Software Quality Attributes: Modifiability and Usability

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Tutorial Objective

To describe a variety of software quality attributes (e.g., modifiability, usability) and methods to analyze a software architecture's fitness with respect to multiple quality attribute requirements.

Software product characteristics:
- the interactions between quality, cost, and schedule

Software quality attributes:
- the concerns, factors, and methods used by different communities

Quality attribute analysis:
- Examples of quality attribute risks, sensitivities and tradeoffs

Indicators of quality attributes:
- component interaction and coupling are qualitative measures of system quality

Processes to discover risks, sensitivities, and tradeoffs:
- Architecture Tradeoff Analysis Method (ATAM)®
- Quality Attribute Workshops (QAW)

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Software Product Characteristics

There is a triad of user oriented product characteristics:

- **quality**
- **cost**
- **schedule**

"Software quality is the degree to which software possesses a desired combination of attributes."

[IEEE Std. 1061]

IEEE Std. 610.12 "Glossary of Software Engineering Terminology":

"quality. (1) The degree to which a system, component, or process meets specified requirements.

(2) The degree to which a system, component, or process meets customer or user needs or expectations."

"quality attribute. A feature or characteristic that affects an item's quality. Syn: quality factor."

IEEE Std. 1061 "Software Quality Metrics Methodology":

•Establish software quality requirements

•Identify software quality metrics

•Implement the software quality metrics

•Analyze the software quality results

•Validate the software quality metrics

Effect of Quality on Cost and Schedule - 1

Cost and schedule can be predicted and controlled by mature organizational processes.

However, process maturity does not translate automatically into product quality.

Poor quality eventually affects cost and schedule because software requires tuning, recoding, or even redesign to meet original requirements.

If the technology is lacking, even a mature organization will have difficulty producing products with predictable performance, dependability, or other attributes.

For less mature organizations, the situation is even worse:

"Software Quality Assurance is the least frequently satisfied level 2 KPA among organizations assessed at level 1",

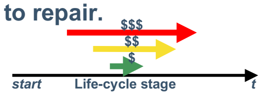
From Process Maturity Profile of the Software Community 2001 Year End Update, http://www.sei.cmu.edu/sema/profile.html

NOTE: The CMM Software Quality Assurance Key Process Area (KPA) includes both process and product quality assurance.

Quality requires mature technology to predict and control attributes

Effect of Quality on Cost and Schedule - 2

The earlier a defect occurs in the development process, if not detected, the more it will cost to repair.
The longer a defect goes undetected the more it will cost to repair.



[Barry Boehm et al, “Characteristics of Software Quality”, North-Holland, 1978.
Watts Humphrey, “A Discipline for Software Engineering”, Addison Wesley, 1995.]

Effect of Quality on Cost and Schedule - 3

The larger the project, the more likely it will be late due to quality problems:

Project outcome	Project size in function points			
	<100	100-1K	1K-5K	>5K
Cancelled	3%	7%	13%	24%
Late by > 12 months	1%	10%	12%	18%
Late by > six months	9%	24%	35%	37%
Approximately on time	72%	53%	37%	20%
Earlier than expected	15%	6%	3%	1%

[Caspers Jones, *Patterns of large software systems: Failure and success*, Computer, Vol. 28, March 1995.]

From C.Jones 95:

“Software management consultants have something in common with physicians: both are much more likely to be called in when there are serious problems rather than when everything is fine. Examining large software systems -- those in excess of 5,000 function points (which is roughly 500,000 source code statements in a procedural programming language such as Cobol or Fortran) -- that are in trouble is very common for management consultants. Unfortunately, the systems are usually already late, over budget, and showing other signs of acute distress before the study begins. The consultant engagements, therefore, serve to correct the problems and salvage the system -- if, indeed, salvaging is possible.”

