules, budgets, performance indicators, team structure, testing and maintenance activities
- Risk management



## When can an Architecture be Evaluated?

- The classical application of architecture evaluation occurs when the architecture has been specified but before implementation has begun.
- Two useful variations from: Early and Late
  - Early - at any stage in the architecture creation process to examine those architectural decisions already made and choose among architectural options.
  - Late - takes place when the architecture is nailed down and the implementation is complete. Mainly used when architecture is inherited from legacy system.

Both early and late evaluations play important roles in the architecture evaluation process. Early evaluation helps guide the decision-making process during the creation of the architecture, enabling adjustments and improvements before significant investments are made. Late evaluation, on the other hand, provides a means to validate the implemented architecture and ensure that it meets the desired goals, especially in cases where the architecture is inherited or modified.

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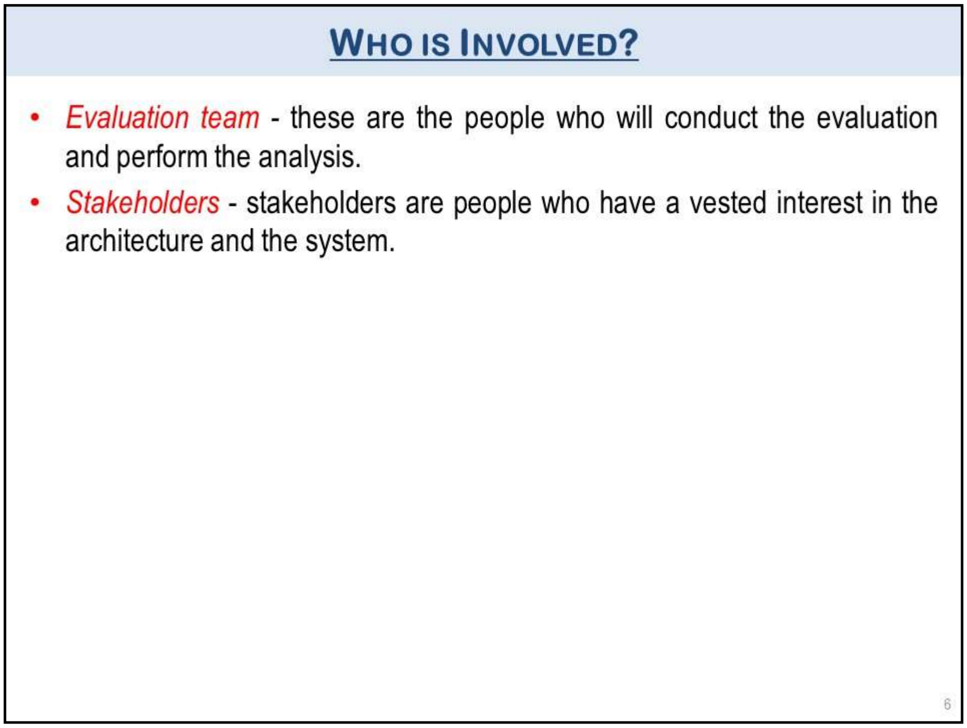

## Who is Involved?

- *Evaluation team* - these are the people who will conduct the evaluation and perform the analysis.
- *Stakeholders* - stakeholders are people who have a vested interest in the architecture and the system.

