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Software Engineering and Architecture

Quality Attributes

Good or Bad?

- When I was taught OO programming and design, there was often statements like
- *”This is not good OO design”*
- Which was more or less equal to the statement
  - *I do not like it…*
- ***Theological statement*** ☹

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What does “good” mean?

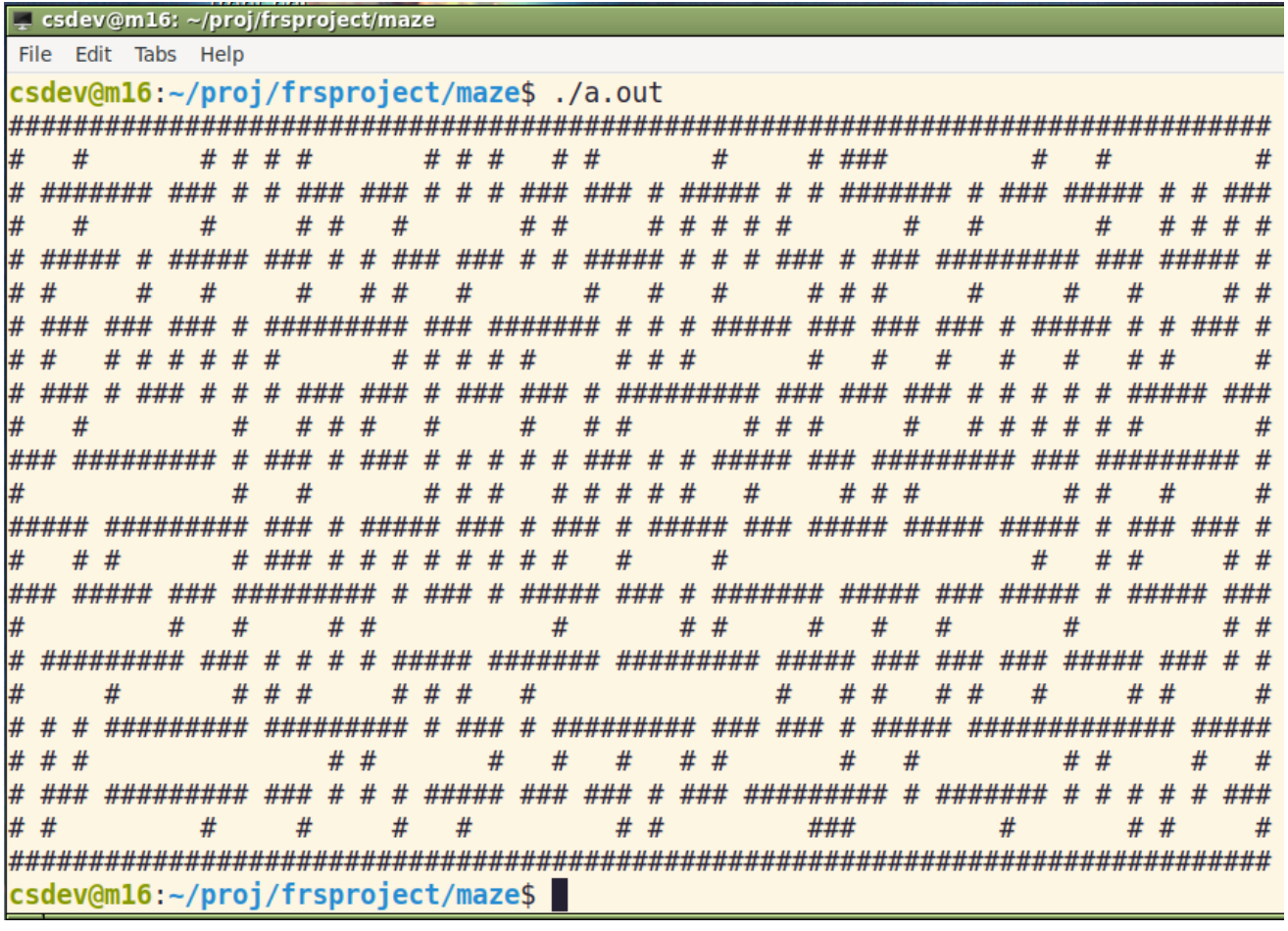
- Question: Is this little C program an example of *good* or *bad* software?

```
int a[1817];main(z,p,q,r){for(p=80;q+p-80;p-=2*a[p])for(z=9;z--
    ;)q=3&(r=time(0) +r*57)/7,q=q?q-1?q-2?1-p%79?-1:0:p%79-
           77?1:0:p<1659?79:0:p>158?-79:0,q?!a[p+q*2
]?a[p+=a[p+=q]=q]=q:0:0;for(;q++-1817;)printf(q%79?"%c":"%c\n","
                          #"[!a[q-1]]);}
```