“From a technical point of view, the most common reason for software disasters is poor quality control. Finding and fixing bugs is the most expensive, time-consuming aspect of software development, especially for large systems. Failure to plan for defect prevention and use pretest defect-removal activities, such as formal inspections, means that when testing does commence, the project is in such bad shape that testing tends to stretch out indefinitely. In fact, testing is the phase in which most disasters finally become visible to all concerned. When testing begins, it is no longer possible to evade the consequences of careless and inadequate planning, estimating, defect prevention, or pretest quality control.”

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The Problems Are Getting Attention From The Main Press

Op-Ed Contributor: Does Not Compute.
By NICHOLAS G. CARR
Published: January 22, 2005

"THE Federal Bureau of Investigation has officially entered what computer professionals call "software hell." After spending $170 million to create a program that would give agents ready access to information on suspected terrorists, the bureau admitted last week that it's not even close to having a working system. In fact, it may have to start from scratch…."

http://www.nytimes.com/2005/01/22/opinion/22carr.html

The article mentions companies that have had to cancel projects:

> "Consider Ford Motor Company's ambitious effort to write new software for buying supplies. Begun in 2000, … The new software was supposed to reduce paperwork, speed orders and slash costs. …. When it was rolled out for testing in North America, suppliers rebelled; …. many found the new software to be slower and more cumbersome than the programs it was intended to replace. Last August, Ford abandoned Everest amid reports that the project was as much as $200 million over budget."

> "A McDonald's program called Innovate was even more ambitious - and expensive. Started in 1999 with a budget of $1 billion, the network sought to automate pretty much the entire fast-food empire. Software systems would collect information from every restaurant - …. - and deliver it in a neat bundle to the company's executives, who would be able to adjust operations moment by moment. … the project went nowhere. In late 2002, McDonald's killed it, writing off the $170 million that had already been spent."

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Software Quality Attributes

There are alternative (and somewhat equivalent) lists of quality attributes. For example:

IEEE Std. 1061	ISO Std. 9126	MITRE Guide to Total Software Quality Control	
Efficiency	Functionality	Efficiency	Integrity
Functionality	Reliability	Reliability	Survivability
Maintainability	Usability	Usability	Correctness
Portability	Efficiency	Maintainability	Verifiability
Reliability	Maintainability	Expandability	Flexibility
Usability	Portability	Interoperability	Portability
		Reusability	

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Quality Factors and Sub-factors

IEEE Std. 1061 subfactors:

Efficiency
- Time economy
- Resource economy

Functionality
- Completeness
- Correctness
- Security
- Compatibility
- Interoperability

Maintainability
- Correctability
- Expandability
- Testability

Portability
- Hardware independence
- Software independence
- Installability
- Reusability

Reliability
- Non-deficiency
- Error tolerance
- Availability

Usability
- Understandability
- Ease of learning
- Operability
- Comunicativeness

From IEEE Std. 1061:

"Software quality is the degree in which software possesses a desired combination of quality attributes. The purpose of software metrics is to make assessments throughout the software life cycle as to whether the software quality requirements are being met.

The use of software metrics reduces subjectivity in the assessment and control of software quality by providing a quantitative basis for making decisions about software quality.

However, the use of metrics does not eliminate the need for human judgment in software assessment. The use of software metrics within an organization is expected to have a beneficial effect by making software quality more visible."

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Quality Factors and Sub-factors

ISO Std. 9126 sub characteristics:

Functionality
- Suitability
- Accurateness
- Interoperability
- Compliance
- Security

Efficiency
- Time behavior
- Resource behavior

Maintainability
- Analyzability
- Changeability
- Stability
- Testability

Reliability
- Maturity
- Fault tolerance
- Recoverability

Usability
- Understandability
- Learnability
- Operability

Portability
- Adaptability
- Installability
- Conformance
- Replaceability

See Suryn et al. "Software Product Quality Practices: Quality Measurements and Evaluation using TL9000 and ISO/IEC 9126" Software Technology and Engineering Practice (STEP) 2002, Montreal, Canada, October 6-8, 2002.

