Assessing Requirements Process Strengths and Weaknesses: A first step to prioritising requirements process implementation

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Technical Report No: 381

Department of Computer Science
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July 2003

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We have created a software process improvement model that focuses on the requirements phase of software development. Our model takes the maturity characteristics from the SEI's Software Capability Maturity Model (SW-CMM) to help guide practitioners in their requirements activities. However, although our RE CMM (R-CMM) compliments the SW-CMM, we consider that an independent self-contained method for assessing requirements strengths and weaknesses is essential. The report combines a rationale for using an independent assessment method together with an implementation guide. This specialised assessment is designed to raise the profile of requirements within the software development quagmire. The assessment method will highlight where requirements need help in both their organisational and technical processes. The approach we propose is adapted from a tried and tested assessment method developed by a high maturity company (Daskalantonakis 1994).

In this report we explain how the assessment method can be tailored to meet individual company needs through a detailed example. The transparency offered by the assessment will help to empower practitioners to influence the state of the requirements process. Once software process improvement managers have a clear idea of the practices involved in requirements engineering they will be better placed to set realistic goals for their improvement.

This Technical Report forms part of a wider study that explains the many stages involved in building a specialised software improvement model that focuses on the requirements process.

1 Introduction

Current software process improvement (SPI) methods do not appear to be reaching practitioners in their requirements engineering activities (Hall et al. 2002; Beecham et al. 2003e). A European survey aimed at highlighting problematic areas in software development found that requirement specification and managing customer requirements were causing the greatest difficulties (Ibanez and Rempp 1996). Though assessment of processes and improvement of processes would appear to be two sides of the same coin, this survey covering 17 European countries and 3,401 responses observes that:

> "when companies reported that they are improving their software processes, less than 15% of the total are applying software assessment methods."(Ibanez and Rempp 1996)

As software process improvement is of course based on software process assessment it would appear that companies need to be guided towards using assessment methods as an integral part of process improvement (Hunter and Thayer 2001). Our Requirements Capability Maturity Model (R-CMM[1])

[1] ®CMM is registered in the U.S. Patent and Trademark Office. Accuracy and interpretation of this document are the responsibility of the University of Hertfordshire, Centre for Empirical Software Process Research. Carnegie Mellon University has not participated in this publication.

includes assessment within its improvement paradigm (Beecham et al. 2003c; Beecham et al. 2003a; Beecham et al. 2003f). The R-CMM guides users into good practise by prioritising requirements activities through its maturity framework. Its adherence to the SW-CMM should provide a clear path to software integrated requirements process improvement (see Figure 1).