- Exercise 1: Argue that this is a **good** program!
- Exercise 2: Argue that this is a **bad** program !

(What does the C program do?)

- Process
  - Paste string into file ‘m.c’
  - Install ‘gcc’
  - gcc m.c
  - ./a.out
  - Done…



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The need for measuring

- *The server is highly available...*
- ***My** software is really easy to read! Self-explantory*
- *Our high performance server will...*
- These are simply claims ☺
- Actual measurements on well defined scale is better...

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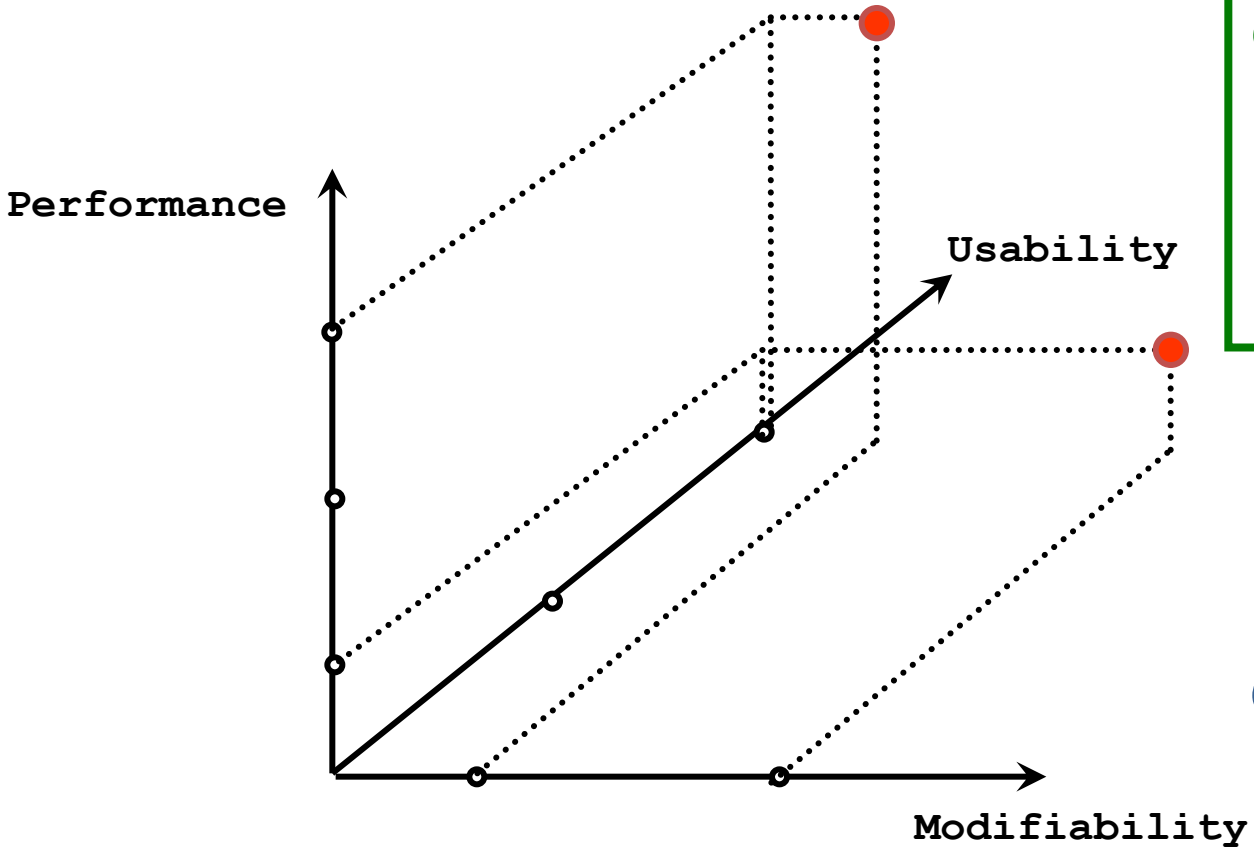
Quality Attributes

