

Gap Finder: User Guide

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1 Introduction

Gap Finder is a SPI (software process improvement) method that supports development teams in improving on the integration and alignment of RE and Testing (RET). The method focuses on assessing and improving the softer aspects of the software processes. Experiences and results from applying Gap Finder in a case study can be found in Bjarnason (2013a).

This document provides a description of the Gap Finder (in Section 2), guidelines (in Section 1-5) for applying the method and generic survey templates (in Appendix). Further Gap Finder material including case-specific survey examples are available on-line (Bjarnason 2013c).

2 The Gap Finder Method

Gap Finder enables assessing a development project by measuring a set of *RE distances* and identifying relevant *RET improvement practices*. These practices can bridge or decrease troublesome distances, i.e. gaps, and can thus support improved alignment between requirements and testing (RET). The distance measurements obtained using the Gap Finder provide an *iRE profile* (integrated RE profile) of the current level of RET integration for a project. This profile and the identified improvement practices are presented to the assessed project team at a *gap workshop*. This workshop has the dual purpose of validating the output of the Gap Finder and agreeing with the team on which improvement practices to implement.

The Gap Finder contains a generic measurement instrument that needs to be tailored before applying it to a specific case. The measurement instrument is then specialised to the specific roles and artefacts involved in the requirements and testing activities for that case. This requires knowledge of the current process and the case.

The Gap Finder also contains a theoretical framework called the *Gap Model* (Chapter 1 of Bjarnason 2013a) that acts as a knowledge base. The Gap Model contains relationships between distances and RET alignment practices. This framework is used in the analysis of the measured distances, called *gap analysis*, to identify relevant improvement practices. These practices are identified by comparing the distances found in the obtained iRE profile with the Gap Model and extracting RET practices known to bridge or decrease troublesome distances.

The main steps of applying the Gap Finder are described in Section 1.1 while the generic measurements are outlined in Section 1.2.

1.1 The Four Main Steps of the Method

Applying Gap Finder to a specific case involves four main steps: (I) *preparations*, (II) *measuring*, (III) *gap*

analysis and (IV) *gap workshop*. After preparing and tailoring the method for the specific case (step I) the distances can be measured (step II). These measurements are then analysed to identify gaps and potential improvement practices (step III). The outcome of this gap analysis is presented at a gap workshop (step IV) and a set of practices are agreed upon. These practices are then implemented (after step IV) and the project is re-assessed by iterating from step II. An overview of the steps involved in applying the Gap Finder is shown in Figure 2.

1.1.1 Step I: Preparations

For successful application of Gap Finder, the scope, extent and timeframe of the assessment needs to be prepared and planned in agreement with the host organisation in which the assessment is to take place. In addition, the Gap Finder measurement instrument needs to be tailored and adapted to the processes of the assessed project. Both of these activities require insight into the processes and practices of the organisation. The method may be applied by someone with this knowledge, e.g. a process engineer. Otherwise initial investigations are needed to obtain this knowledge. In particular, knowledge of roles and artefacts involved in the requirements and testing processes and how these interact and interrelate is needed.

The tailoring entails adapting the measurement instrument (see Section 1.2) by configuring it for the exact roles and artefacts applicable to the specific case. For example, if developers are involved in detailing requirements their role needs to be included in the assessment as part of the set of roles involved in requirements activities. This entails tailoring the measurement instrument to include their technical skills as developers in the measurement of cognitive distance. For this example, the measurement instrument needs to be extended with an additional measure to cover this technical skill (design and development) and a survey question added for this. Further guidelines for tailoring the method is found in Section 1.

The output of the preparation step is a measurement instrument adapted to the specific case, and an agreement concerning the project and time period for which to perform the assessment.

1.1.2 Step II: Measuring Distances

Gap Finder's measurement instrument consists of three surveys: profile, communication and artefact survey. The profile and communication surveys contain questions concerning the project members, while the artefact survey investigates distances for specific requirements. Templates for the survey are available on-line (Bjarnason 2013c) together with examples of the surveys as tailored to a specific case.