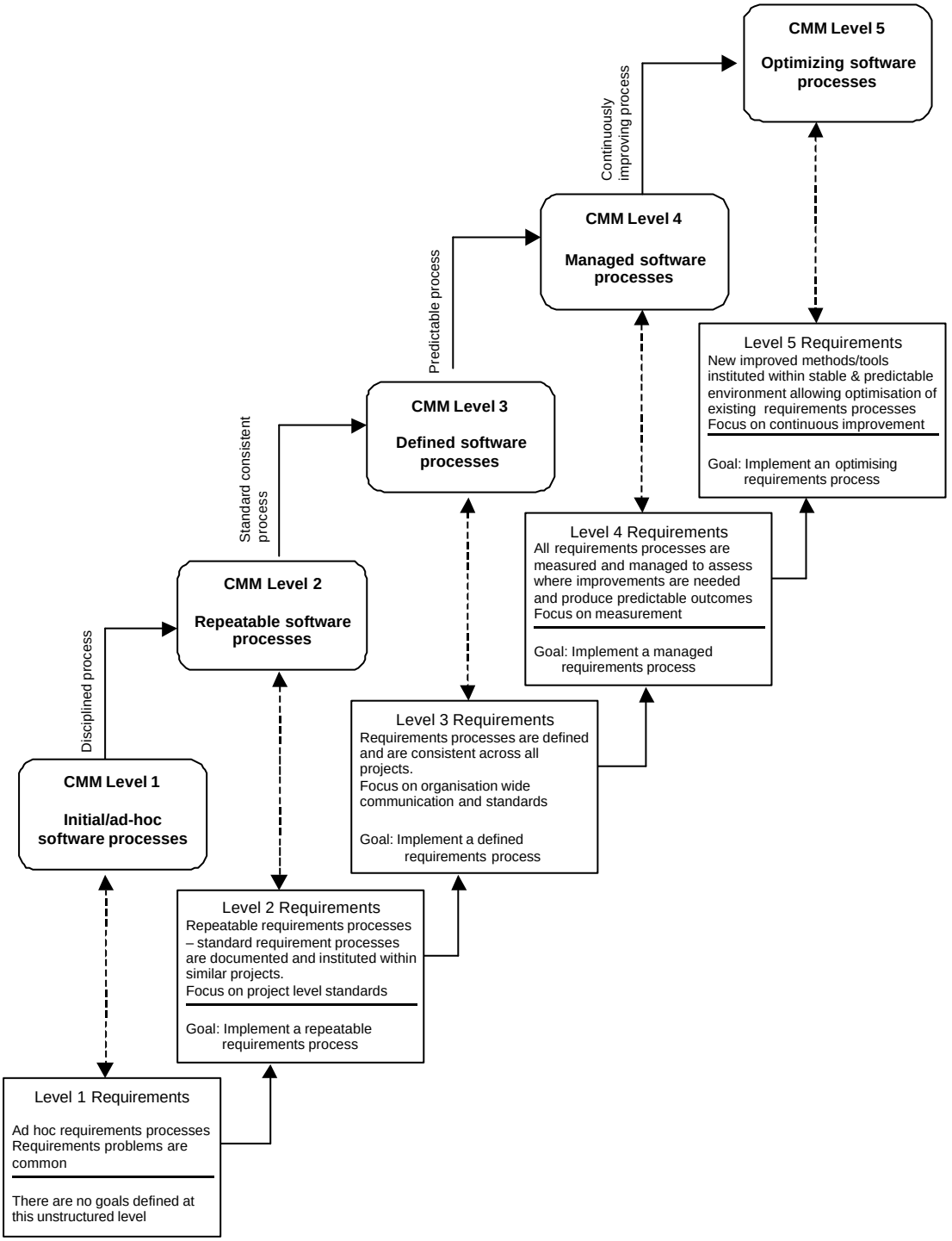

Figure 1: The R-CMM as derived from the SW CMM

Assessment depends on a clear understanding of the processes that underpin the requirements stage of software engineering. The R-CMM presents processes that are key to producing a complete specification of the requirements functions and performance characteristics of the software (Conte et al. 1986). These processes are both technical (i.e. visible tasks directly involved in the production of

the requirements specification) and organisational (i.e. supportive and less visible). The organisational processes include activities related to resource allocation and methods of communication that are integral to the requirements phase (Hall et al. 2002; Beecham et al. 2003e; Beecham et al. 2003b; Beecham et al. 2003d). Providing this framework allows SPI managers to assess where they need to strengthen their requirements process and can assist in process implementation prioritisation decisions.

The R-CMM focuses on a limited set of key requirements activities to include requirements process definitions and requirements assessment (Beecham et al. 2003b; Beecham et al. 2003d; Beecham et al. In review). Requirements processes are integrated with related software activities through their adherence to the SW-CMM (Paulk et al. 1995). The R-CMM places requirements best practices in a framework to help identify possible areas for improvement. A practical way to improve processes is to identify weaknesses through a structured assessment. In a systematic survey of CMM experience and results, Herbsleb and Goldenson (1996) found that 90% of companies said SPI effort was directed by the outcome of CMM assessment. The experience of the sample used by Herbseb and Goldenson appears very different to the findings of the European survey where very few companies were using assessment to guide the improvement activities (Ibanez and Rempp 1996).

The R-CMM guides companies to set goals to achieve higher levels of requirements process capability. Having set these improvement goals, a company then needs to monitor and measure the status of each of these goals. Indeed, there is clear evidence that processes can be measured (Pfleeger and Rombach 1994). However, as there is no consensus as to the best way to proceed, we adapt a method developed by Motorola for assessing the current status of processes (Daskalantonakis 1994). This assessment method is tried and tested and allows engineers and managers to evaluate requirements processes in a structured and transparent way. It emulates the SW CMM concept of measuring levels of process capability through a checklist. This checklist is a methodological way to measure the degree to which a recommended process is present in an organisation and how useful it is to the organisation. It is a straightforward means of gauging process maturity between projects and departments (Peters and Pedrycz 2000). This checklist approach is also an established way to prompt for issues (Conte et al. 1986).

In this report we present a method for measuring the strength of a requirements process within an organisation. Model development themes, as shown in Figure 2, are covered in depth to allow researchers to build on our work, to emulate or amend the strategies presented and apply the R-CMM as an aid to process improvement. The details given in this report will also help practitioners and researchers to gain a deeper understanding the requirements process and process evaluation.

2 Requirements Process Assessment in context with R-CMM development

Model development is initiated by outlining the structure for the specialised software process improvement model that is based on the SW CMM (Beecham et al. 2003b). We develop this theme by defining how the R-CMM is populated with key requirements processes and guidelines (Beecham et al. 2003d). This structure ensures that current processes are identified and defined as part of an improvement assessment. Defining processes needs to be built into software development as it is not a natural activity, as (Thomas and McGarry 1994) point out, 4 out of 5 software-development groups have nothing that can be recognised as a software process. They continue, “processes are like programs – you must get the specification and design right before you start worrying about optimisation”. The R-CMM therefore guides companies towards defining their own processes prior to implementing new methods, as “if you don’t know where you are, a map won’t help” (SEI 1996).