> *TL 9000 Handbooks are designed specifically for the communications industry to document the industry's quality system requirements and measures. ISO/IEC 9126 standards take the initial quality requirements into account during each of the development phases, allowing for quality planning, design, monitoring, and control.*
>
> *Both TL 9000 and ISO/IEC 9126 offer process support for identification, definition, measurement, and evaluation of software product quality.*

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Values Are Context Dependent

Attributes values are not absolute e.g., a system is more or less secure depending on the threat.

Attribute evaluations must be performed within specific context:

- intended uses
- operational environment

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Models Are Not Independent

Some attribute models are *inter*dependent:

- there are parameters shared between different models
- shared parameters provide an opportunity to tradeoff between multiple attributes
- making tradeoffs might be necessary to satisfy system requirements

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Performance

"Performance. The degree to which a system or component accomplishes its designated functions within given constraints, such as speed, accuracy, or memory usage."
[IEEE Std. 610.12]

"Predictability, not speed, is the foremost goal in real-time-system design"

[J.A. Stankovic, "Misconceptions About Real-Time Computing: A Serious Problem for Next-Generation Systems," *IEEE Computer*, Volume 21, Number 10, October 1988.]

A misnomer is that performance equates to speed; that is, to think that poor performance can be salvaged simply by using more powerful processors or communication links with higher bandwidth.

Faster might be better, but for many systems faster is not sufficient to achieve timeliness. This is particularly true of real-time systems

As noted in [Stankovic 88], the objective of "fast computing" is to minimize the average response time for some group of services, whereas the objective of real-time computing is to meet individual timing requirements of each service.

•Hardware mechanisms such as caching, pipelining and multithreading, which can reduce average response time, can make worst-case response times unpredictable.

•In general, performance engineering is concerned with predictable performance whether its worst-case or average-case performance. Execution speed is only one factor.

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Dependability

"Availability. The degree to which a system or component is operational and accessible when required for use."

[IEEE Std. 610.12]

"Dependability is that property of a computer system such that reliance can justifiably be placed on the service it delivers"

[J.C. Laprie (ed.) "Dependability: Basic Concepts and Terminology", Volume 5 of Dependable Computing and Fault-Tolerant Systems. Springer-Verlag, February 1992.].

Security

"Secure systems are those that can be trusted to keep secrets and safeguard privacy."

[J. Rushby, *Critical System Properties: Survey and Taxonomy*, SRI International, Technical Report CSL-93-01, May 1993]

From Security to Survivability

Large-scale, distributed systems cannot be totally isolated from intruders - no amount of "hardening" can guarantee that systems will be invulnerable to attack.

We design buildings to deal with environment stress such earthquakes as well an intentional attacks such as a break-in.

We need to apply a similar approach to software where the faults are malicious attacks.

Extend security to include the ability to maintain some level of service in the presence of attacks.

Success is measured in terms of the success of mission rather than in the survival of any specific system or component.

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Modifiability

Modifiability encompasses two aspects:

"Maintainability. (1) The ease with which a software system or component can be modified to correct faults, improve performance or other attributes, or adapt to a changed environment. (2) The ease with which a hardware system or component can be retained in, or restored to, a state in which it can perform its required functions."

"Flexibility: The ease with which a system or component can be modified for use in applications or environments other than those for which is was specifically designed."

[IEEE Std. 610.12]

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Modifiability Taxonomy

- **Modifiability**
  - **Concerns**
    - **Extensibility**
    - **Simplification**
    - **Restructuring**
    - **Time to deploy**
    - **Functional scalability**
    - **Functional flexibility**
  - **Factors**
    - **Component complexity**
    - **Component size**
    - **Scope of modification**
  - **Methods**
    - **Modularity**
    - **Encapsulation**
    - **Software practice**

Concerns

- Extensibility - adding/enhancing/repairing functionality
- Simplification - streamlining/simplifying functionality
- Restructuring - rationalizing services, modularizing/optimizing/creating reusable components
- Time to deploy - time taken from specifying a requirement for new capability to the availability of that capability
- Functional scalability - ability to scale both up/down in terms of users, system throughput, availability, etc.
- Functional flexibility - turning an existing capability to new uses, new locations, or unforeseen situations