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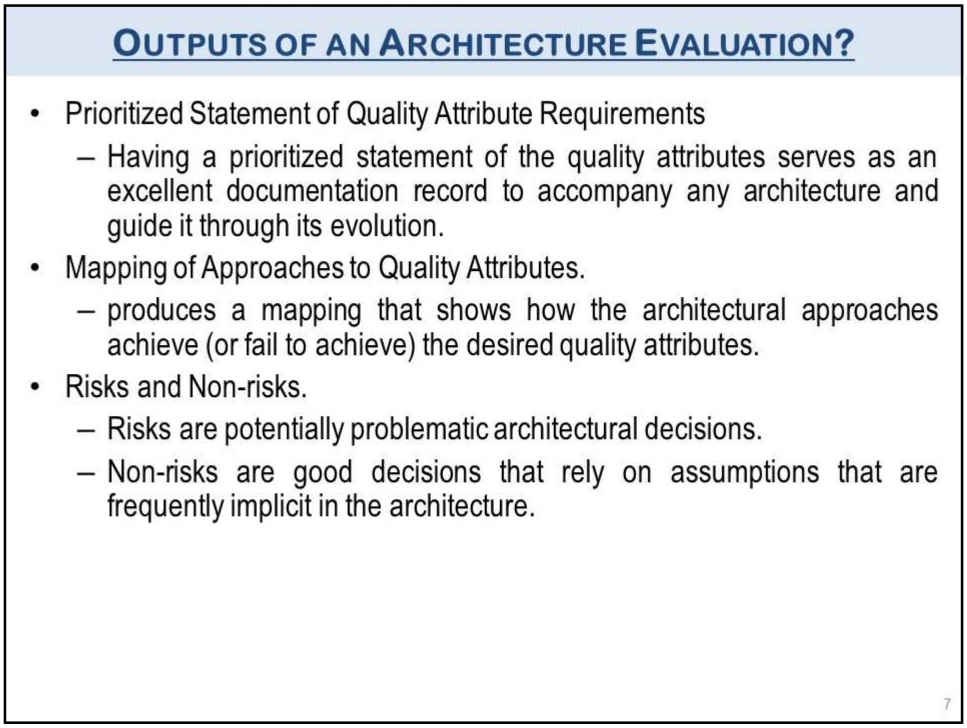
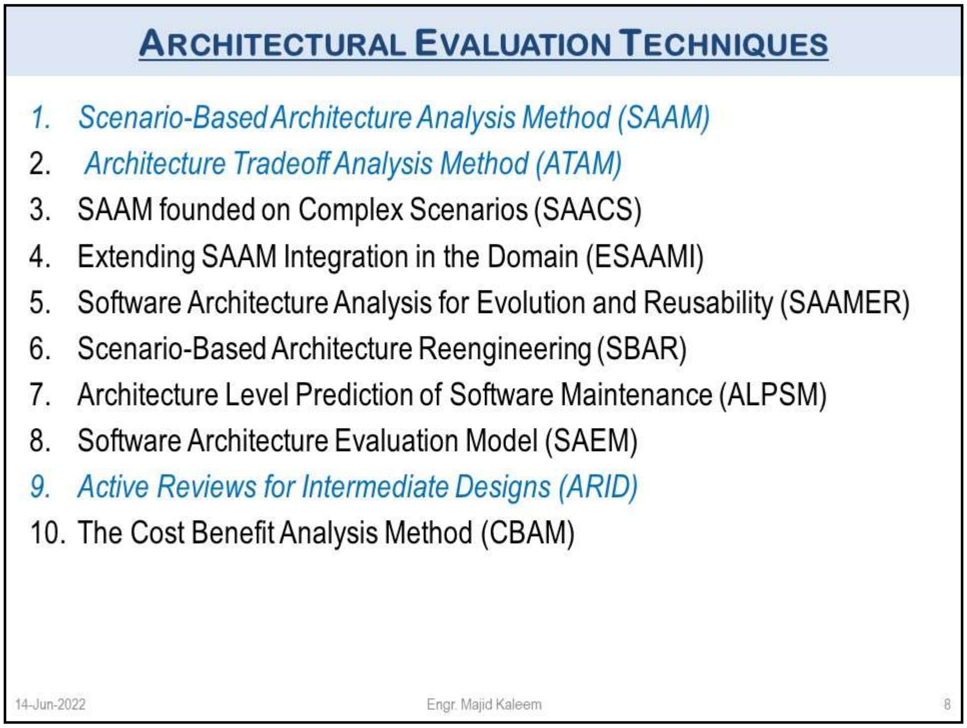


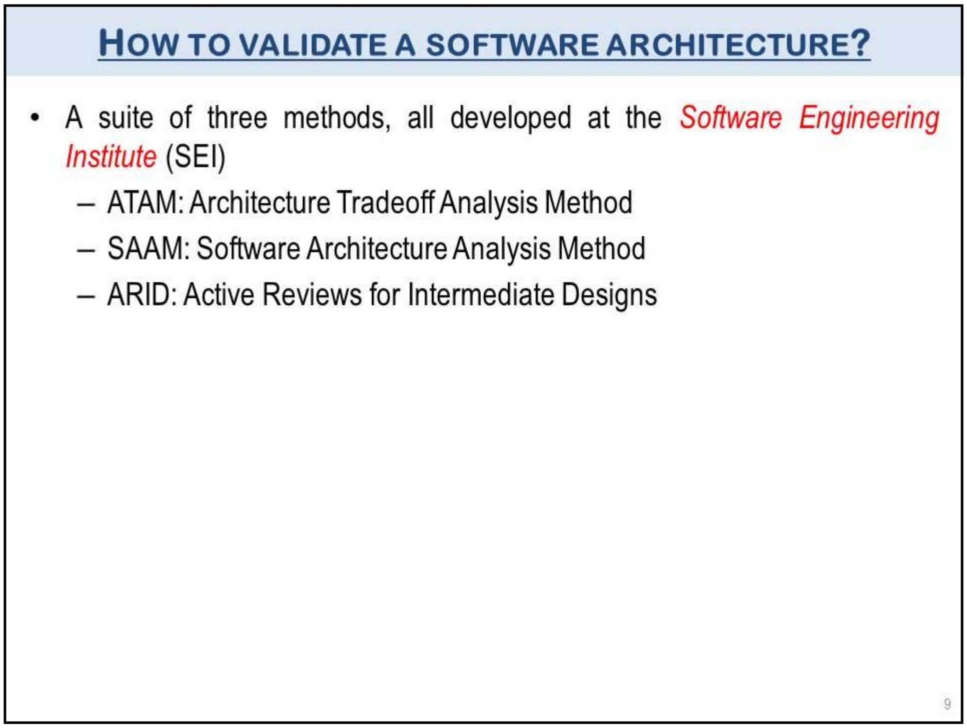
## OUTPUTS OF AN ARCHITECTURE EVALUATION?