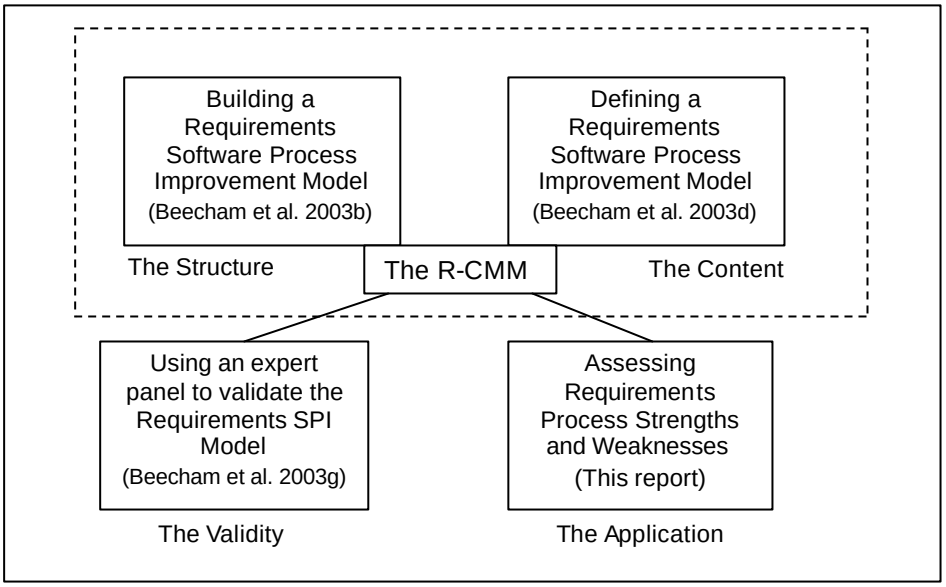

Figure2: Requirements Assessment in context with related R-CMM Development

Figure 2 shows the four areas covered in our development of the R-CMM. Many models are built to support software improvement but fail to assess its worth or report how the model works in practice. The reason for this omission is likely to be that "building models is relatively easy – empirically validating them in the real world is hard" (Christie 1999). Indeed, the increasing use of models as aids to resolving problems has encouraged a parallel effort in developing and applying methodologies for model validation (Gass 1983).Therefore, to add rigour to our model and increase confidence in its use, we planned to validate the model from the outset by setting criteria for success against which to test the model as detailed in (Beecham et al. 2003a). We report the findings of this study in (Beecham et al. 2003g). The validation, involving a group of experts in the fields of requirements and software process improvement, proved useful in highlighting where our model can be improved and guides future model development. Part of the validation involved the experts looking at this assessment method which is a component of the overall model. Having developed a model (that although in need of improvement), appears to reflect the needs of some development companies, the assessment method we now present will help to establish how useful the model is in practice. A perceived weakness of the model is that the assessment component presented to our group of experts required further examples and definitions in order to be applied. To counter the weakness we produce a detailed example of how to use the assessment to measure a requirements process.

3 Purpose of the Assessment

The idea of process assessment is not unique to software and is derived from Shewarts "Plan Do Check Act' cycle developed in the 1930s (Shewart 1981) and Juran's four steps to quality improvement (Juran 1981), Demming's approach to continuous improvement (Deming 1982) and Crosby's TQM 5 staged-maturity approach (Crosby 1979). The SW CMM, on which we base our model, takes many of its characteristics from these works. There are several forms of process assessment, ranging from a full formal organizational appraisal based on the SW CMM (or other improvement framework), to working in small groups with a simple facilitated brainstorming session (Wiegers 1998). This section explains how we opt for a scalable assessment method that is specific to stakeholders involved in requirements. We show the purpose of the R-CMM assessment and review the suitability of other assessment and appraisal methods.

3.1 Software Process assessment and Software Capability evaluation

According to Paulk (1997), there are two general classes of process appraisal; the software process assessment (SPA) and the software capability evaluation (SCE). SCEs are conducted by an external organisation to evaluate the organisation's conformance to the SW CMM for awarding and monitoring contracts. Since the R-CMM is designed to be a part of the SW CMM, this form of evaluation does not apply to the requirements process alone, and does not form a part of R-CMM assessment. Also, although a high requirements capability is an indication of a qualified software company, it is only one aspect of software development, and cannot be viewed in isolation when monitoring the state of the whole of the software process.

The purpose of an R-CMM assessment is to determine the state of an organisation's current requirements process in order to support internal process improvement activities. Results are used to identify high priority requirements process related issues facing an organisation and to obtain organisational support for requirements process improvement. The R-CMM form of assessment therefore in more in line with a SPA that helps developers in their process improvement activities by focussing on strengths and weaknesses with respect to the model guidelines. According to Baumert (1994) the benefit in this form of assessment is that it is introspective and confidential and encourages participants to paint an accurate picture of an organization's process.

