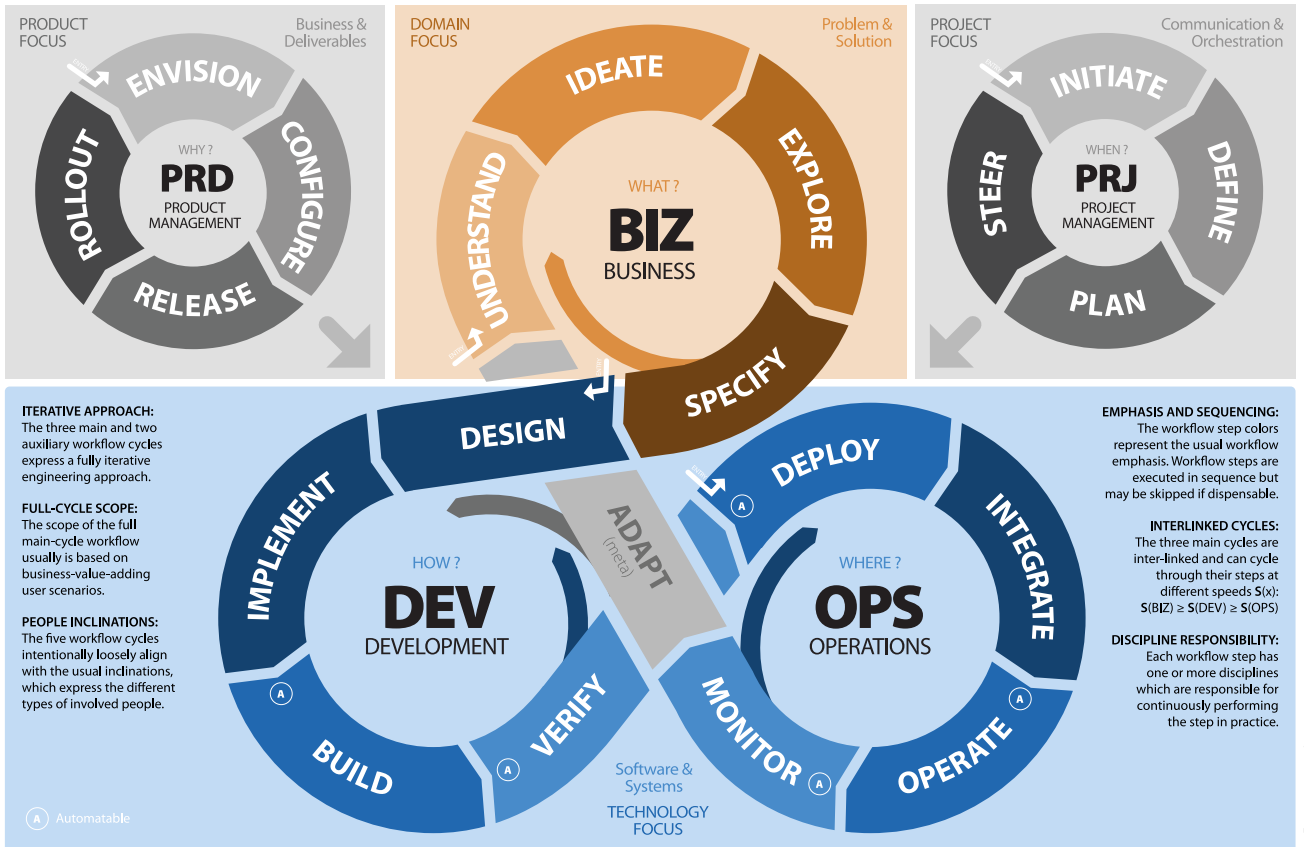




Software Engineering in Industrial Practice (SEIP)

Dr. Ralf S. Engelschall



The Workflow Model describes the work segregation in Software Engineering. In the **Workflow**, three main and two auxiliary workflow cycles express the iterative approach. The full main-cycle workflow is usually based on business-value-adding user scenarios.

The three main cycles are interlinked and can cycle through their steps at different speeds, $S(x)$, with $S(BIZ)$ is greater or equal $S(DEV)$, which in turn is greater or equal $S(OPS)$. Because the cycles with earlier steps should not slow down the cycles not later steps.

The step colors represent workflow emphasis. Workflow steps are executed in sequence but may be skipped if dispensable.