The surveys are administered to the roles involved in the requirements and testing activities. The first

time Gap Finder is applied to an organisation, it is recommended to use interviews for the surveys. This will allow the participant to ask for clarifications, which can enable a more uniform understanding of the questions and of the scales used to answer them. In addition, the interviewer can ask follow-up questions and thereby obtain a richer picture of potential issues and reasons for them. This is particularly important when the interviewer is not intimately acquainted with the project.

1.1.3 Step III: Gap Analysis

When the results of the distant measurements have been collated into the iRE profile this can be analysed to identify gaps. Where the project displays potentially troublesome gaps the Gap Model is consulted. The model provides information on practices that can address these types of distance. Through analysis and comparison of the distances found in the iRE profile against the information in the Gap Model a set of improvement practices are identified. This analysis is further supported by any additional knowledge about the specific case, e.g. contextual factors such as project size, development model, specific practices applied.

The output of the gap analysis consists of a set of improvement practices that may address the gaps identified in the iRE profile. Guidelines for performing the gap analysis is found in Section 4 and for visualising the iRE profile is found in Section 5.

1.1.4 Step IV: Gap Workshop

The visualised iRE profile and the improvement suggestions are presented to the assessed project team at a gap workshop. For each distance type, the relevant parts of the iRE profile including the gaps are shown and improvement practices presented. The project members are encouraged to share their observations of potential issues caused by the identified gaps and if and how the suggested practices may address them. This allows for a validation of the gaps and practices identified through applying Gap Finder. Furthermore, it includes the project members in the decisions regarding which improvements to implement thereby increasing the probability of successfully implementing the new practices.

1.1.5 After Step IV: Implement Practices and Iterate from Step II

After having implemented the agreed practices, the situation is re-assessed by iterating from step II. The distances are re-measured (step II) and another gap analysis (step III) is performed. In this gap analysis, the original and the new iRE profiles are compared to assess if the previous gaps have been reduced and/or that the effects of them have been minimised by the implemented practices. Additional or different improvement practices may be uncovered through analysis of the new iRE profile. These are then reviewed and discussed with the project team at another gap workshop (step IV). At this session a

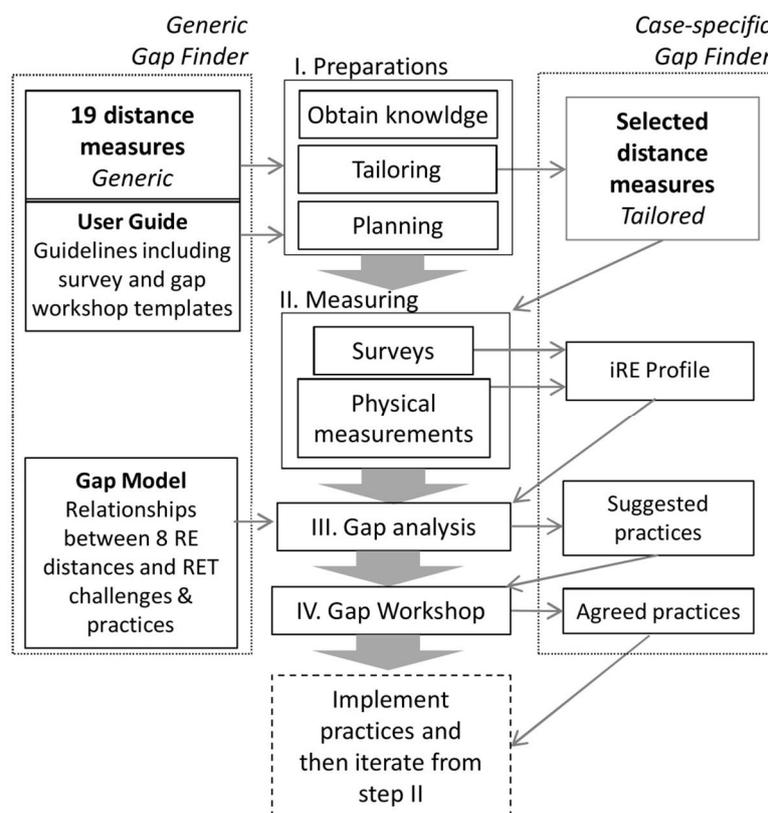


Figure 2. An overview of the Gap Finder method (generic and case-specific parts) and the four steps of method application.

decision is made as to whether or not the SPI effort is completed, and if not the Gap Finder is re-iterated again from step II.