- Prioritized Statement of Quality Attribute Requirements
  - – Having a prioritized statement of the quality attributes serves as an excellent documentation record to accompany any architecture and guide it through its evolution.
- Mapping of Approaches to Quality Attributes.
  - – produces a mapping that shows how the architectural approaches achieve (or fail to achieve) the desired quality attributes.
- Risks and Non-risks.
  - – Risks are potentially problematic architectural decisions.
  - – Non-risks are good decisions that rely on assumptions that are frequently implicit in the architecture.



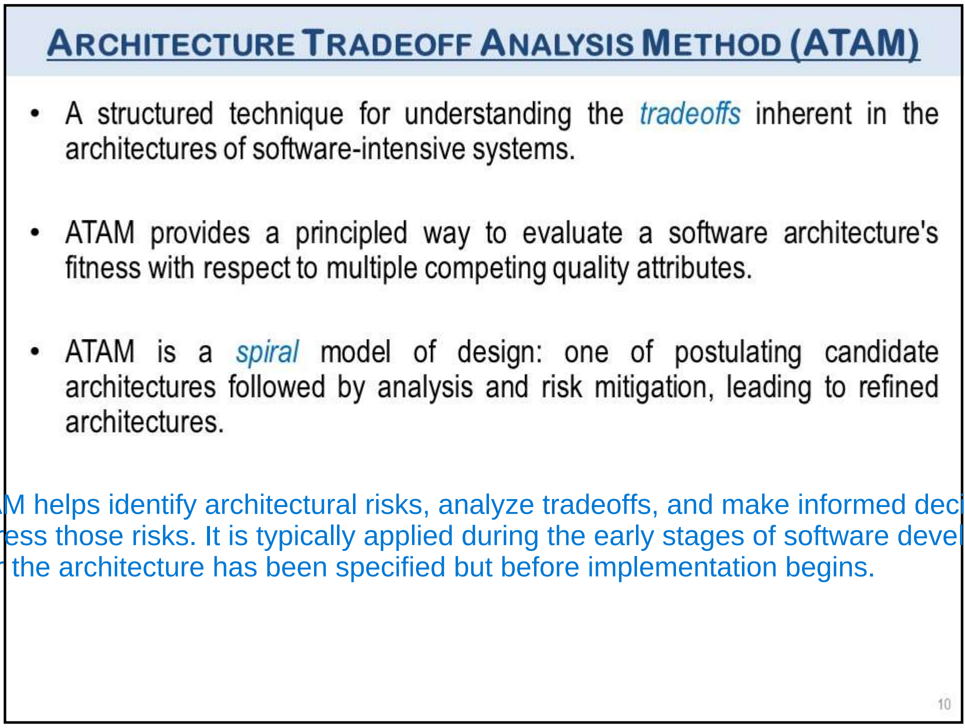
## ARCHITECTURAL EVALUATION TECHNIQUES

1. *Scenario-Based Architecture Analysis Method (SAAM)*
2. *Architecture Tradeoff Analysis Method (ATAM)*
3. SAAM founded on Complex Scenarios (SAACS)
4. Extending SAAM Integration in the Domain (ESAAMI)
5. Software Architecture Analysis for Evolution and Reusability (SAAMER)
6. Scenario-Based Architecture Reengineering (SBAR)
7. Architecture Level Prediction of Software Maintenance (ALPSM)
8. Software Architecture Evaluation Model (SAEM)
9. *Active Reviews for Intermediate Designs (ARID)*
10. The Cost Benefit Analysis Method (CBAM)