The ten discipline areas of Software Engineering express the different roles of involved people. The five inclinations express the different types of involved people. Hence the Workflow consists of exactly five cycles.

Questions

- ❓ What does the Workflow-Model of Software Engineering describe?



Software Engineering, on an operational level, can be alternatively understood through 20 distinct **Steps** which are continuously performed within the **Software Engineering Workflow**. Each Step belongs to one primarily responsible Discipline and zero or more secondarily responsible Disciplines.

Workflow Steps are the adequate concept to understand which activities have to be performed in each iteration of a **Software Engineering Process**.

Questions

- ? Which concept allows one to best understand which activities have to be performed in a Software Engineering Process?

1. WORKFLOW CYCLES

The workflow has five cycles which continuously iterate through their steps. Workflow steps are executed in each cycle in sequence, but may be skipped if dispensable in a particular iteration of the process. The length of an iteration is arbitrary, but can be e.g. about 1/3 of a Scrum sprint.

2. WORKFLOW STEPS:

The workflow steps describe a logical activity which has to be performed. Each step relates to one or more discipline areas and their corresponding disciplines, which express the operative responsibilities for each workflow step. In each discipline individual roles act.

3. WORKFLOW ROLES:

The workflow roles are held by individual persons. Each role is primarily responsible for a particular workflow step. In addition, each role can be secondarily responsible for other workflow steps or at least actively support those steps.

4. PROJECT SCHEDULE:

To create a particular project execution schedule, the five cycles, their iterations and their steps have to be mapped onto a timeline. The cycles are mapped onto (horizontal) timeline tracks, the iterations are mapped onto (vertical) timeline phases, and the steps are mapped onto timeline activities.

5. PROCESS FLOWS (THE CRUX):

The activities across the cycles can (and should) be linked into individual (diagonal) waterfall-like flows, although the execution schedule, from the perspective of the cycles, is fully iterative. There are multiple such flows in parallel and they are usually highly interleaved on the project timeline in order to maximally utilize the team.

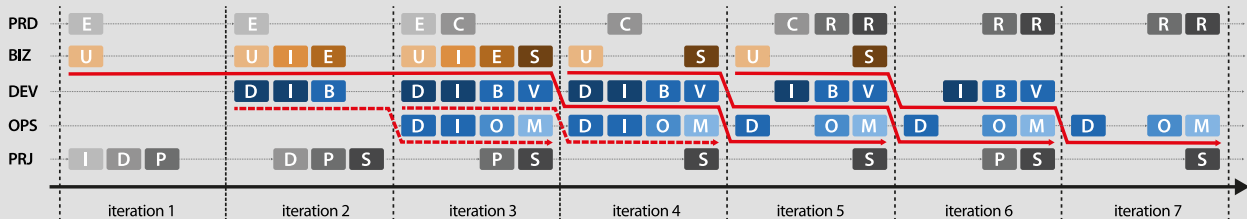
6. PROCESS ADAPTION:

In the meta-step ADAPT, the process is adapted by choosing which workflow steps are required for the next iteration. The major input for this decision is the current solution state and the feedback on it by the customer.

	business-oriented & domain-specific					constructive & technological					infrastructural & technological					analytical & domain-specific					process-oriented & process-oriented				
	AN	EX	UXP	UD	UD	AR	DEV	REF	VER	ASW	DL	DL	REV	AC	CP	MG	PRD	COI	AD	AD	MG	PRD	COI	AD	AD
	Requirements Engineer	Business Architect	User Experience Expert	User Interface Designer	Software Architect	System Architect	Software Developer	Software Developer	Configuration Manager	Build Manager	System Engineer	System Administrator	Software Tester	Software Tester	Technical Writer	Product Trainer	Product Owner	Project Manager	Project Manager	Change Manager					
PRD																									
ENVISION	+	+	+																						
CONFIGURE																									
RELEASE																									
ROLLOUT																									
BIZ																									
UNDERSTAND	+	+	+																						
IDEATE																									
EXPLORE																									
SPECIFY																									
DEV																									
DESIGN																									
IMPLEMENT																									
BUILD																									
VERIFY																									
OPS																									
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INTEGRATE																									
OPERATE																									
MONITOR																									
ADAPT																									
PRJ																									
INITIATE																									
DEFINE																									
PLAN																									
STEER																									

■ responsible (primarily)
■ responsible (secondarily)
+ supporting

roles & tasks



The workflow has five main cycles which continuously iterate through their steps. Workflow steps are executed in each cycle in sequence but may be skipped if dispensable.