However a weakness of formal SPAs is that they occur too infrequently to track progress, and findings are often kept at an organisational level and are not fed back to the individual projects that "contribute information that makes up the composite" (Baumert 1994). The R-CMM takes an internal audit approach where a flexible mini requirements process assessment can be applied directly and frequently to a wide variety of groups and projects. This internal assessment structure supports companies with their software operations in the following ways:

- Assessment teams can identify requirements strengths and weaknesses in the organisation
- Assessment teams can monitor changes in the requirements process over time and give regular feed back improvements made directly to those responsible
- Assessment teams can monitor changes in the requirements process over time and give regular feed back processes in need of further improvement directly to those responsible
- Evaluation teams can isolate which particular requirements process is having a negative effect on software development
- Quality Management team can prioritise their process improvement plans
- Technical staff, e.g. designers, coders, testers, can will have greater confidence in the delivered requirements specification (i.e. understanding weaknesses is likely to lead to fewer requirements defects)
- Upper management can use the assessment to understand the requirements activities and allocate the resources necessary to launch a requirements process improvement initiative
- Developers can use the assessment to investigate alternative improvement methods to meet specific needs

These purposes include and supplement the SW CMM approach to assessment in Paulk et al (1995). The R-CMM assessment method appraises software processes as characterised by the SW CMM to include measuring goals, commitment to perform; ability to perform; activities performed; measurement and analysis; and verifying implementation. Results of this assessment indicate:

1. The strength of individual processes (at various levels of granularity)
2. The strength of each requirements phase (i.e., management, elicitation, analysis, documentation, validation), that incorporate groups of processes.
3. The strength of the whole of the requirements process to include technical and organisational requirements related processes.

This analysis gives a visibility into how individual processes translate themselves into weakening or strengthening the higher level requirements phases, which in turn represent the requirements process (see Figure 3). The aims of the R CMM assessment are similar to those in the SEI model (SEI 1996) where data gathering is designed to provide managers and practitioners with insight into the organization's software practices.

3.2 SEI Assessment regulations

The regulations enforced by the SEI (Masters 1995) that relate to the validity of assessments are not imposed on the requirements assessment. This is because the requirements assessment is used as an indication of process maturity and is not a formal test. Some of the SEI stipulations are included here as some recommended best practices apply to internal assessments (we have excluded formal external compliance related practices).

- All the organization's assessment team members have the necessary training and skills to perform the required functions.
- A (Yu and Mylopoulos 1997) authorized lead assessor leads the assessment.
- An assessment plan must be created.
- Observations must sufficiently cover the R CMM components.
- The assessment participants must review the draft findings.
- Ratings must be based on the processes actually implemented and practiced.
- An organization doesn't have to implement practices as described in the guidelines to satisfy the intent of the reference model – alternatives are acceptable provided that they support the key process goals.
- Two types of risks should be considered by appraisal method users: risk inherent in the method chosen to be performed, and risks based on the appropriate execution of that method.

(Masters 1995)

The R-CMM adds

- The assessment participants must represent a cross section of practitioners involved in Requirements engineering

4 Structure of Requirements based process assessment

Figure 3 shows how individual process scores are combined to create a capability maturity level for the five requirements phases. For example if 'skills allocation' or 'use of appropriate tools' processes are mismanaged they are likely to impact the Elicitation, Negotiation and Analysis, Documentation and Validation phases in requirements. This phased view of requirements supports the management, analysis, application and interpretation of processes.

Figure 3 shows how an individual process is measured and contributes towards creating high quality requirements. Defining the type and level of quality required from the requirements phase is left to individual companies. This is because company goals are likely to reflect individual company needs. For example, one company may define high quality requirements as defect free as they develop safety critical software. While another company may be driven by cost, and will define high quality requirements as a specification that meets customer's needs within a specified budget. However, successful implementation of the candidate processes in the R-CMM creates a strong foundation that allows companies to meet their individual quality goals. Each individual process is descriptive allowing companies to tailor it to meet their individual needs. Each process is then subjected to an evaluation (through the generic evaluation questionnaire modelled in Figure 3), that results in a capability score. The resulting score highlights where their requirements process weaknesses lie.

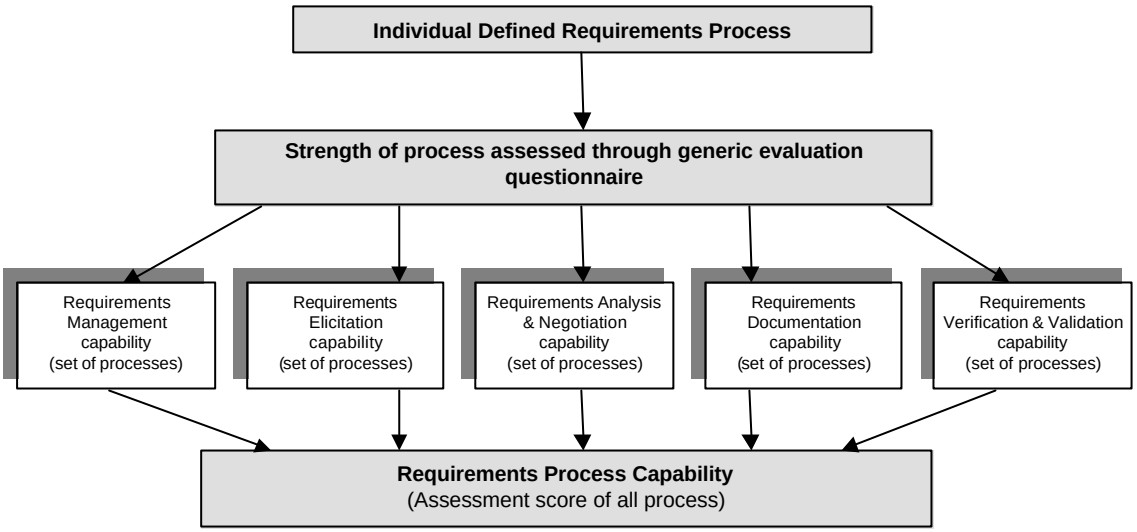

Figure 2: Stages in Requirements process assessment

4.1 The Evaluation Questionnaire

The generic evaluation questionnaire analyses the company's approach, deployment and application of the process. This scheme reflects the SW CMM focus on