1.2 The Gap Finder Measurement Instruments

The Gap Finder measurement instrument used for assessing a project contains eighteen measurements (see Table 1). These cover the eight RE distances of the Gap Model (chapter 1 of Bjarnason 2013a) namely (D1) geographical, (D2) organisational, (D3) psychological, (D4) cognitive, (D5) adherence, (D6) semantic, (D7) navigational and (D8) temporal.

These measurements are applied to artefacts and people involved in the requirements and testing activities. While some distances are straight forward to assess, others are estimated through surveys with self-rating questions. For example, geographical distance (D1) is assessed by measuring the physical distance to walk between desks, while psychological distance (D3) is measured through a survey question asking each team member to rate the distance towards each other member of the team.

A majority of the distances are complex and contain several aspects. For these distances there is one measurement per aspect and, thus, several measurements per distance. For example, for cognitive distance (D4) five aspects are measured: one aspect of prioritisation of quality aspects for the system, and three aspects of different types of knowledge specifically domain, technical skill, organisation and process.

Most of the survey questions have Likert-type scales with five options for the respondent to choose between. For example, for psychological distance (D3, M3.1) the respondents were asked to rate how hard it was to communicate with colleague *n* by noting 1-5 for *Not hard (1)*, *Some effort required (2)*, *Medium effort (3)*, *Much effort (4)*, *Extremely hard (5)*. Similarly, for the knowledge aspects of cognitive distance (M4.1-M4.3) the respondents were asked to grade their own competence using Benner's (1982) five levels of experience, i.e. *Novice (1)*, *Advanced beginner (2)*, *Competent (3)*, *Proficient (4)* and *Expert (5)*. The cognitive distance between two people was then measured by calculating the difference between their levels of competence. For the artefact survey, the aspects abstraction (M5.2.3, M6.3) and coverage (M5.1.2, M5.2.2, M6.2) are directional, i.e. the abstraction level of artefact A may be higher or lower than artefact B. For these questions the following scale was used: *Much more*, *Somewhat more*, *The same*, *Somewhat less*, *Much less*, and *Can't say*.

The aspect of priority for cognitive distance (M4.4) was assessed with a survey question on the relative priority of the quality characteristics specified in ISO/IEC 9126-1. The respondent was asked to distribute 30 *resources* over the six quality

characteristics. The distance between two people was then assessed by calculating the Cartesian distance between their responses.

The distance for the measured aspects can be calculated in various ways either individually per measurement or combined to a total distance for the whole project. For example, the average value for one aspect of distance between each pair of team members can be considered, or the distance between the minimum and the maximum value. The total distance for a distance type for which multiple aspects are measured can be obtained by calculating the Cartesian distance between the multi-dimensional data points for each participant.

3 Case-Specific Tailoring

The Gap Finder measurements need to be tailored and adapted to the specific organisation and processes each time the method is applied to a new case. The factors impacting the measurement instrument are outlined in Table 1. The following information about the case is needed to perform the tailoring:

- **Relevant roles**, i.e. the roles involved in the requirements engineering (RE) and testing processes. For RE, this could include a requirements analyst, but also customers, project managers, developers etc. that are actively involved in eliciting, specifying and detailing requirements. The same applies to testing roles. Note that the relevant set of roles is to be defined by how the requirements and testing work is (actually) performed in the case organisation. This may differ from the formal process.
- **Relevant artefacts** used in the RE and testing process. For example, business goals, requirements specifications, user stories, test cases etc.

The set of roles and artefacts that are 'relevant' is affected by the extent and focus of the assessment. Decisions need to be made to define this. For example, should the alignment of RET throughout the whole life cycle from product initiation to product maintenance be covered? Or, should only part of the life cycle be investigated, e.g. from the design to the function testing. Should an entire software system be assessed or a sub-system? For a wide and general assessment the set of roles and artefacts can be expected to be larger, but may also be limited to key roles and artefacts.