The workflow steps are annotated with discipline areas to express operative responsibilities. In each area, multiple roles act.

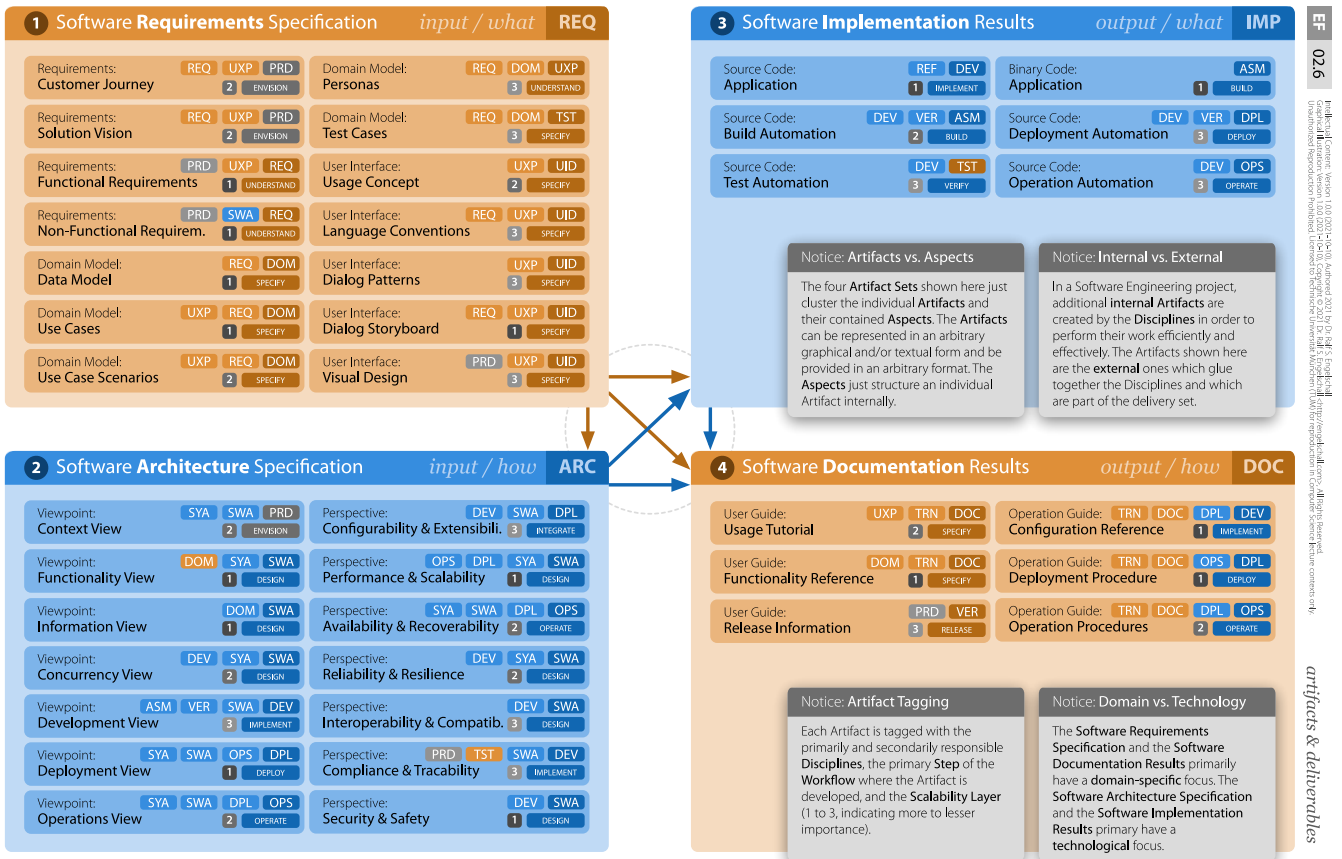
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Questions

- ? How can maximum utilization of the team be achieved in Software Engineering, despite a division of labor?