- evaluating a company's commitment towards the practice
- assessing typical activities expected of the practice
- checking that metrics are taken of the process
- checking that metrics are evaluated

(Love and Siddiqi 2000)

Motorola (Daskalantonakis 1994) developed this form of assessment to track its progress in achieving a higher CMM level. Motorola felt that waiting 2 years between SEI formal assessment was too long and therefore created a method for internal, incremental assessment. This applied assessment method is therefore designed for internal use, which makes it a suitable tool for self-assessment of the requirements process.

5 Applying the Requirements Process Assessment

5.1 Assessors and participants

Assessment results are often dependent on the subjective interpretation of assessors and are not, therefore, reliable for long-term benchmarking and monitoring (Kauppinen et al. 2002). We take lessons learnt from this assessment study and create a systematic scheme that is an internal assessment based on the sound judgement of those who are using the process. The R-CMM assessment questionnaire is detailed enough to include all essential areas and the results of the assessment should give a realistic account of the current state of the requirements process. In line with SEI advice, the R-CMM advocates that when determining who should fill out the questionnaire, individuals are chosen who will provide answers that represent the entire project/organisation/requirements phase (SEI 1996). Choosing a representative cross section of requirements stakeholders should also ensure consistent results over time.

5.2 The stages involved in the R-CMM assessment

In Appendix A we give an example of how to apply the Motorola assessment method (Daskalantonakis 1994) to measure the strengths and weaknesses of individual requirements processes.

The activities involved in this assessment require the following steps:

Assessment Administrator:
1. Selects a group of stakeholders who have a required level of influence and involvement in requirements:

Individual stakeholders then fill in a questionnaire as follows:

2. Note individual process definition
3. Confirm a level of understanding of process
4. Complete a series of questions that relate to the company's:
   4.1 approach to the process
   4.2 deployment of the process
   4.3 results of deploying the process

The assessment administrator then

5. collects the questionnaire data
6. Analyses the questionnaire data
7. documents
   7.1 The strength of individual processes (individual score)
   7.2 The strength of the Management, Elicitation, Negotiation, Documentation, Verification phases (aggregate score)
   7.3 The strength of the Requirements process (aggregate score) .

The results of this assessment therefore allows SPI managers to gain a 'snap shot' idea of the strength of the requirements process at a given stage in development. If the requirements process appears weak, information will be available to allow the manager to view where the problems lie, by examining the requirements phases. For a more definite idea of where the problem, individual processes can then be viewed. Here the underling issues relating to approach, deployment and results can help pin point where improvements are needed. This transparency into the requirements process will aid decision making when considering areas in need of improvement.

This method will allow for comparison of requirements strengths within the same project over time, or will allow across project comparisons where sharing of best practices can be then encouraged.

5.1 Aggregate/composite measure

El Emam & Birk (2000) state that many empirical predictive validity studies use a composite measure of process capability. This composite measure is similar to Daskalantonakis (1994) method where the capability of individual processes are measured and then these individual measures are aggregated to produce an overall project or organizational measure. These composite scores, El Emam & Birk suggest, have the most value when used for supplier selection, but have a "weak utility in a process improvement context". As the requirements process assessment presented in this report is used for internal process improvement purposes there is limited use in aggregating the score to give a picture of how strong the requirement process is in a project. However, the level of detail made possible through the Motorola method allows software requirements process improvement managers to identify a) a weak process, and b) where the weakness lies i.e. in the approach, the deployment, or in the application as seen in the results section.

6 The Software Process Improvement Paradigm

This section places the requirements assessment in context with the software CMM maturity characteristics.

6.1 Linking scores to CMM Levels

Motorola is a high maturity company that focuses on the optimizing stage of process maturity having already implemented repeatable, organisational and measurable processes. Their model therefore includes higher level maturity characteristics that are not necessarily relevant to a company needing to establish baseline processes. However, their evaluation includes options for a assessing the capability of lower maturity level processes.

Motorola designed this evaluation for use with their SEI SW CMM formal assessment. They adjust their scores according to their previous SEI maturity rating. If a company is using this requirements process assessment with no previous process assessment history, the following can be used as a guide:

Process Score		Capability Maturity
0 → 2	=	Level 1
3 → 4	=	Level 2
5 → 6	=	Level 3
7 → 8	=	Level 4
9 → 10	=	Level 5

This assessment has not been tested and therefore is open to interpretation.