Factors

- Component complexity - in general the more complex the components, the more difficult they are to change
- Component size - smaller components are generally easier to modify than large ones
- Scope of modification - architecture level modifications are more difficult; may involve a complete redesign with different components and interactions

Methods

- Modularity - partition a system into distinct modules representing separate areas of functionality; a classical modifiability technique

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Concerns in Modifiability - 1

Concerns

- **Extensibility** — *adding/enhancing/ repairing functionality*
- **Simplification** — *streamlining/simplifying functionality*
- **Restructuring** — *rationalizing services, modularizing/optimizing/ creating reusable components*
- . . . .

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Concerns in Modifiability - 2

Concerns

- . . . .
- **Time to deploy** — *time taken from specifying a requirement for new capability to the availability of that capability*
- **Functional scalability** — *ability to scale both up/down in terms of users, system throughput, availability, etc.*
- **Functional flexibility** — *turning an existing capability to new uses, new locations, or unforeseen situations*

Functional flexibility must take advantage of the special characteristic of software components (i.e. low cost of duplication, zero marginal cost of transport) to provide the best possible fallback functionality.

Software applications should be designed and deployed in such a way that the software components that they are built from could (in extreme circumstances) be combined in new ways to construct new functionality.

Factors in Modifiability

Factors

- **Component complexity** — *in general the more complex the components, the more difficult they are to change*
- **Component size** — *smaller components are generally easier to modify than large ones*
- **Scope of *modification*** — *architecture level modifications are more difficult; may involve a complete redesign with different components and interactions*

Methods in Modifiability - 1

Methods

- **Modularity** — *partition a system into distinct modules representing separate areas of functionality; a classical modifiability technique*
- **Encapsulation** — *isolate system functionality within a module to limit the effects of changes within the module on other components*
- **Process oriented** — *ensure that the design process supports modifiability*

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Usability

"Usability. The ease with which a user can learn to operate, prepare inputs for, and interpret outputs of a system or component."
[IEEE Std. 610.12]

Usability is a measure of how well users can take advantage of some system functionality.

Usability is different from utility, a measure of whether that functionality does what is needed.

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Usability Taxonomy

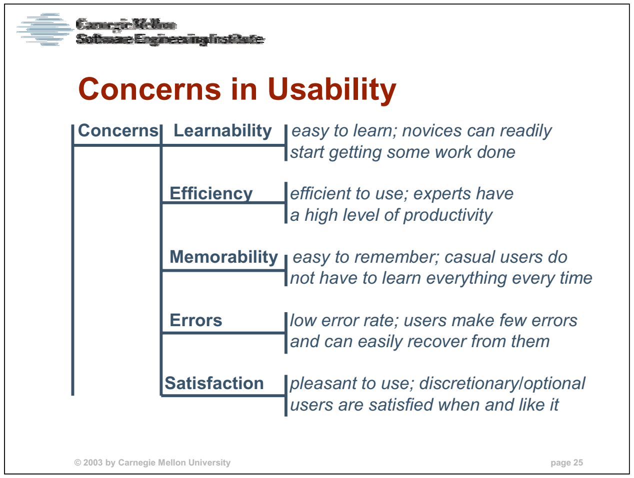
- **Usability**
  - **Concerns**
    - Learnability
    - Efficiency
    - Memorability
    - Errors
    - Satisfaction
  - **Factors**
    - Tradeoffs
    - Categories of users
  - **Methods**
    - Usability Eng. lifecycle
    - Lifecycle stage methods
    - Architecture mechanisms