The four **Artifact Sets** just cluster the individual **Artifacts** and their contained **Aspects**. The **Artifacts** can be represented in an arbitrary graphical and/or textual form and be provided in an arbitrary format. The **Aspects** just structure an individual Artifact internally.

In a Software Engineering project, additional **internal Artifacts** are created by the **Disciplines** in order to perform their work efficiently and effectively. The shown Artifacts are just the **external** ones which glue together the Disciplines and which are part of the delivery set.

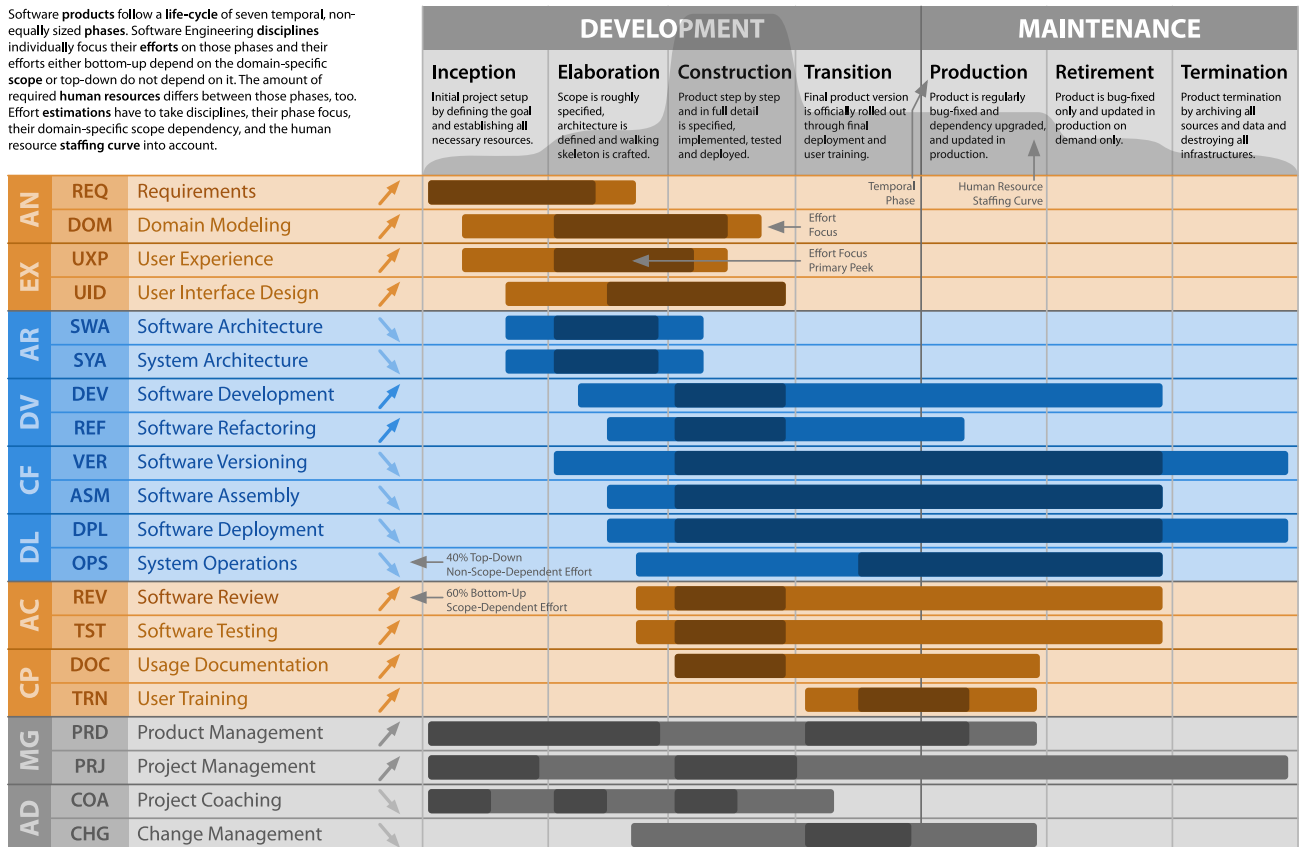
Each **Artifact** is tagged with the primarily and secondarily responsible **Disciplines**, the primary **Step** of the Workflow where the Artifact is developed, and the Scalability Layer (1 to 3, indicating more to lesser importance).