- The problem about ”good” or ”bad” is that they are subjective measures...
- We need to *measure* our software. This requires
  - that we define the aspects/**qualities** we measure
  - that we agree on some kind of scale: a **metric**
- Quality attributes (da: kvalitets-attributter)

Measuring quality



Quality Framework

Quality Attribute

Metric

Measurement

Choose alternatives

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’Quality communities’

- One aspects of qualities is that most of them have dedicated research communities associated:
  - performance freaks (algorithm people, database, ...)
  - usability freaks (HCI – human computer interface)
  - security freaks
  - cost freaks (managers ☺)
  - reusability freaks (pattern community ☺)

- ...which has lead to lack of common vocabulary…
  - user input, attack, event, failures, are all *stimulus*

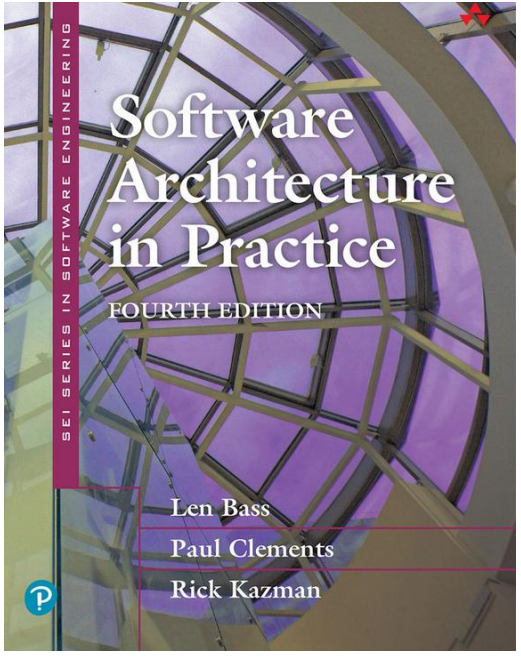
- *We need to provide common ground*

SAiP's Contribution

- The book *Software Architecture in Practice* has defined a conceptual framework that allow different architecturally qualities to be expressed in a similar form: A quality framework

- **Quality Attributes:**
  Set of qualities to consider

- **Quality Metric:**
  A technique for measuring them



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Quality framework (Bass et al.)

- System quality attributes
  - Availability
  - Modifiability
  - Performance
  - Security
  - Testability
  - Usability
  - Integrability
  - Deployability
  - Energy Efficiency
  - Safety
- Business qualities
  - Time to market
  - Cost
  - Projected lifetime
  - Targeted market
  - Roll-out schedule
  - Integration with legacy sys.
- Architectural qualities
  - Conceptual integrity
  - Correctness and completeness
  - Buildability

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The System Qualities

- Availability
  - Concerned with the **probability that the system will be operational when needed**
- Modifiability
  - Concerned with the **ease with which the system supports change**
- Performance
  - Concerned with **how long it takes the system to respond** when an event occurs

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The System Qualities

- Security
  - Concerned with the systems **ability to withstand attacks/threats**
- Testability
  - Concerned with the **ease with which the software can be made to demonstrate its faults**
- Usability
  - Concerned with **how easy it is for the user to accomplish a desired task** and the kind of user support the system provides

The System Qualities

- Deployability
  - Concerned with the ease at which the system can be **allocated to an environment for execution**
- Energy Efficiency
  - Concerned with the **energy required for the system to perform its tasks**
- Safety
  - Concerned with **the systems ability to avoid states that lead to damage, injury, or loss of life to actors in environment**

Exercise

- System quality attributes
  - Availability
  - Modifiability
  - Performance
  - Security
  - Testability
  - Usability
  - Deployability
  - Energy Efficiency
  - Safety

- Business qualities
  - Time to market
  - Cost
  - Projected lifetime
  - Targeted market
  - Roll-out schedule
  - Integration with legacy sys.