## How to validate a software architecture?

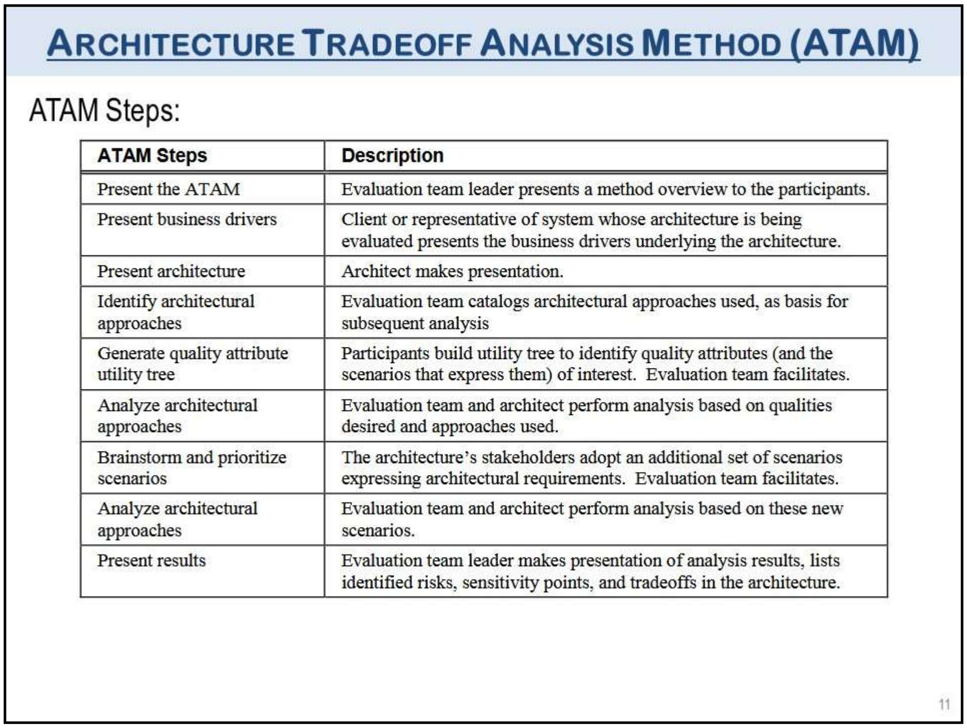
- A suite of three methods, all developed at the *Software Engineering Institute* (SEI)
  - ATAM: Architecture Tradeoff Analysis Method
  - SAAM: Software Architecture Analysis Method
  - ARID: Active Reviews for Intermediate Designs



## Architecture Tradeoff Analysis Method (ATAM)

- A structured technique for understanding the *tradeoffs* inherent in the architectures of software-intensive systems.
- ATAM provides a principled way to evaluate a software architecture's fitness with respect to multiple competing quality attributes.
- ATAM is a *spiral* model of design: one of postulating candidate architectures followed by analysis and risk mitigation, leading to refined architectures.

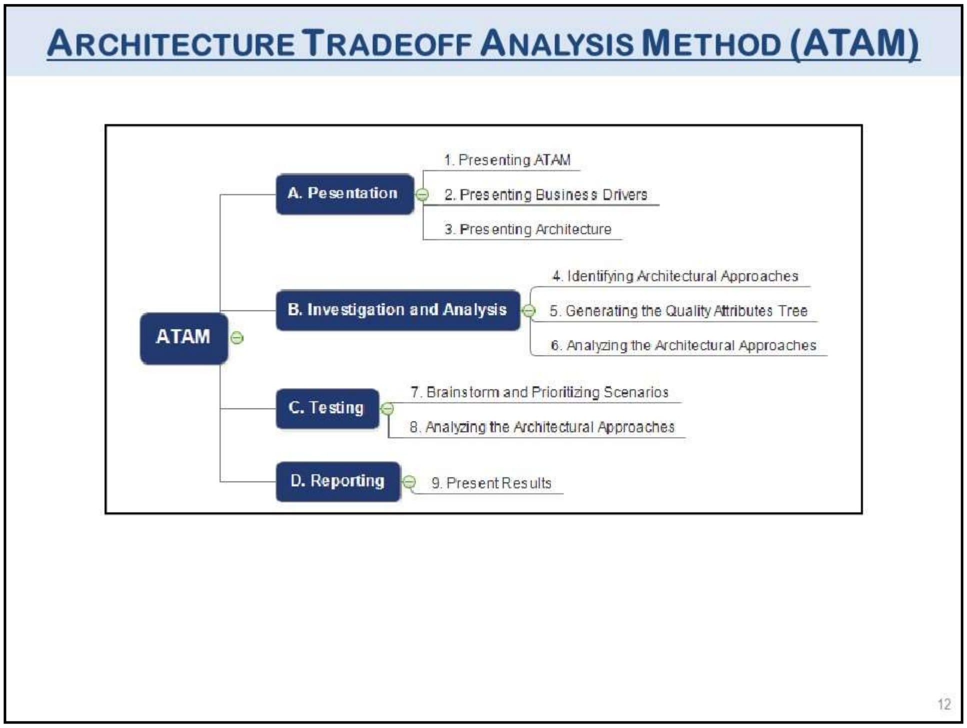
ATAM helps identify architectural risks, analyze tradeoffs, and make informed decisions to address those risks. It is typically applied during the early stages of software development, after the architecture has been specified but before implementation begins.