Apart from impact on the measurement instrument, the planning of the assessment is affected as additional roles are identified as relevant. For each included role and artefact, agreement for involving these in the assessment need to be obtained from the relevant management. For example, for people to participate in surveys, access to artefacts etc.

Table 1. Overview of measurements (M1-M8) per distance (D1-D8, see Section 1.2) and impacting case characteristics.

<i>Measurement</i>		<i>Distance</i>	<i>Aspect</i>	<i>Factors impacting instrument tailoring</i>	<i>Survey</i>
M1	Physical distance between desks	D1	Physical	Office layout	Profile survey
M2	Length of path in line organisational tree between two people	D2	Home unit in line organisation	Case organisation	
M3.1	Perceived effort to communicate with another person	D3	Uni-directional	People in all relevant roles	Comm survey
M3.2	Perceived effort to communicate between two people		Bi-directional		
M4.1	Difference between people's knowledge of system domain	D4	Domain knowledge	Software system names	Profile survey
M4.2	Differences in competence within technical areas affecting requirements and testing alignment		Technical skill	Key competence areas for RE and Testing roles	
M4.3	Differences in knowledge of project and organisation including processes		Process and organisation	Organisation name	
M4.4	Differences in prioritisation around product		Priorities	-	
M5.1.1	Difference between product actual and agreed product behaviour	D5.1: Delivered vs agreed reqs	Similarity	Used requirements artefacts	Artefact survey
M5.1.2	Difference in coverage between actual and agreed product behaviour		Coverage		
M5.2.1	Difference in meaning between documented vs agreed requirements	D5.2: Agreed vs documntd reqs	Similarity		
M5.2.2	Degree of coverage between documented vs agreed requirements		Coverage		
M5.2.3	Difference in abstraction level between documented vs agreed requirements		Abstraction		
M6.1	Difference in meaning between requirements and testing artefacts	D6: Reqs vs test cases	Similarity		
M6.2	Degree of coverage between requirements and testing artefacts		Coverage		
M6.3	Difference in abstraction level between requirements and testing artefacts		Abstraction		
M7.1	Number of clicks to navigate from a requirement to the test cases which verifies it	D7	Req to Test cases	Artefact storage solution	
M7.2	Number of clicks to navigate from a test case to the requirement(s) that is verifies		Test case to Reqs		
M8	Length of time between specifying a requirement and defining a test case for verifying it	D8	Reqs – Test case definition		

3.1 Tailoring the Measurements

All three survey templates need to be adapted to the specific case context. In addition to tailoring the measurements to match the specific roles and artefacts, the survey questions need to be adapted to refer to case-specific terminology. This will reduce misunderstandings and support a more consistent understanding of the questions by the survey participants.

3.1.1 The Profile Survey

The set of competence areas covered by the relevant roles affect measurement M4.3 of cognitive distance. For each competence area a sub-question needs to be defined. For example, if the relevant roles are limited to requirements engineer and tester questions 2a and 2b are defined to enquired about experience of RE and of testing. If in addition developers are involved n detailing requirements question 2c needs to be defined to assess the level of competence in Design & Development.

The measuring of geographical distance, i.e. question 6, requires the use of an overview of the office location, e.g. a campus map.

For the following questions the terminology needs to be adapted to the one used for the specific case:

- 1a, 1b: name of the system under development
- 3a, 3b, 3d, 5: name of case organisation
- 4: name of development project

3.1.2 The Communication Survey

The time period which the survey aims at covering needs to be formulated in questions 1 and 2. In addition, the response options for communication frequency (question 1a) need to be adapted to this.

The current requirements for the selected time period and terminology for theses need to be expressed in question 1c.

Question 2 needs to be tailored to contain the names of relevant people, e.g. team members, or people in key roles.

3.1.3 The Artefact Survey

Specific requirements and test cases need to be selected for all the questions of the artefact survey. These requirements should have completed the part of the life cycle which is in scope for the Gap Finder application. For example, if RET alignment within a development team is to be covered the requirements referred to in the survey should have been implemented and tested by the team.

All questions also need to be adapted to the terminology used to denote *requirements* and *test cases*, e.g. user story or system requirement.