Which of these will have the greatest impact on your professional and personal lives?

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“We want them all”

Qualities in conflict

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The conflict of qualities

- Many qualities are in direct conflict – they must be balanced !
  - modifiability and performance
    - many delegations costs in execution speed – and memory footprint
  - cost and reusability
    - highly flexible software costs time, effort, and money
  - security and availability
    - availability through redundancy – increase opportunities of attack
  - modifiability and energy efficiency
    - Simpler language like Python – increased energy cost

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Design Patterns in Perspective

Examples of Good turning Bad

Iteration

- In a **distributed** system, the clients need to iterate over all order lines in an order object...

```
public void processStream() {
  getOrderFromServer().stream().forEach(this::processOrder);
}
```

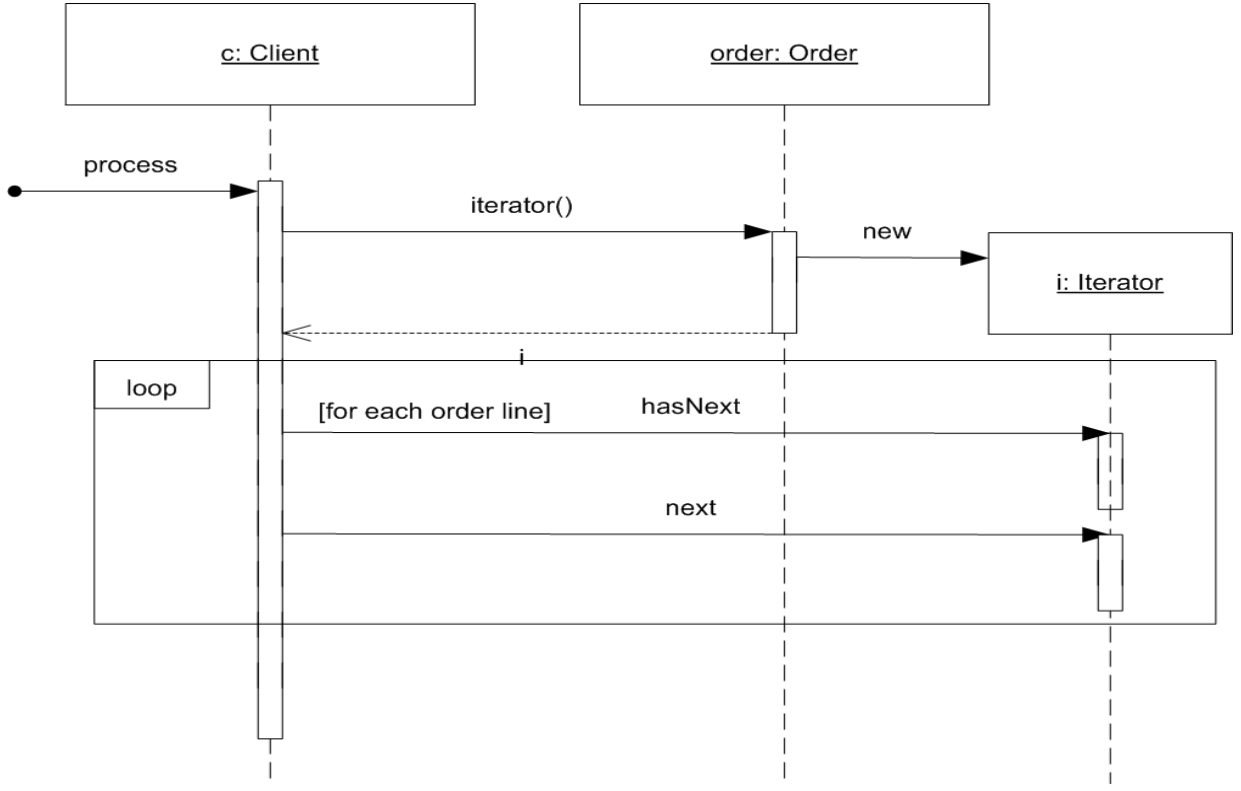
```
public void processJava8() {
  List<OrderLine> order = getOrderFromServer();
  for(OrderLine line : order) {
    processOrder(line);
  }
}
```

```
public void processJava1() {
  List<OrderLine> order = getOrderFromServer();
  Iterator<OrderLine> iter = order.iterator();
  while(iter.hasNext()) {
    OrderLine line = iter.next();
    processOrder(line);
  }
}
```