## ARCHITECTURE TRADEOFF ANALYSIS METHOD (ATAM)

ATAM Steps:

| ATAM Steps | Description |
|---|---|
| Present the ATAM | Evaluation team leader presents a method overview to the participants. |
| Present business drivers | Client or representative of system whose architecture is being evaluated presents the business drivers underlying the architecture. |
| Present architecture | Architect makes presentation. |
| Identify architectural approaches | Evaluation team catalogs architectural approaches used, as basis for subsequent analysis |
| Generate quality attribute utility tree | Participants build utility tree to identify quality attributes (and the scenarios that express them) of interest. Evaluation team facilitates. |
| Analyze architectural approaches | Evaluation team and architect perform analysis based on qualities desired and approaches used. |
| Brainstorm and prioritize scenarios | The architecture's stakeholders adopt an additional set of scenarios expressing architectural requirements. Evaluation team facilitates. |
| Analyze architectural approaches | Evaluation team and architect perform analysis based on these new scenarios. |
| Present results | Evaluation team leader makes presentation of analysis results, lists identified risks, sensitivity points, and tradeoffs in the architecture. |



## ARCHITECTURE TRADEOFF ANALYSIS METHOD (ATAM)

ATAM

A. Pesentation
1. Presenting ATAM
2. Presenting Business Drivers
3. Presenting Architecture

B. Investigation and Analysis
4. Identifying Architectural Approaches
5. Generating the Quality Attributes Tree
6. Analyzing the Architectural Approaches

C. Testing
7. Brainstorm and Prioritizing Scenarios
8. Analyzing the Architectural Approaches

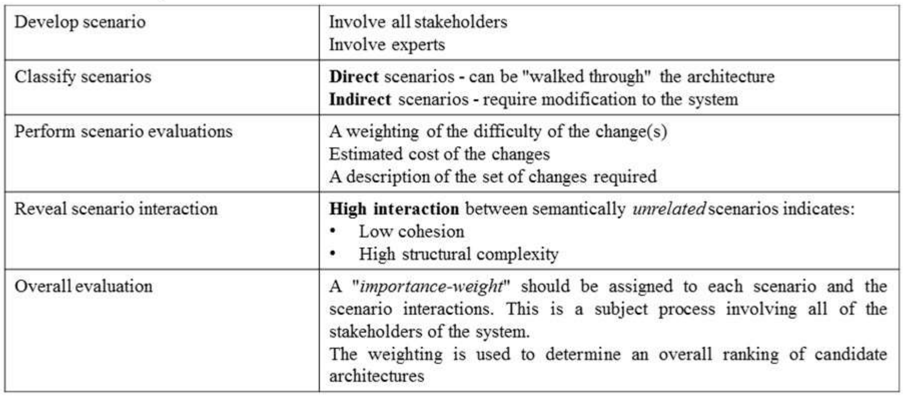
D. Reporting
9. Present Results

## SOFTWARE ARCHITECTURE ANALYSIS METHOD (SAAM)

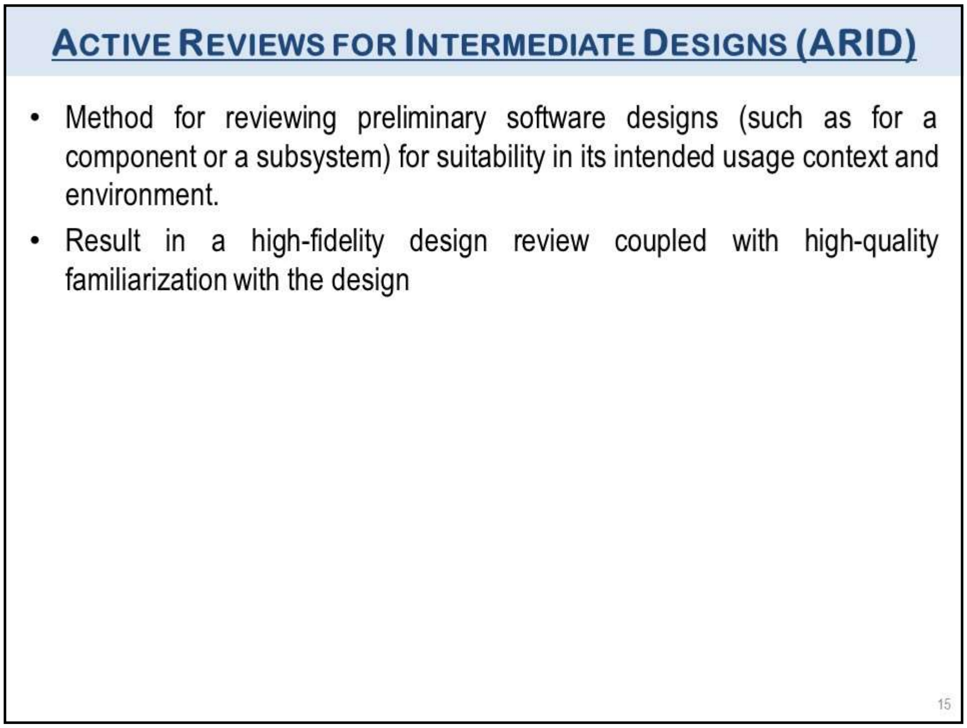
- Aims to predict the quality of a system before it has been developed.
- The quality of the architecture is validated by analyzing the impact of predefined scenarios on architectural components.
- Addresses concerns at the architecture design level which inherently crosscut multiple architectural components.
- Based on scenarios
  - A scenario represents a description of a stakeholder's interaction with the system
- Scenarios are created depending on the point of view of each stakeholder:
  - **Developer** – interested in reusability, implementation, maintenance
  - **Project Manager** – interested in time, cost, quality, extensibility
  - **Tester** – interested in usability, mapping to requirements