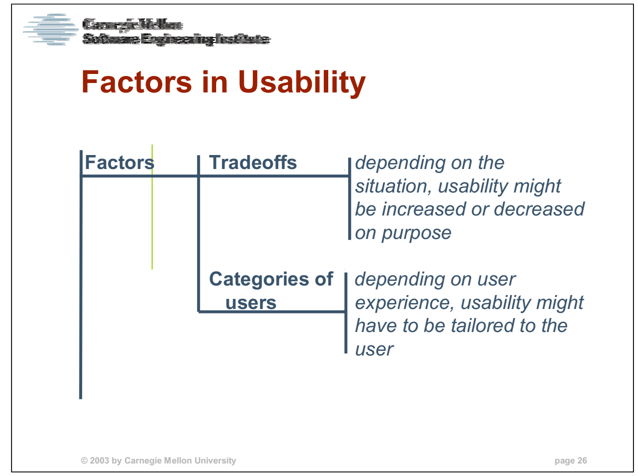
Jakob Nielsen, "Usability Engineering", Academic Press, AP Professional, Cambridge, MA, 1993.

Concerns
- Learnability - easy to learn; novices can readily start getting some work done
- Efficiency - efficient to use; experts have a high level of productivity
- Memorability - easy to remember; casual users do not have to learn everything every time
- Errors - low error rate; users make few errors and can easily recover from them
- Satisfaction - pleasant to use; discretionary/optional users are satisfied when and like it

Factors
- Tradeoffs - depending on the situation, usability might be increased or decreased on purpose
- Categories of users - depending on user experience, usability might have to be tailored to the user

Methods
- Usability lifecycle - activities that take place during the lifecycle of a product
- Lifecycle methods - techniques used in different lifecycle stages
- Architecture mechanisms - components built into the architecture of the system





Tradeoffs:

- Learning curves for systems that focus on novice or expert users.
- Accelerators or shortcuts are user interface elements that allow the user to perform frequent tasks quickly.
- Efficiency might be sacrificed to avoid errors, Learnability might be sacrificed for security or by hiding functions from regular users

Categories of users depend on their experience

- Experience with the specific user interface
- Experience with computers
- Experience with the task domain

Methods in Usability

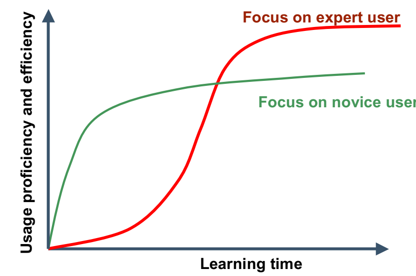
- **Methods**
  - **Lifecycle** — *activities that take place during the lifecycle of a product*
  - **Methods** — *techniques used in different lifecycle stages*
  - **Mechanisms** — *components built into the architecture of the system*

Usability Engineering is a set of activities that take place throughout the lifecycle of a product:

•It applies to the development of product lines and extended projects where products are released in several versions over time.

•Early decisions have ripple effects — subsequent products and versions must be backward compatible

Factors: Learning Time Tradeoffs



[J. Nielsen, Usability Engineering, Fig. 2]

Learning curves for systems that focus on novice or expert users. J. Nielsen, Usability Engineering, Fig. 2.

•It is not the case that a system is either easy to learn but inefficient or hard to learn and efficient. A user interface can provide multiple interaction styles:

•users start by using a style that is easy to learn

•later move to a style that is efficient

•Learnable systems have a steep rise at the beginning and allow users to reach a reasonable level of proficiency within a short time.

Most systems have learning curves that start out with the user being able to do very little at time zero, when they start using it.

Some systems are meant to be used only once and need to have zero learning time:

• Walk-up-and-use (e.g., museum information systems, car-rental directions to hotels)

• Systems that require reading instructions (e.g., installation programs, disk formatting routines, tax preparation programs that change every year)

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Factors: Accelerator Tradeoffs

Accelerators or shortcuts are user interface elements that allow the user to perform frequent tasks quickly, e.g.:

- function keys
- command name abbreviations
- double-clicking
- *etc.*

System can push users to gain experience:

- expert shortcuts in the novice menus
- On-line help
- analyze users' actions and offer alternatives

Users normally don't take the time to learn a complete interface before using it; they start using it as soon as they have learned to do "enough" -- measures of learnability should allow for this and not test for complete mastery of the interface.