The **Software Requirements Specification** and the **Software Documentation Results** primarily have a **domain-specific** focus. The **Software Architecture Specification** and the **Software Implementation Results** primarily have a **technological** focus.

Questions

- ? What focus has the **Software Requirements Specification**?

Software products follow a **life-cycle** of seven temporal, non-equally sized **phases**. Software Engineering **disciplines** individually focus their **efforts** on those phases and their efforts either bottom-up depend on the domain-specific **scope** or top-down do not depend on it. The amount of required **human resources** differs between those phases, too. **Effort estimations** have to take disciplines, their phase focus, their domain-specific scope dependency, and the human resource **staffing curve** into account.



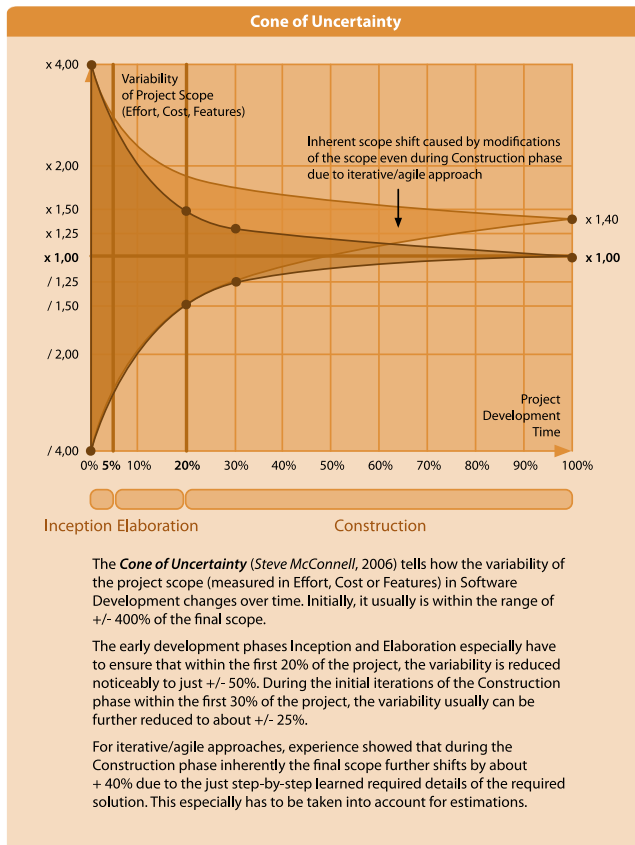
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Effort estimations have to take disciplines, their phase focus, their domain-specific scope dependency, and the human resource staffing curve into account.

Furthermore, the seven sequential phases especially do not conflict with agile process models: agile time **periods** (named "sprints" in Scrum) merely subdivide the individual phases.

Questions

- ? What is the Software Engineering **Phase** called, which has the greatest personnel requirements and in which primarily the functionalities are realized?



The **Cone of Uncertainty** tells how the variability of the project scope (measured in Effort, Cost or Features) in Software Development changes over time. The early development phases Inception and Elaboration especially have to ensure that the variability is reduced noticeably.

For iterative/agile approaches, experience showed that during the Construction phase, inherently the final scope further shifts due to the just step-by-step learned required details of the required solution.

The Elaboration phase is especially important for the creation of the **Walking Skeleton**, where all the technical integrations of libraries, frameworks, build procedures, etc., are done without already implementing any domain-specific functionalities.

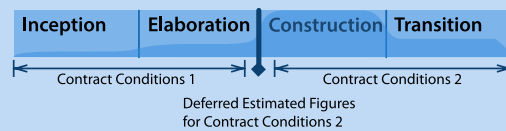
Essential Elaboration Phase

Walking Skeleton:

The **Walking Skeleton** (or *Technical Breakthrough*) is the design and implementation of the bare technical foundation of an application, still *without* any domain-specific functionalities. It is made during the Elaboration phase with the primary purpose to establish a stable integration of all technical aspects (libraries, frameworks, build procedures, etc) onto which the domain-specific functionalities later can be successively put onto.



Agile Fixed-Price Contracts:



The **Agile Fixed-Price** is an agile variant of a fixed-price contract, not a fixed-price project with an agile development process.