- Using Broker – the code looks exactly the same even when the Order and each OrderLine objects are on the server side !!! Great!
- ***Iterator*** is a nice, flexible, design pattern ☺

The sequence diagram

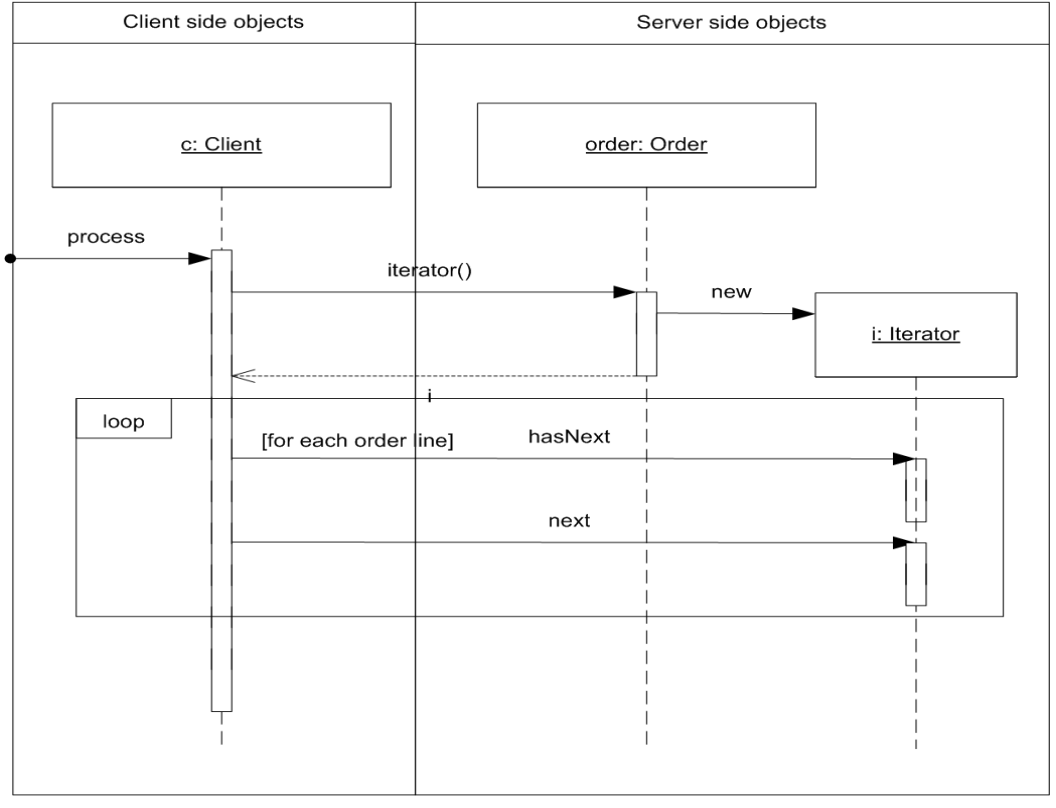
- All is fine ...



... but

- Let us consider the **deployment** of objects

What's wrong?



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... what about performance ?

- Message-call is *really* expensive over a network
  - 2018 data on TeleMed:
    - Between a factor 11 to 275 times slow-down
      - (depends on geography of the two machines)

Configuration	Average time (ms)	Max time (ms)	Factor
Local call	1,796	3,366	1.0
Localhost	9,731	12,806	5.4
Docker	17,091	35,873	9.5
On switch	19,690	22,025	11.0
Frankurt	494,966	513,411	275.6

- The *iterator* pattern produces an extreme slow-down compared to transferring *all order line objects in a single network package* !
  - Modifiability/maintainability high Performance low

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Conclusion

- We build software that has **architectural quality attributes**
  - Availability — Always working when I need it
  - Modifiability — Low cost to change or add features
  - Performance — Fast response time, no waiting for answer
  - Security — Authorized users only, no 3rd part
  - Testability — Easy to verify correctness by tests
  - Usability — Fast to learn, easy to use, productive
  - Energy effiency — Get most work done for least Watts
  - …
- We have to evaluate *which are important in which contexts* and then focus our efforts to achieve them in the best balance
  - (Sometimes flexibility/patterns/frameworks are not the way to go!)