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Factors: Intentional Deficiency Tradeoffs

Efficiency might be sacrificed to avoid errors, e.g.:

- asking extra questions to make sure the user is certain about a particular action

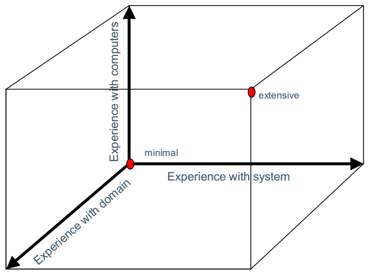
Learnability might be sacrificed for security, e.g.:

- not providing help for certain functions e.g., not helping with useful hints for incorrect user IDs or passwords

Learnability might be sacrificed by hiding functions from regular users, e.g.:

- hiding reboot buttons/commands in a museum information system

Factors: Categories of Users



[J. Nielsen, Usability Engineering, Fig. 3]

Dimensions in which users' experience differs, *J. Nielsen, Usability Engineering, Fig. 3*

- •Experience with the specific user interface is the dimension that is normally referred to when discussing user expertise.
  - •In reality most people do not acquire comprehensive expertise in all parts of a system, no matter how much they use it.
  - •Complex systems have so many features that a given user only makes extensive use of a subset
  - •An expert could be a novice on parts of the system not normally used by that user and need access to help for those parts of the interface
- •Experience with computers also has an impact on user interface design. The same utility might have to be provided with two different interfaces
  - •Utilities for system administrators vs. home computer users (e.g., disk defragmentation
  - •Experience with other applications "carries over" since the users have some idea of what features to look for and how the computer normally deals with various situations (e.g., look for a "sort" function on a new word processor because is common in spreadsheets and databases)
  - •Programming experience determines to what extent the user can customize the interface using macro languages in a way that is maintainable and modifiable at a later date
  - •In addition, programmers' productivity can range by a factor of 20!

Prioritizing Quality Attributes

Quality attribute requirements are often in conflict.

Sometimes there is no easy easy way to satisfy ALL quality attributes.

- Not all attributes are relevant to a system and some can be discarded right away
- Remaining attributes can be ranked by importance
- Attributes that are above some threshold need to be evaluated
- Evaluation techniques relevant to important attributes must be quantifiable and testable

Jim Brosseau, http://www.clarrus.com/documents/Quality Attributes primer.pdf

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Step 1: Identify Qualities That Clearly Do Not Apply

Attribute	Interest	Explicit requirements	In/out
reliability	user		
robustness	user		
availability	user		
integrity	user		
flexibility	user		
usability	user		
interoperability	user		
efficiency	user		
testability	developer		
maintainability	developer		
reusability	developer		
portability	developer		

Notes:
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Step 2: Prioritize Remaining Attributes

If the left side attribute is more important, identify with a '<' character, otherwise use a '^' character
The Rank column will automatically tally the results and pass along to the next sheet
Include or refer to this information in the Requirements Specification

Attribute	In/Out	Score	reliability	robustness	availability	integrity	flexibility	usability	interoperability	efficiency	testability	maintainability	reusability	portability
reliability	0	11		<	<	<	<	<	<	<	<	<	<	<
robustness	0	0			^	^	^	^	^	^	^	^	^	^
availability	0	8				<	^	<	<	<	<	^	<	<
integrity	0	1					^	^	^	^	^	^	^	^
flexibility	0	9						<	<	<	<	^	<	<
usability	0	7							<	<	<	^	<	<
interoperability	0	2								^	^	^	^	^
efficiency	0	5									<	^	<	^
testability	0	4										^	<	^
maintainability	0	10											<	<
reusability	0	3												^
portability	0	6												

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Jim Brosseau, http://www.clarrus.com/documents/Quality Attributes primer.pdf

E.g., Usability has a score of 7:

Reliability –
Robustness +
Availability –
Integrity +
Flexibiltiy -
Interoperability +
Efficiency +
Testability +
Maintainability –
Reusabiltiy +
Portability +

Total 7+ (or 4 -)