There are two important inherent aspects:

First, the contract contains two types of conditions: one (usually *Time & Material* but fixed duration based) for the Inception and Elaboration phases in order to make experiences and to gather necessary figures, and one (usually *Fixed-User-Story* and/or *Fixed-Price* based) for the Construction and Transition phases based on deferred estimated figures, gathered in the Elaboration phase.

Second, the Fixed-Price aspect of the contract is actually based on an amount of User-Stories (resulting in costs by multiplying them with either an average hourly rate of an engineer or individual rates based on engineer job levels), which the customer can 1:1 exchange during the project for different deliverables.

The crux of an Agile Fixed-Price contract is: first, during the Inception and Elaboration phases the supplier can shrink the *Cone of Uncertainty* and this way its risks dramatically, and second, during the Construction and Transition phases the customer still remains flexible in scope.

Because of the **Cone of Uncertainty**, **Agile Fixed-Price** project contracts usually differentiate between the early phases Inception and Elaboration and the main phases Construction and Transition. The contract conditions of the latter usually depend on figures which seriously can only be estimated at the end of the Elaboration phase.

Questions

❓ What is especially developed in the project phase "Elaboration"?

Estimation & Variability

Three-Point Estimation and Estimation Variability Classes:

$$e = (b + 4 \times m + w) / 6 \quad \text{expected effort (weighted average)}$$

$$s = (w - b) / 6 \quad \text{standard deviation (effort variation)}$$

b: best-case (optimistic)
m: most-likely (realistic)
w: worst-case (pessimistic)

Insane Variability: +/- 10%
Very Good Variability: +/- 15%
Good Variability: +/- 20%
Acceptable Variability: +/- 25%

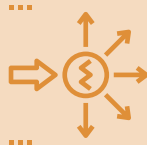


Sizes & Variability

Estimation Sizes and Estimation Variability:

T-Shirt-Size (Logically)	XXS	XS	S	M	L	XL	XXL	XXXL
Fibonacci-Size (PD or SP)	0,50	1	2	3	5	8	13	21
Size Variability (-)	0,25	0,25	0,50	0,50	1,00	1,50	2,50	4,00
Size Variability (+)	0,25	0,50	0,50	1,00	1,50	2,50	4,00	8,00

Notice: Estimations can be done in *Person-Days (PD)* or *Story-Points (SP)*. In both cases, keep in mind to use something like the *Fibonacci* numbers which increase in a non-linear fashion and express the increasing variability with the increasing total amount of estimated effort.



Conversion & Normalization

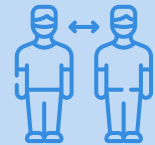
1. Ask Estimator:

"How many Person-Days do you need when you can focus on this task?"

2. Convert from Estimator to Performer:

(see also CAP model, <http://cap-model.com>)

		Performer				
		0%	10%	25%	45%	80%
Estimator	Novice	1,00	0,90	0,75	0,55	0,20
	Practitioner	1,11	1,00	0,83	0,61	0,22
	Master	1,33	1,20	1,00	0,73	0,27
	Expert	1,82	1,64	1,36	1,00	0,36
	Guru	5,00	4,50	3,75	2,75	1,00



Risk Mitigation & Upscaling

3. Adjust for Reality:

Estimator Optimism: +30%
Performer Meetings: +20%

4. Adjust for Uncertainty:

Domain		Inception			Elaboration			Construction		
		Technology			Technology			Technology		
		unknown	partially known	fully known	unknown	partially known	fully known	unknown	partially known	fully known
		30%	15%	0%	20%	10%	0%	60%	30%	0%
Process		Inception			Elaboration			Construction		
		People			People			People		
		unknown	partially known	fully known	unknown	partially known	fully known	unknown	partially known	fully known
		60%	30%	0%	40%	20%	0%	10%	5%	0%



Effort Estimations are usually based on a **Three-Point Estimation** where a weighted average of "best case", "most likely" and "worst case" are used. A good estimation variability in practice is about +/- 20%.