## SOFTWARE ARCHITECTURE ANALYSIS METHOD (SAAM)

- SAAM Steps:



| | |
|---|---|
| Develop scenario | Involve all stakeholders<br>Involve experts |
| Classify scenarios | **Direct** scenarios - can be "walked through" the architecture<br>**Indirect** scenarios - require modification to the system |
| Perform scenario evaluations | A weighting of the difficulty of the change(s)<br>Estimated cost of the changes<br>A description of the set of changes required |
| Reveal scenario interaction | **High interaction** between semantically *unrelated* scenarios indicates:<br>• Low cohesion<br>• High structural complexity |
| Overall evaluation | A "*importance-weight*" should be assigned to each scenario and the scenario interactions. This is a subject process involving all of the stakeholders of the system.<br>The weighting is used to determine an overall ranking of candidate architectures |



## ACTIVE REVIEWS FOR INTERMEDIATE DESIGNS (ARID)

- Method for reviewing preliminary software designs (such as for a component or a subsystem) for suitability in its intended usage context and environment.
- Result in a high-fidelity design review coupled with high-quality familiarization with the design

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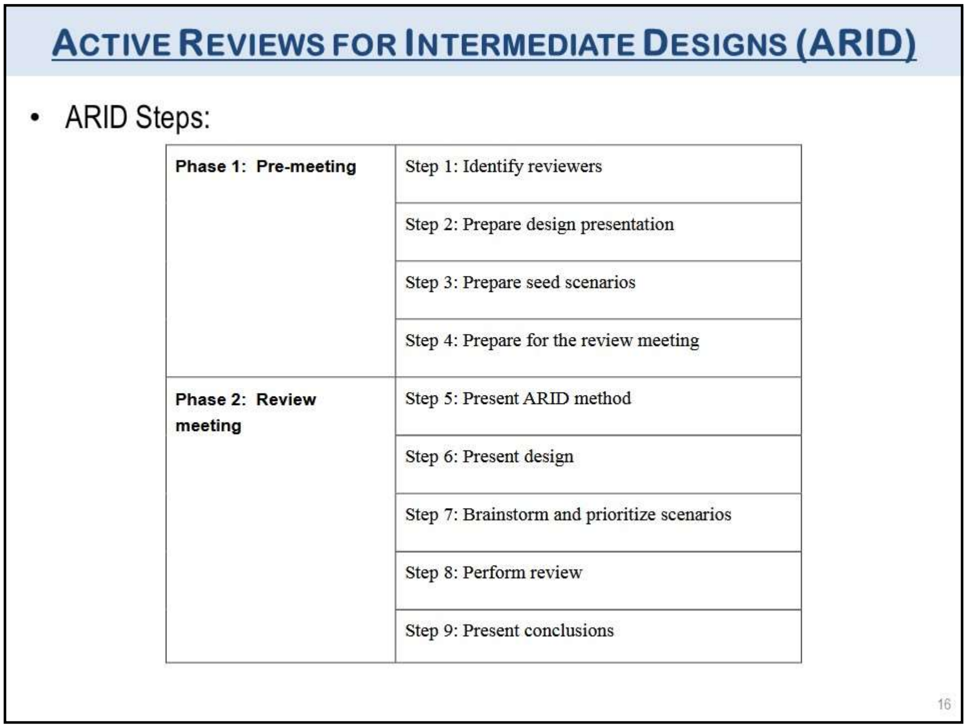

## ACTIVE REVIEWS FOR INTERMEDIATE DESIGNS (ARID)

- ARID Steps:

| | |
|---|---|
| **Phase 1: Pre-meeting** | Step 1: Identify reviewers |
| | Step 2: Prepare design presentation |
| | Step 3: Prepare seed scenarios |
| | Step 4: Prepare for the review meeting |
| **Phase 2: Review meeting** | Step 5: Present ARID method |
| | Step 6: Present design |
| | Step 7: Brainstorm and prioritize scenarios |
| | Step 8: Perform review |
| | Step 9: Present conclusions |