6.2 Changing the goal posts in process maturity – an evolutionary path

The assessment method spans maturity levels to give a less staged view of process maturity. A recognised limitation of the SW CMM version 1.1 is that it does not take into account the ability of different processes to exist at different maturity levels (Hather et al. 1996). An SEI working paper (Bramble and Stream 1995) explains some of the reasons why measuring software process maturity solely by the maturity level number (one through to five) is insufficient:

- An organization requires a progress indicator to show how it is progressing since the change from one level to the next may take upwards of 1 year.
- Organization's need to be motivated by successes. A progress indicator, which shows small incremental improvements as they occur, provides that motivation.
- A sufficiently granular scale for improvements would help an organization understand its rate of progress.

The SW-CMM therefore has had to evolve in line with change requests from projects such as BOOTSTRAP (Haase 1992) and SPICE (Dorling 1993). The new thinking is that processes will span maturity levels and the granularity of process ratings will be more detailed (El Emam and Madhavji 1999)(p.18). Case studies have found that "a 'continuous' view of the capability of each process area is more useful than the classic staged 'level' designation" (Pflugrad 2000). This integrated measurement of processes is demonstrated in the SEI's current improvement model, the CMMI (CMMI 2001), where the broader maturity categories are not so restrictive as the SW-CMM 5 levels (Stark 2003). The R-CMM form of scoring incorporates this continuous view of process improvement where process strength is measured across all 5 maturity levels.

NASA suggests an alternative view to maturity that follows the CMM concept and is also on an ordinal scale:

Level 1: reliance on the abilities of individuals
Level 2: reliance on project based processes
Level 3: reliance on organizationally defined processes
Level 4: quantifiably predictable processes
Level 5: continuously improving processes

(Stark 2003)

These different views of process maturity demonstrate how the CMM is evolving. The R-CMM incorporates the new thinking with its focus on controlling processes from within a maturity framework defined by SEI SW CMM principles.

6.3 Top-down/bottom up approach

There is an ongoing debate as to whether companies should take a top-down or a bottom up approach to process improvement, e.g. (Thomas and McGarry 1994). Quality improvement models such as ISO9001, Bootstrap and the SW CMM impose a top down view of improvement where universal practices are presented. Whereas according to Thomas and McGarry, companies need to take a 'bottom up' approach as an organisation's goal is 'product' improvement not 'process' improvement. The top down approach assumes the connection that an improved process will improve the product. However, unless a bottom up view is taken where products, goals, characteristics and local attributes of a software organisation are taken into account it is not possible to guide the evolutionary process changes.

This report views the assessment component of the R-CMM only. The assessment is similar to the SW CMM, where a top-down approach is used to measure given 'universal' requirements processes. However, viewing the R-CMM as a complete model as given in (Beecham et al. 2003b; Beecham et al. 2003d) a bottom up approach is also encouraged where companies are guided towards identifying processes that are of particular importance to a particular organisation, project or group. After all, the objective of this assessment exercise is to improve the requirements process in order to support the software process in developing high quality software. The top down method highlights areas of best practice that need improving, whereas the bottom up approach will determine how well individual process are helping to meet company improvement goals. Both methods are in line with SW CMM principles and highlight areas in need of immediate attention and improvement.

7 Conclusion

This report shows how the requirements process is measured to assess its strength in supporting the software process. The R-CMM provides a framework for the assessment of an organisation's ability to produce high quality requirements. The method used is an adaptation of Motorola's internal process evaluation scheme. The example given shows how an individual requirements process is measured and how one process impacts the whole of the requirements phase. The assessment is viewed from within a SW CMM maturity context.

The requirements process assessment is part of a requirements process framework that aims to provide guidance to practitioners in their improvement effort. The R-CMM focuses on the difficulties involved in this phase of software development through a series of requirements related questions. Requirements process improvement *is* a complex task that can be improved once weaknesses have been identified through the assessment method promoted in this report. It is pragmatic way of making use of a company's limited resources to focus on the common problems in the requirements process.

The R-CMM assessment is a structured and systematic exploration of an organisation's ability to control the requirements process. The deliverables from each assessment reveal relative strengths and weaknesses of the requirements process. The assessment monitors the status of the requirements process as each result informally relates to a level of process capability. The R-CMM incorporates a measurement scheme that can be used over time to assess changes and improvement in the requirements process. This is due to its generic structure and the involvement of stakeholders who directly or indirectly influence the processes being measured. The assessment is used to help software producers improve their requirements processes in line with their business aims.

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Appendix A: An example of a requirements process assessment

This example shows how the R-CMM measures the capability of the elicitation phase of requirements. The elicitation phase is just one of the 5 phases represented in the R-CMM. The processes listed in Table 2 define the requirements elicitation phase:

The R-CMM Level 2 Requirements Elicitation Phase	
Process Ref.	Process Description
P6	Establish process to **identify skills needs** within *elicitation phase* of the project, e.g. UML, Formal methods
P8	Explore **alternative solutions** , requirements techniques and tools for *the elicitation phase* of project
P10	Establish and maintain process to **involve key stakeholders** in requirements *elicitation phase* of project
P11	**Set realistic goals** to address business requirements and requirements process improvements needs within project
P12	Establish and implement process to **assess feasibility & external environment** of project
P13	Establish and maintain repeatable requirement **traceability process** that is specific to the project
P19	**Agree and document** technical and organisational attributes specific to the *elicitation process* in the project

Table 2: Level 2 R-CMM Elicitation processes

1. Measuring individual processes

The first stage involved in measuring the capability of the requirements process assesses the strength of an individual process. Process P19 in Table 2 is used as an example. This method can be used to assess the strength of any defined process within the R-CMM. Three elements of the process are measured: the approach, the deployment and the application.