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Evaluation!

Fill in the evaluation ☺
Start again at xx.xx

Softwarekonstruktion og softwarearkitektur (E25.520171U009.A)

Studerende

https://go.blueja.io/pufvcFPHvEmrW6xw-NfTFQ

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Quality Attribute Scenarios

Measuring QAs

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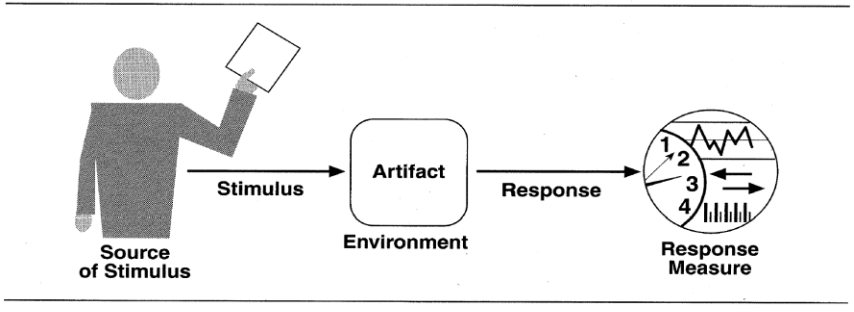
QaS: A Writing Template

- ***Source of stimulus***. This is some entity (a human, a computer system, or any other actuator) that generated the stimulus.
- ***Stimulus***. The stimulus is a condition that needs to be considered when it arrives at a system.
- ***Environment***. The stimulus occurs within certain conditions. The system may be in an overload condition or may be running when the stimulus occurs, or some other condition may be true.
- ***Artifact***. Some artifact is stimulated. This may be the whole system or some pieces of it.
- ***Response***. The response is the activity undertaken after the arrival of the stimulus.
- ***Response measure***. When the response occurs, it should be measurable in some fashion so that the requirement can be tested.



Modifiability

- Concerned with *the ease with which the system supports change*
- *The central QA that SWEA is all about!*

Table 7.1. Modifiability General Scenario

Portion of Scenario	Possible Values
Source	End user, developer, system administrator
Stimulus	A directive to add/delete/modify functionality, or change a quality attribute, capacity, or technology
Artifacts	Code, data, interfaces, components, resources, configurations, . . .
Environment	Runtime, compile time, build time, initiation time, design time
Response	One or more of the following: ▪ Make modification ▪ Test modification ▪ Deploy modification
Response Measure	Cost in terms of the following: ▪ Number, size, complexity of affected artifacts ▪ Effort ▪ Calendar time ▪ Money (direct outlay or opportunity cost) ▪ Extent to which this modification affects other functions or quality attributes ▪ New defects introduced

Exercise

- ”In WoW world design phase, it should be easy to change a landscape feature of the world”

- How to formulate it using a QAS
  - *Just how easy, is easy?*

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Exercise

- *A **UI developer** wants to **add a tree** to part of the world (**landscape model**) during **design time**; the modification **is made/tested** in **N staff minutes***
- What is N???
- *How does Blizzard ensure N is low?*

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Keypoint

- The keypoint of the template is

- *Some **source** generates some events (**stimuli**) that arrives at some **artefact** under some conditions (**environment**) and must be dealt with (response) in a satisfactory way (**response measure** = the architectural requirement)*

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Discussion

- Architectural qualities need to be specified as well as functional ones!
  - It is difficult to make them measurable, yes!
  - *Pretty measurable is much better than not measurable*
    - *The best is the worst enemy of the good…*
- Bass et al.'s QaS is a pretty good tool!
- Modifiability is measured in ***the cost of the change!***
  - Which is basically 'man hours'