3.2 Keeping the Measurement Instrument Updated

As practices, roles and terminology change for a case the measurement instrument may need to be updated to reflect this. Thus, each time Gap Finder is to be reapplied the tailored measurement instrument needs be revised to ensure that it is up to date and reflects the current set of roles, artefacts and terminology.

4 Gap Analysis: Identifying Improvement Practices

The set of distances within an iRE profile can be compared to the existing knowledge of distances found in the Gap Model (see Chapter 1 of Bjarnason 2013a), thereby identifying improvement practices that may address gaps within a project. For example, if a large organisational distance is seen in the iRE profile the Gap Model, based on empirical knowledge, suggests 14 different practices for mitigating this gap. This large set can be whittled down to a more manageable number of practices by a combination of matching the sets proposed by Gap Model for each identified gap and considering the suitability including cost of each practice for the assessed development organisation. The aim is to identify a small set of practices that can address all the identified gaps and that are a good match for the organisation at hand.

5 Visualising the iRE Profile

A project's integrated RE profile for testing, or *iRE profile*, provides a view of the project's current level of RET integration. The iRE profile is produced by collating the measurements for each distance. For example, the cognitive and psychological distances between the roles responsible for requirements and testing are included in the iRE profile.

The range and average value for each type of distance can be presented as part of the project's iRE profile. For measurements with the same scale, or scales that can be normalised, the various aspects and distances can be visualised together in a radar diagram, see example in Figure 3. In order to avoid the limitations of this type of visualisation, the ordering of the axes needs to be considered and kept consistent, in particularly when comparing diagrams over time.

The iRE profile is used as input to the gap analysis (step III) and to the gap workshop (step IV). When analysing the iRE profile individual distances between project members and roles may need to be considered to identify distances that need addressing. Similarly upon re-assessing a project, the two versions of the iRE profile can be compared to assess the effect of the implemented practices.

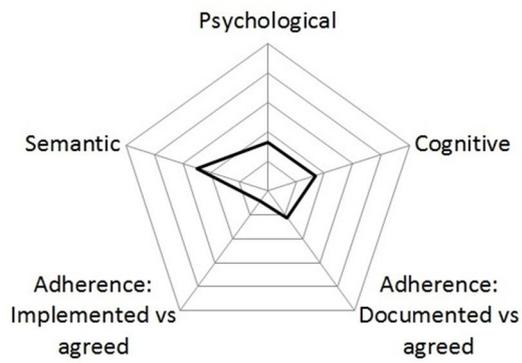


Figure 3. A radar diagram visualising part of an iRE profile of the assessed project.

References

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- Bjarnason E (2013c) Gap Finder material including measurement instrument, interview guide etc. (latest access: 2013-11-13) http://serg.cs.lth.se/research/experiment_packages/GapFinder/

APPENDIX: Survey Templates

Generic Profile Survey

Q#	Question	Scale	Distance		
			Type	M#	Measurement area
1a	How long have you been exposed to the system under development?	years, months	NA (Background info)		
1b	How familiar are you with the system under development, e.g. its users, usage and functionality?	none + [Benner] Novice, Advanced beginner, Competent, Proficient, Expert	Cognitive (D4)	M4.1	Domain knowledge
2	How would you rate your knowledge and experience of [Tech area for RE or Testing] ?	None + [Benner] Novice, Advanced beginner, Competent, Proficient, Expert	Cognitive (D4)	M4.2	Tech skill
3a	How long have you worked with [Development] at [Company/Organisation]?	years, months	NA (Background info)		
	How familiar/experienced are you with [Company/Organisation] work process & practices for your role?	None + [Benner] Novice, Advanced beginner, Competent, Proficient, Expert	Cognitive (D4)	M4.3	Process- & Organisational knowledge
3b	What connections to your work/role are there, e.g. who/what feeds into your work?	Free text	Cognitive (D4)	M4.3	Process- & Organisational knowledge
3c	For these areas (see 3c), how familiar are you with [Company/Organisation] work process & practices for these activities?	None + [Benner] Novice, Advanced beginner, Competent, Proficient, Expert	Cognitive (D4)	M4.3	Process- & Organisational knowledge
3d	For the software developed by [Dev project], how would you prioritise between the following: functionality, reliability, usability, efficiency, maintainability, portability [ISO].	Divide 100 points over the characteristics according to priority, e.g. if all that matters is usability place 100 on that and 0 on all others, if all are equally important place 100/6 on each.			
4	Which part of the [Company/Organisation] do you work for (who is your line manager)?	Free text	Cognitive (D4)	M4.4	Priorities
5			Organisational (D2)	M2	Line organisation
6	Where is your desk located?	Position on [Company/Organisation] site map	Geographical (D1)	M1	Physical location