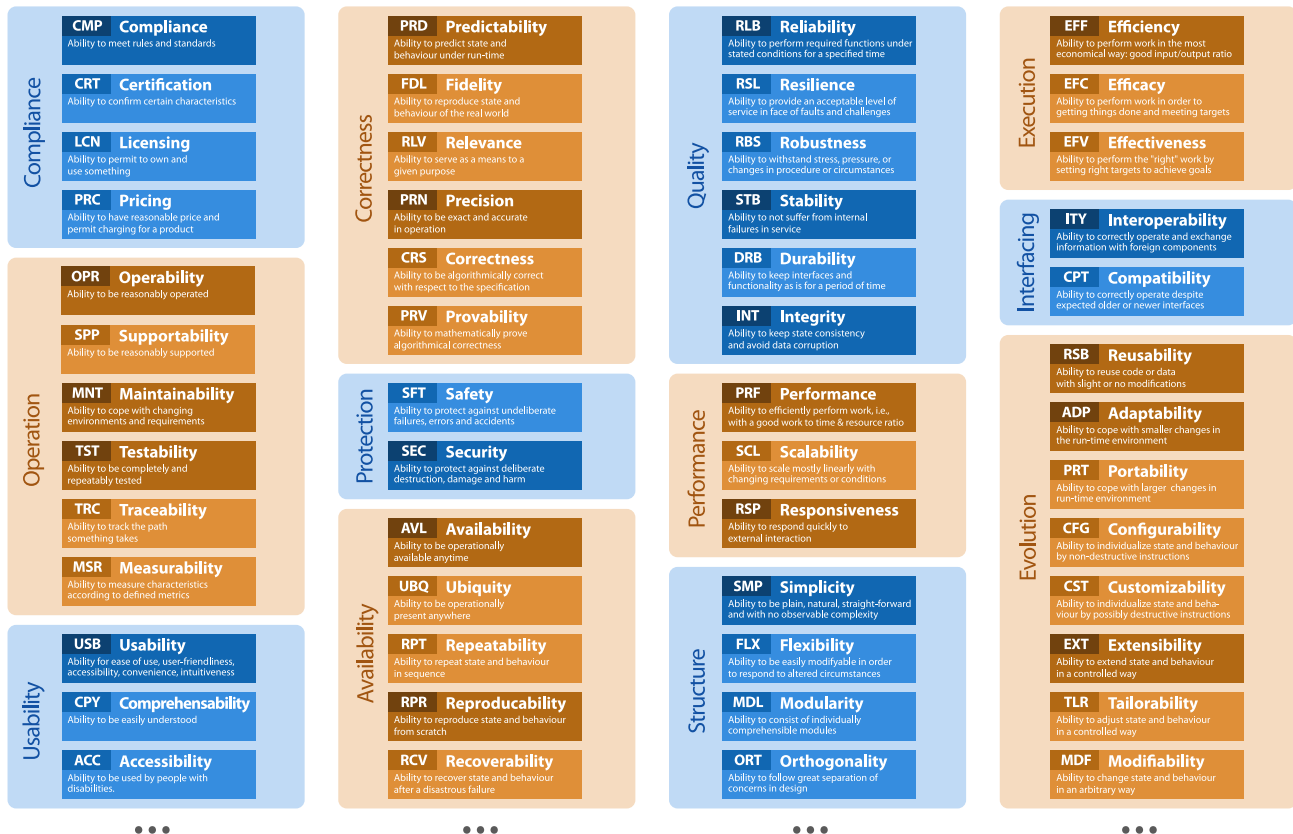
For **Expert Estimations**, a fixed scale of estimation sizes are usually used in practice, which is based on the **Fibonacci** sequence of numbers, to take into account the fact that higher estimated efforts also have higher estimation variability.

Additionally, one usually has to post-adjust the estimation of experts to further take into account the different skill and experience levels between the task estimator and the subsequent task performer, the usual human optimism of the estimator and the practical meeting and inevitable communication distractions of the performer.

In case of uncertainty because of entirely unknown or at least just partially known aspects Domain, Technology, Process and People, the total estimated efforts of the usual project phases have to be additionally upscaled.

Questions

? What variability does a good Estimation have?



There are potentially many **Non-Functional Requirements**. For any solution, one must therefore first determine the actual quantity of such Requirements. This quantity must be minimized by the Architect!

For every contractually stipulated Requirement, one should take into account that it is clearly defined since there are great similarities between Requirements and the differences are sometimes very subtle.

A few of the Non-Functional Requirements that almost always have to be considered in practice are **Maintainability, Usability, Security, Availability, Reliability, Performance, Responsiveness and Adaptability.**

Questions

- 🔍 Name 3 in practice frequently considered **Non-Functional Requirements**!