Step 3: Map Selected Attributes to Quantifiable Criteria

For those attributes that are critical, select criteria to determine 'doneness' of attribute
Hide those attributes that are not included or are low priority
Hide those criteria that no longer satisfy any attributes
Add additional criteria that make sense for your organization, project, client, or product
Include or refer to this information in the Requirements Specification

Attribute	reliability	availability	flexibility	usability	maintainability
Score	11	8	9	7	10
MTBF	X	X			
MTTR		X			
GUI Standards				X	X
Response Times				X	
Inline code use					X
Configurability			X	X	
McCabe complexity	X				X
... and so on			X	X	
... and so forth					X
... as required	X				X
count	3	2	2	4	5

Notes:
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Next step is to set a threshold. We won't worry about attributes below the threshold!!

A threshold is not mandatory but the prioritization suggest that there some attributes are more important than others.

From the scores in the previous slide, the attributes above the threshold are: Reliability (11), Maintainability (10), Flexibility (9), Availability (8), and Usability (7).

Step 4: Identify Specific Quality Measures

For each of the selected criteria, specify precise measures required for the application
The following are typical examples
Include this information explicitly in the Requirements Specification
- these are part of your Non-Functional Requirements.

Criterion	Measure
MTBF	The system shall have a mean time between failure of at least 75 days
MTTR	The system shall have a mean time to repair of less that 30 minutes
GUI Standards	The software shall conform completely for the GUI standards for Microsoft Windows as published in <referred published standard> version X, dated yyyy.
Response Times	The average time required to generate and display an online report shall be less than 2 seconds, and no online reports shall take more than 5 seconds. For those that require more than 250 milliseconds, there shall be graphical feedback to the user that th
. . . .	

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Jim Brosseau, http://www.clarrus.com/documents/Quality Attributes primer.pdf

The measures are scenarios that, when analyzed, can identify risks, sensitivities, and tradeoffs.

Impact of Software Architecture on Quality Attributes

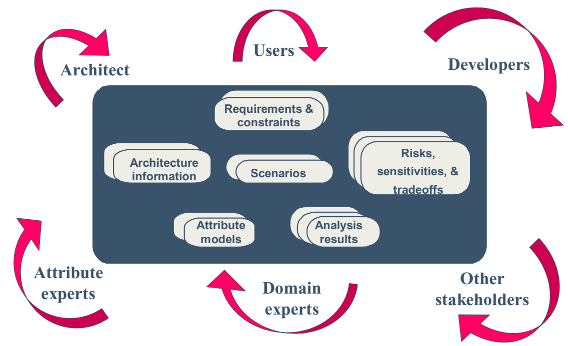
In large software systems, the achievement of quality attributes is dependent not only upon code-level practices (e.g., language choice, algorithms, data structures), but also upon the software architecture.

It is more cost effective to detect potential software quality problems earlier rather than later in the system life cycle.

When the software architecture is specified, designers need to determine:

- the extent to which features of the software architecture influence quality attributes
- the extent to which techniques used for one attribute support or conflict with those of another attribute
- the extent to which multiple quality attribute requirements can be satisfied simultaneously

Interactions Between Stakeholders



Imagine the stakeholders sharing a blackboard:

- participants can provide or obtain information at any time
- participant can use information from any other participant

Stakeholders must identify the quality attribute requirements and constraints.

The architect provides architectural information including the components and connections between components, showing the flow of data, and the the behavior — underlying semantics of the system and the components, showing the flow of control.

Stakeholders propose scenarios describing an operational situation, a modification to the system, a change in the environment, etc.

- Scenarios are used to explore the space defined by the requirements, constraints, and architectural decisions. Scenarios define tests to be conducted through architecture analysis

Some stakeholders (e.g., domain experts) identify models for evaluating quality attributes. Some models are specific to certain quality attributes, other models are applicable to multiple attributes.

Depending on the attributes of interest, there are different qualitative and quantitative techniques to conduct the analysis: focus on system activities (e.g., latency, availability), focus on user activities (e.g., time to complete a task), focus on the system (e.g., modifiability, interoperability).