Generic Communication Survey

Q#	Question	Scale	Distance	
			Type	M# Measurement area
1	For each person that you communicated with [time period] provide details of interaction.			
1a	Communication frequency	[Custom values]		
1b	Natur of interaction	Communication of changes, Coordination of activities, Requirements clarification, Requirements negotiation, Test design, Issues / Bugs, Other		NA (Background info)
1c	Concerning requirement	[relevant req id]		
2	For each person that you communicated with [time period] answer the following			
2a	How long have you worked together?	years + months		NA (Background info)
	How hard is it for you to communicate and reach understanding with this person?	1 = Not hard, 2 = Some effort required, 3 = Medium effort, 4 = Much effort, 5 = Extremely hard		
2b			Psychological (D3)	M3.1 Uni-directional

Generic Artefact Survey

Q#	Question	Scale	Reference	
			Distance	Measurement
	Q1. For the documented [Req entity] nr x relative the the agreed requirements (as you understand them).			
1a	The documented reqs express ... meaning as the agreed requirements.	Exactly the same, Almost the same, Roughly the same, Somewhat similar, Very different n times more / less OR Much more, Somewhat more, The same, Somewhat less, Much less	Adherence (D5.2)	M5.2.1
1b	The documented reqs specify ... level of details than the agreed requirements.	n times more / less OR Much more, Somewhat more, The same, Somewhat less, Much less	Adherence (D5.2)	M5.2.2
1c	The documented reqs cover ... content than the agreed requirements.	n times more / less OR Much more, Somewhat more, The same, Somewhat less, Much less	Adherence (D5.2)	M5.2.3
	Q2. For [Req entity] nr x, the relationship between the implemented behaviour and the agreed requirements.			
2a	The implemented behaviour is ... (similar in meaning) to the agreed requirements.	Exactly the same, Almost the same, Roughly the same, Somewhat similar, Very different n times more / less OR Much more, Somewhat more, The same, Somewhat less, Much less	Adherence (D5.1)	M5.1.1
2b	The implemented behaviour covers ... content than the agreed requirements.	Exactly the same, Almost the same, Roughly the same, Somewhat similar, Very different n times more / less OR Much more, Somewhat more, The same, Somewhat less, Much less	Adherence (D5.1)	M5.1.2
	Q3. For the documented requirements.			
1a	The TCs express ... meaning as the documented requirements.	Exactly the same, Almost the same, Roughly the same, Somewhat similar, Very different n times more / less OR Much more, Somewhat more, The same, Somewhat less, Much less	Semantic (D6)	M6.1
1b	The TCs contain ... level of detail than the documented requirements.	Exactly the same, Almost the same, Roughly the same, Somewhat similar, Very different n times more / less OR Much more, Somewhat more, The same, Somewhat less, Much less	Semantic (D6)	M6.2
1c	The TCs cover ... content than the documented requirements.	Exactly the same, Almost the same, Roughly the same, Somewhat similar, Very different n times more / less OR Much more, Somewhat more, The same, Somewhat less, Much less	Semantic (D6)	M6.3
	Q4. For the documented req [Req entity nr x] and the test cases which verify it [test case nr a..b]			
4a	How many clicks does it take to navigate from the requirement to the test cases that verify it?	n clicks	Navigational (D7)	M7.1
4b	How many clicks does it take to navigate from the test cases to the requirement that it verifies?	n clicks	Navigational (D7)	M7.2
	Q5. For [Req entity] nr x and test case nr y that verifies it			
5	How long time after specifying the requirement was the test case defined?	m days	Temporal (D8)	M8