Step One. A clear understanding of the process is confirmed

A detailed definition is included with each question. The participant only continues with the assessment if the definition is clearly understood. An example of a process summary is given in Figure 3.

PROCESS 19 "Agree and document technical and organisational attributes specific to the elicitation process of the project".

The requirements elicitation document should show clear links to resources, must be traceable, and must be cohesive.

This document your company produces on how system requirements are discovered should explain how you:

- Consult with stakeholders
- Study existing system documents
- Record requirements rationale
- Gather domain knowledge and document domain constraints
- Define the systems operational environment
- Assess system feasibility
- Agree requirements with stakeholders
- Record any organisational and political considerations and requirements sources
- Use business concerns to guide requirements
- Undertake market studies
- Document technical, cognitive, social and organizational processes that suit your project's particular elicitation needs and characteristics. I.e. explain what techniques and tools are used (e.g. prototype poorly understood requirements, scenarios to elicit requirements, reuse requirements). Include a summary of the requirements; make a business case for the system; define specialised terms; lay out the document for readability; make document easy to change.

A software life cycle with predefined stages of manageable size is identified or defined. One method should be used project wide, e.g. waterfall, spiral, rapid and joint application development, eXtreme Programming (Paulk et al, 1995). A requirements process should also have pre-defined stages.

Figure 3: Process summary for P19

Prior to participating in the questionnaire assessment, participants are told "Please note: you do not have to personally be involved in performing the process – it's enough that you know who performs it to answer the following" (SEI 1996).

Step Two: The Approach to P19 is assessed

The first of the 3 measurement elements is based on the participant's understanding of the company's approach to the process. This encompasses the SW CMM characteristics of demonstrating a commitment to perform and ability to perform the process. Table 3 gives an example of how a participant might respond to the following approach related statements:

APPROACH		Score
Management Approach	*(Tick one of the options)*	
No management recognition of need		*Poor (0)*
Management has begun to recognise the need		*Weak (2)*
Wide but not complete commitment by management		*Fair (4)*
Some management commitment/some are proactive	✓	*Marginally qualified (6)*
Total management commitment; majority are proactive		*Qualified (8)*
Management provides zealous leadership & commitment		*Outstanding (10)*
Management interest not known		*N/a*
Management interest not believed relevant		*N/a*
Organisational Approach	*(Tick one of the options)*	
No organisational ability/ No organisational commitment		*Poor (0)*
The practice is implemented in one or two projects		*Weak (2)*
Road map for practice implementation defined	✓	*Fair (4)*
Practice implementation under way in parts of the organisation		*Marginally qualified (6)*
Practice established as an integral part of the requirements phase		*Qualified (8)*
Organisational excellence in practice recognised even outside org		*Outstanding (10)*
Organisational approach not known		*N/a*
Organisational approach not believed relevant		*N/a*
Support for Practice	*(Tick one of the options)*	
Practice not evident		*Poor (0)*
Support items for the practice start to be created		*Weak (2)*
Several supporting items for the practice in place		*Fair (4)*
Supporting items in place	✓	*Marginally qualified (6)*
Supporting items encourage and facilitate use of practice		*Qualified (8)*
All support items in place continue to be improved		*Outstanding (10)*
Support for practice not known		*N/a*
Support for practice not believed relevant		*N/a*

Table 3: Generic matrix measuring an organisation's approach to a process

Approach score for process 19: The process *"Agree and document technical and organisational attributes specific to the elicitation phase of the project"* is marginally qualified, i.e. (6 + 4 + 6 / 3 = 5.33)

Step Three: The Deployment of Process 19

This section assesses how a process is deployed in practice. The statements in Table 4 incorporate SW CMM characteristics where each process is analysed, measured and verified. Table 4 shows how a participant might respond to the following statements that relate to how the process is deployed.

DEPLOYMENT		Score
Use of practice	*(Tick one of the options)*	
No part of the organisation uses the practice		*Poor (0)*
Fragmented or inconsistent use in one or two projects		*Weak (2)*
Less fragmented use; consistency in some projects		*Fair (4)*
Consistent use across most projects	✓	*Marginally qualified (6)*
Deployed in almost all parts of the organisation		*Qualified (8)*
Pervasive/ consistent deployment across all parts of org		*Outstanding (10)*
Use of practice not known		*N/a*
Use of practice not thought relevant		*N/a*
Monitoring of Practice	*(Tick one of the options)*	
No part of the organisation monitors use of practice		*Poor (0)*
Very limited monitoring of use		*Weak (2)*
Monitoring of practice use in some projects		*Fair (4)*
Monitoring of practice use in many projects		*Marginally qualified (6)*
Monitoring of practice use for almost all projects	✓	*Qualified (8)*
Monitoring of practice is continuous across all projects		*Outstanding (10)*
Monitoring of practice not known		*N/a*
Monitoring of practice not thought relevant		*N/a*
Verification of practice	*(Tick one of the options)*	
No part of the organisation verifies use of practice		*Poor (0)*
Very limited verification of deployment		*Weak (2)*
Verification of practice deployment in some projects		*Fair (4)*
Verification of practice deployment in many projects		*Marginally qualified (6)*
Verification of practice deployment in almost all projects	✓	*Qualified (8)*
Verification of practice is continuous across all projects		*Outstanding (10)*
Verification of practice not known		*N/a*
Verification of practice not thought relevant		*N/a*