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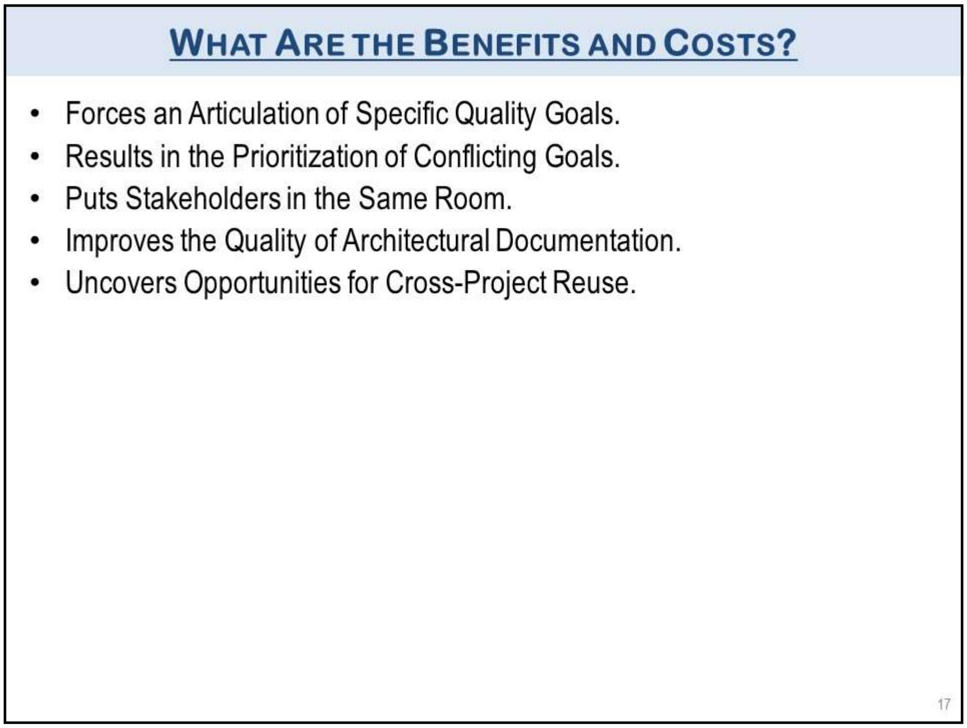
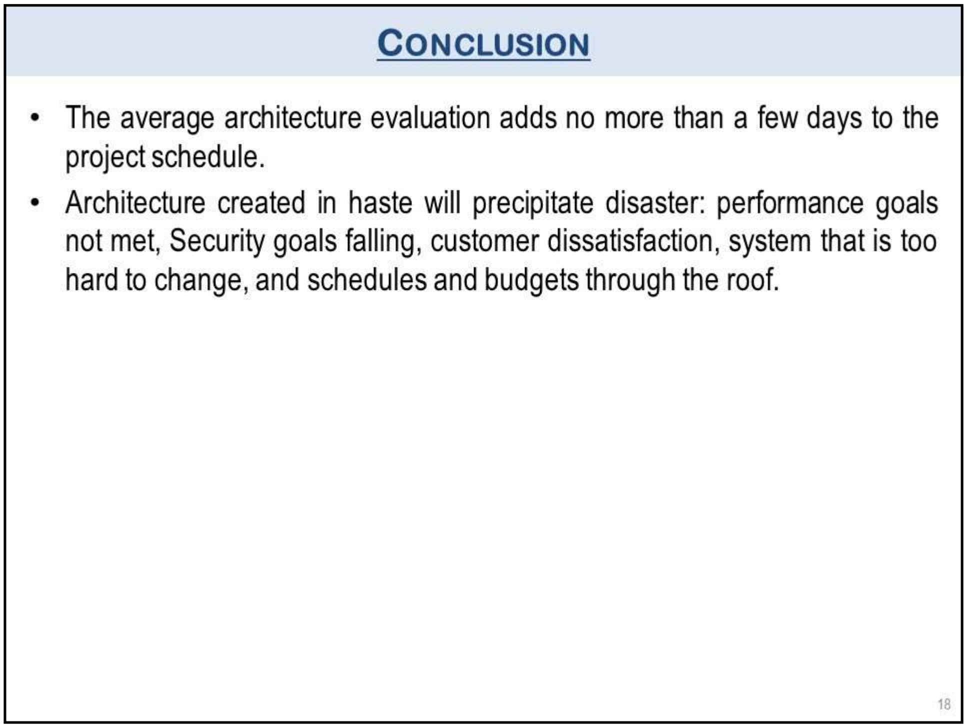