Depending on the attribute models and the architectural approaches, various risks, sensitivities and tradeoffs can be discovered during the analysis:

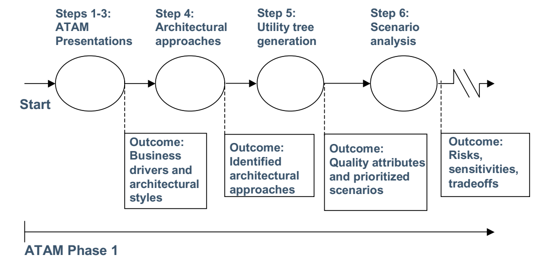
- risks — alternatives that might create future problems in some quality attribute
- sensitivity points — alternatives for which a slight change makes a significant difference in some quality attribute
- tradeoffs — decisions affecting more than one quality attribute

The ATAM Process

An evaluation team moderates the discussions, records the findings, and presents a summary report to the participants:

- evaluation meeting(s) are short, 2~3 days, not including preparation time for moderators and stakeholders
- preparation time could extend over weeks, depending on the work required e.g., negotiate with sponsors, draft architectural documentation, availability of participants

ATAM Phase 1



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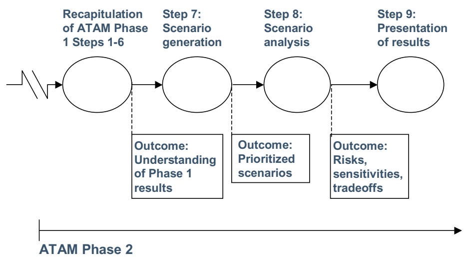
ATAM Phase 2



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Quality Attribute Workshops

The Quality Attributes Workshops (QAW) are a variation of ATAM that is applicable earlier in the life-cycle, before a complete software architecture has been defined.

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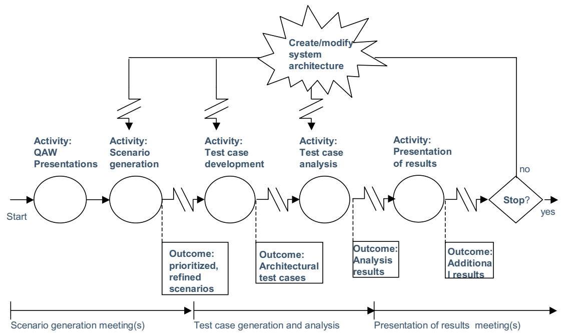
The QAW Process



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M.R. Barbacci, et al., *Quality Attribute Workshops, 2nd Edition,* (CMU/SEI-2002-TR-019). Pittsburgh, Pa.: Software Engineering Institute, Carnegie Mellon University, 2002.

The process can be organized into four distinct segments: (1) QAW presentation, scenario generation, prioritization, and refinement; (2) test case development; (3) analysis of test cases against the architecture; and (4) presentation of the results.

The first and last segments of the process occur in facilitated one-day meetings. The middle segments take place off-line and could continue over an extended period of time.

The process is iterative in that the test case analyses might lead to the development of additional test cases or to architectural modifications. Architectural modifications might prompt additional test case analyses, etc.

There is a further iteration, not shown in the figure, in which test cases are developed in batches, sequential analyses are performed, and each time, the architecture is modified accordingly.

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ATAM and QAW Benefits

There are a number of benefits from performing the ATAM or QAW processes:

- clarified quality attribute requirements
- improved architecture documentation
- documented basis for architectural decisions
- identified risks early in the life-cycle
- increased communication among stakeholders

The results are improved architectures.

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Requirements

Both methods rely critically on:

- appropriate preparation by the customer
- clearly-articulated quality attribute requirements
- active stakeholder participation
- active participation by the architect
- evaluator familiarity with architectural styles and analytic models

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ATAM and QAW Status

We have experience in using the methods in a wide variety of application areas.

There is an ATAM handbook and a training course to make process repeatable and transitionable. Most of the material is relevant to the QAW process.

Additional information available:

http://www.sei.cmu.edu/activities/ata