Table 4: Generic Matrix measuring process deployment

Deployment score for process 19: The responses in this section show that the process *"Agree and document technical and organisational attributes specific to the elicitation phase of the project"* is deployed in a qualified way, i.e. (6 + 8 + 8 / 3 = 7.3).

Step Four: Measuring the application of Process 19

This final dimension measures whether the process goals are appropriate and looks at the effectiveness of the activities performed. These measurements are also characteristics of the SW-CMM.

The statements in Table 5 show how processes are measured to give proof of their value and how they are used throughout the organisation.

RESULTS		Score
Effectiveness of Practice	*(Tick one of the options)*	
Ineffective		*Poor (0)*
Some evidence of effectiveness in a few projects		*Weak (2)*
Useful for some projects but not for all		*Fair (4)*
Positive, measurable results over time across many projects	✓	*Marginally qualified (6)*
Positive, measurable results over time across almost all projects		*Qualified (8)*
Requirements exceeded; counsel sought by others		*Outstanding (10)*
Use of practice not known		*N/a*
Rating this practice is not thought relevant		*N/a*
Consistency of Results	*(Tick one of the options)*	
Totally random; inconclusive; not measured		*Poor (0)*
Inconsistent results		*Weak (2)*
Consistent and positive results for some projects		*Fair (4)*
Consistently positive results over time across many projects		*Marginally qualified (6)*
Consistently positive results over time across almost all projects	✓	*Qualified (8)*
Requirements exceeded		*Outstanding (10)*
Consistency of results not known		*N/a*
Consistency of results not relevant		*N/a*
Sharing of Results/Best Practice	*(Tick one of the options)*	
No practices shared within project,		*Poor (0)*
Some practices shared within project		*Weak (2)*
Most practices shared/applied within project		*Fair (4)*
Practices repeated in many similar projects	✓	*Marginally qualified (6)*
Practices shared throughout all projects		*Qualified (8)*
New practices introduced to support world class results		*Outstanding (10)*
Sharing of this best practice not known		*N/a*
Sharing of this best practice not thought relevant		*N/a*

Table 5: Generic Matrix to establish the strength of process application

Results score for process 19: The responses to this assessment indicate that the results of process *"Agree and document technical and organisational attributes specific to the elicitation phase of the project"* is marginally qualified, i.e. ((6 +8 + 6)/3 = 6.6).

Step Five: Combining Process scores to assess the strength of each requirements phase

All three evaluation dimensions and their scoring guidelines are examined simultaneously and all dimensions are equally weighted. Averaging the score of process assessment indicates a level of capability. For example P19 is 'marginally qualified' having received an average score of 6 for its approach, deployment and application, i.e. (5 + 7 + 6 = 18 / 3 = 6).

When all the processes in the requirements phase have been assessed, then a capability for each phase can be obtained. Figure 4 gives an example of a Requirements Phase Assessment sheet. It shows how each measured process is combined to give a score that relates to – in this case – the capability of the elicitation phase of requirements. All the 5 requirements phases are assessed in a similar way.

This assessment gives the following results:

- A score for each process
- A score for each requirements phase
- A score for the requirements process

The validation of the R-CMM highlighted that giving each of the above dimensions the same weighting may not suit some companies. For example, the 'application' section may be considered

more important than the 'approach', i.e. if the process proves to be very useful and is being used successfully, management support may not be so important. In this case, a company may decide to place a weighting on the application dimension.

Section 5 has shown how a process is defined and assessed to establish its strength within the requirements process. In Section 6 we show how this assessment method relates to the SW-CMM.

Organisation: ORG_NAME

CMM Level 2 Processes Date:
KRPA: Requirements Elicitation Phase Average Score: 5
(3+ 4 + 5 + 4 + 6 + 7 + 6 = 35 / No of processes (7) = 5)

	List of key processes	1	2	3	4	5	6	7	8	9	10
P6	Establish process to **identify skills needs** within *elicitation phase* of the project, e.g. UML, Formal methods			✓							
P8	Explore **alternative solutions**, requirements techniques and tools for *the elicitation phase* of project				✓						
P10	Establish and maintain process to **involve key stakeholders** in requirements *elicitation phase* of project					✓					
P11	**Set realistic goals** to address business requirements and requirements process improvements needs within the project				✓						
P12	Establish and Implement process to **assess feasibility & external environment** of project						✓				
P13	Establish and maintain repeatable requirement **traceability process** that is specific to the project							✓			
P19	**Agree and document the technical and organisational attributes** specific to the *elicitation process* in the project						✓				

Figure 4: Requirements Phase Assessment sheet.