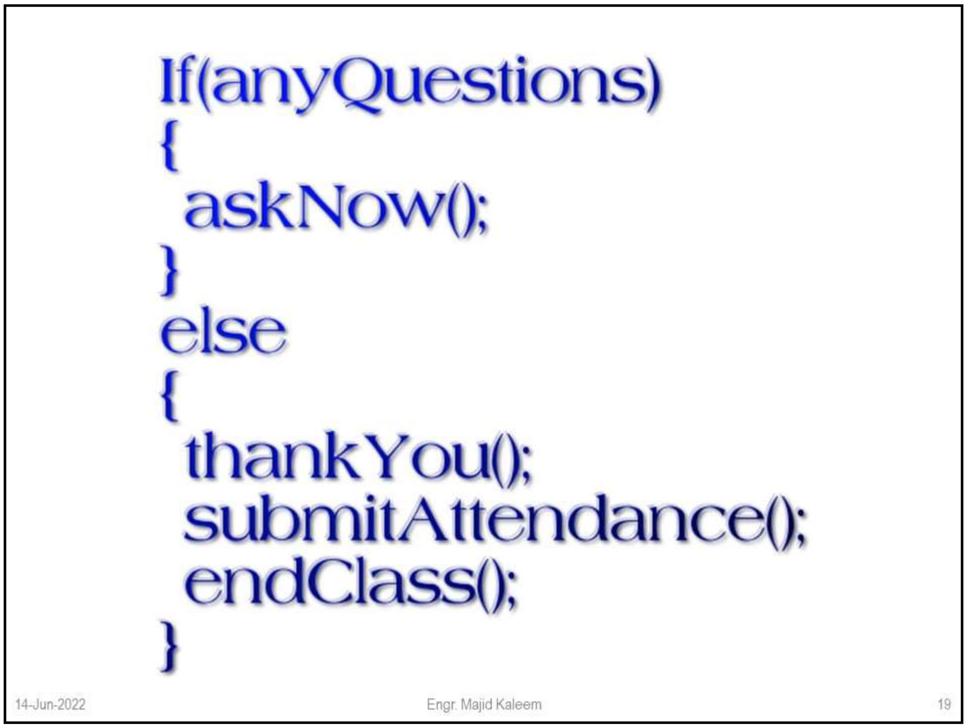
## WHAT ARE THE BENEFITS AND COSTS?

- Forces an Articulation of Specific Quality Goals.
- Results in the Prioritization of Conflicting Goals.
- Puts Stakeholders in the Same Room.
- Improves the Quality of Architectural Documentation.
- Uncovers Opportunities for Cross-Project Reuse.

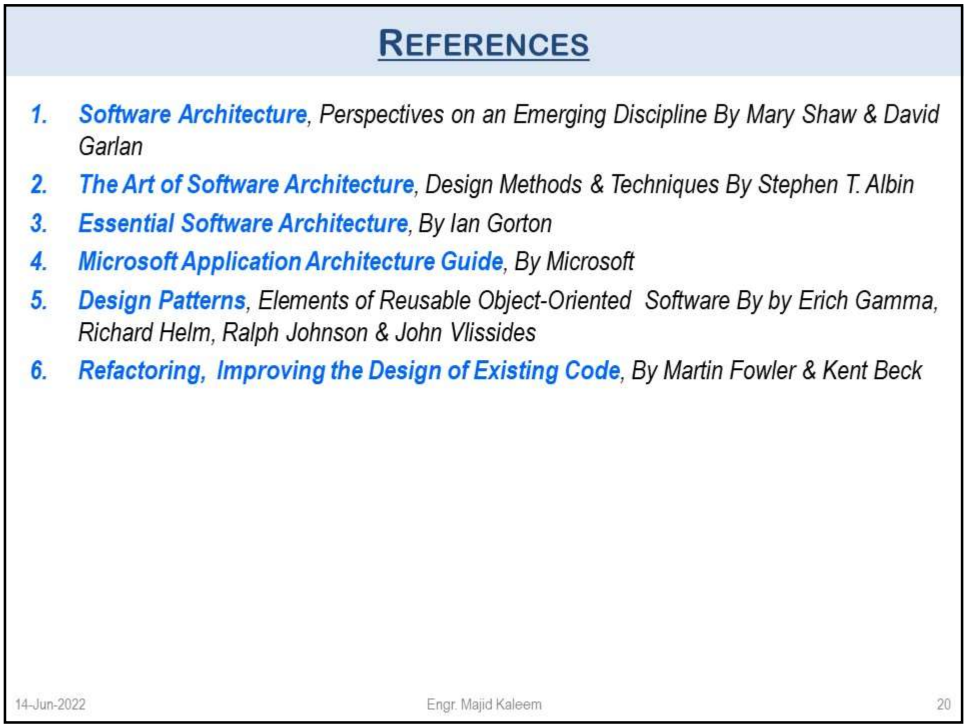


## CONCLUSION

- The average architecture evaluation adds no more than a few days to the project schedule.
- Architecture created in haste will precipitate disaster: performance goals not met, Security goals falling, customer dissatisfaction, system that is too hard to change, and schedules and budgets through the roof.



```
If(anyQuestions)
{
 askNow();
}
else
{
 thankYou();
 submitAttendance();
 endClass();
}
```



## REFERENCES

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2. ***The Art of Software Architecture***, *Design Methods & Techniques By Stephen T. Albin*
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5. ***Design Patterns***, *Elements of Reusable Object-Oriented Software By by Erich Gamma, Richard Helm, Ralph Johnson & John Vlissides*
6. ***Refactoring, Improving the Design of Existing Code***, *By Martin Fowler & Kent Beck*